ADDENDUM #1

CONTRA COSTA COMMUNITY COLLEGE DISTRICT

L-1201 SCIENCE BUILDING BAS UPGRADE

Los Medanos College
2700 E Leland Rd, Pittsburg, CA 94565

Date: April 18, 2022

NOTICE TO ALL CONTRACTORS

You are hereby notified of the following changes, clarifications and/or modifications to the original Contract Documents, Project Manual, Drawings, Specifications and/or previous Addenda. This Addendum shall supersede the original Contract Documents and previous Addenda wherein it contradicts the same, and shall take precedence over anything to the contrary therein. All other conditions remain unchanged.

This Addendum forms a part of the Contract Documents and modifies the original Contract Documents dated ***March 31, 2022.*** Acknowledge receipt of this Addendum in space provided on the Bid Proposal Form. Failure to acknowledge may subject Bidder to disqualification.

A. DELETIONS, ADDITIONS, CHANGES, REVISIONS

Item:

1. **REPLACE**: **Specification Section 250000 BUILDING AUTOMATION SYSTEMS.**
   DELETE existing Section 250000 BUILDING AUTOMATION SYSTEMS, in its entirety, and **REPLACE WITH** new Specification Section 250000 BUILDING AUTOMATION SYSTEMS (dated 04-12) – ADDENDUM #1, (attached), in its entirety. Note: There are changes throughout including additional bid alternate.

2. **REPLACE: Specification Section 00300 – BID PROPOSAL FORM**
   DELETE existing Section 00300 – BID PROPOSAL FORM, in its entirety, and **REPLACE WITH** new Section 00300 – BID PROPOSAL FORM – ADDENDUM #1 (attached), in its entirety. Note: The Bid Proposal Form was updated to include additional bid alternate noted above. There were adjustments made to note that there are also deductive alternates. Section in introduction that referenced Statement of Qualifications from bidders was also removed due to not being required.

3. **Add:** LMC Science Building Summer Class Schedule (attached).
   The Summer Class Schedule shows the rooms that will be unavailable for work during summer session and must remain climatized for the duration. The schedule shows only 1 week however this same schedule applies to the entire summer session from Notice to Proceed until July 22, 2022.

4. **Requests of Information/Responses**
   Q.1 What is the Contact Information for the Air Valve Vendor and the AFMS Vendor?
   A.1
   Air Valves Contact: Al Alexy alalexy@att.net.
   AFMS Vendor Contact: Dan Schuster dan@baysidehvac.com

5. **Add:** Meeting Minutes from Mandatory Pre-Bid Meeting, dated April 14, 2022.

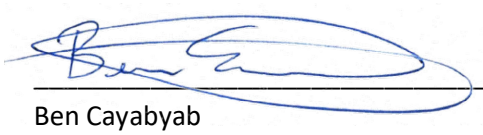
6. **Revise: Laboratory Air Valves will now be an Owner-furnished item.**
   Note: Due to current lead times, the Laboratory Air Valves (AccuValves) as detailed in Specification Section 250000 subsection 2.10 Laboratory Air Valves, will be purchased ahead of time by the District. Contractor to reference the Applied Equipment LLC Quote dated April 18, 2022. The Contractor will still be responsible for receiving, installation, warranty, and all other work associated with the air valves. The purpose is solely to expedite the laboratory air valve procurement process and the District will not take on any other responsibility for the equipment. Executed purchase order to be provided at a later date.

7. **Add: Approved AccuValve submittal from Applied Equipment LLC.**
   Note: For reference purposes and to be include in final close out documents, attached is the approved AccuValve submittal package.

B. If you have any questions regarding this Addendum, please contact:

Mr. Ben Cayabyab, Contracts Manager
Contra Costa Community College District
500 Court St., Martinez, CA 94553
Email: **bcayabyab@4cd.edu**
Facsimile: **925-370-7512;**

All other terms and conditions of BID are to remain the same.



Ben Cayabyab
Contracts Manager

ADDENDUM #1

ATTACHMENTS

NEW SPECIFICATION SECTION 250000 - BUILDING AUTOMATION SYSTEMS
NEW SPECIFCATION SECTION 00300 – BID PROPOSAL FORM
Meeting Minutes from Mandatory Pre-Bid Meeting
LMC Science Building Class Schedule
AccuValve Submittal
Applied Equipment LLC Quote dated 4/18/2022.

SECTION 250000

BUILDING AUTOMATION SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. This project consists of replacing the existing Andover direct digital control (DDC) systems and Triatek air valves at Los Medanos Science College (LMC) Building with a new ALC Building Automation System (BAS) and AccuValve air valves.

B. The purpose of the replacement is to replace obsolete control equipment and upgrade to state-of-the-art systems that meet current Contra Costa Community College District (4CD) standards, including optimized control sequences based on ASHRAE Guideline 36.

C. Work Excluded

1. Cost of repairing existing equipment that is specified to be reused, if required.

2. Fire Alarm Systems (FAS). The existing FAS in the building is separate from the existing BAS and shall remain independent with existing interlocks to remain as-is.

3. Integration with existing lighting controls.

~~3.~~4. ACI/AC)-1, 2, 3, and 4 base bid only.

1.2 CONTRACTOR PROPOSALS

A. Contractor shall visit site prior to bid. Ascertain and check all conditions and take all measurements that may affect the work. No allowance shall subsequently be made for any additional expenses or claims due to the failure or neglect under this Section to make such examination, including examination of restricted working conditions or such other difficulties that can be visually observed during site visit.

B. The system requirements described in this specification are generally performance based. Where requirements are prescriptive, the intent is to provide minimum quality, not to give unfair advantage to any given manufacturer or product. If a contractor finds that a certain requirement is unduly difficult or expensive to meet, contact the Engineer prior to bid due date and an addendum modifying the requirement will be considered.

C. Original design drawings provided as part of the bid package do not represent as-built conditions. All conditions should be field verified.

D. Where requirements are unclear, the contractor shall clarify the requirements with the Engineer before the bid due date. Where requirements continue to be unclear, the contractor's proposal must accurately describe what is included and excluded.

E. By submitting a proposal, contractor guarantees that their proposal is in full compliance with these specifications and is complete and turnkey, except where specific exceptions are provided herein or clearly noted in the contractor's proposal.

F. Include any charges, including overtime wages, required to perform work within scheduling criteria and use-of-premises restrictions specified in Paragraph 1.4.

G. Bid proposals shall include:

1. Completed bid form, including breakout pricing. Breakout pricing shall include overhead, profit, installation, programming, commissioning, etc.; it may be approximate and is for info only.

2. Proposed construction schedule. The proposed date of completion will be a factor in contractor selection. Include details that indicate the use-of-premises restrictions specified in Paragraph 1.4 have been taken into account.

3. Any clarifications and exceptions to these specifications.
   a. Do not exclude work that is required – this is a turn-key project with no other prime Contractors involved. BAS Contractor shall serve as the prime Contractor and hire subcontractors as required.

H. Alternate Pricing. Alternate prices shall include all equipment, material, labor, design engineering, balancing, start-up and testing costs necessary to provide a complete operational system. Provide a separate price for each alternate.

1. ARCnet for Primary LAN. The base bid shall be based on ALC's IP controllers for ASCs and AACs, including VAV zones. For this alternate assume ARCnet and ZN line and ME/SE line controllers may be used with new twisted pair network cabling. If contractor does not wish to use ARCnet, this alternate need not be priced.

2. Onsite Virtual Server. The base bid shall be based on using the existing ALC server located on the Brentwood campus to serve as the CSS for this project. For this alternate, include all required server software configured on a virtual server (provided by LMC) located in the main MDF on the LMC campus, configured in a hierarchical arrangement serving as the "parent" with the existing Brentwood server serving as the "child". Alarms shall be configured to propagate between systems.
   a. Fully comply with ALC procedures, e.g.

      To set up the parent system
      (/alc/s/knowledge/article/SiteBuilderv65FindInfo-8203)

      To set up a child system
      (/alc/s/knowledge/article/SiteBuilderv65FindInfo-39148)

      To finish setting up your hierarchical system
      (/alc/s/knowledge/article/SiteBuilderv65FindInfo-25089)

3. VFD Integration. The base bid does not include integration of VFDs to the ALC system, as they are not integrated to the existing Andover system. For this alternate, provide BACnet MS/TP network to VFD interfaces (assumed to exist or provided by others), map points via BACnet, and provide graphics of VFD data and hyperlinks on associated graphics as specified herein. VFDs include:
   a. Cooling tower fan
   b. CHW pump
   c. AH-2 and 3 fans
   d. AC-1 fans
   e. EF-1 and 2 fans

4. Reuse VAV and Lab Zone Reheat Coil Valves. The base bid includes at least new analog actuators on zone HW valves (valve bodies may be reused or replaced at contractor's option). For this alternate, reuse the existing valves and actuators.

5. Add DCW multi-jet or compound flow meters. The base bid does not include domestic water meters. For this alternate, provide FM-6 multi-jet or compound flow meters with pulse output at:
   a. 4" main in Plumbing Equipment Room 123
   b. 1.5" main to Chiller Room

6. Add DCW magnetic flow meters. The base bid does not include domestic water meters. For this alternate, provide FM-1 full bore or FM-2 insertion magnetic flow meters with pulse output at:
   a. 4" main in Plumbing Equipment Room 123
   b. 1.5" main to Chiller Room

7. Add natural gas meter. The base bid does not include natural gas meter. For this alternate, provide a FM-3B meter with pulse output locate in the Plumbing Equipment Room 123 mounted in the existing 2 inch low pressure gas line.

8. No CAD files. The base bid assumes that architectural drawings will be available in CAD format for use in graphics. For this alternate, assume that the only drawings available are the pdf files included in the Bid Package.

9. VAV box calibration unit price (cost per VAV box). The base bid does not include calibrating VAV reheat boxes; the ALC default coefficients will be used based on box inlet size. For this alternate, the Contractor shall inspect VAV box inlet conditions during controller installation and tag those that do not have at least 1½ times the inlet duct diameter of straight duct at the VAV box inlet. (A concentric reducing taper with maximum 15° angle shall qualify as straight duct.) For those zones that do not meet this criterion, adjust BAS calibration constants so that the VAV box controller and measured air flow rate at air outlets matches the ALC reading within range listed at all of the following conditions:
   a. Maximum airflow setpoint, ±5%
   b. Controllable minimum airflow setpoint, ±10%. The controllable minimum value shall be that determined under Section 259000.
   c. Zero flow

10. ACI/ACO-1, 2, 3, 4. These split units have programmable thermostats and not currently controlled by the DDC system, and remain so for the base bid. For this alternate, replace thermostat with an ALC OptiPoint BACnet Plus thermostat integrated to the ALC network via MS/TP. Alarms same as ACS/CU1, 2 sequences except no supply air temperature sensor not required.

1.3 INTEGRATION WITH EXISTING SYSTEM

A. This section applies to the base bid option of using the existing Brentwood server.

B. Include all services required to integrate this building into existing BAS for a fully operational system.

C. Procedure

1. Obtain a copy of the campus database with access privileges.

2. BACnet devices
   a. Create new building database following the BACnet device instance numbering scheme specified under Paragraph 3.12B.4.
   b. Double check existing database to ensure there are no duplicate BACnet device instance numbers. This includes 3rd party equipment such as VFDs.

3. Graphics
   a. Upgrade all graphics to the latest 4CD standard graphics file template, including using the same file template name. See sample graphics herein. Also refer to the graphics used for the CCC Science Building.
   b. For new or modified graphics custom to the new building, ensure file template name do not duplicate any existing file names.

4. Programming
   a. For standard sequences covered by ASHRAE Guideline 36, use the programming provided by Automated Logic, first ensuring they have been updated by the manufacturer to reflect the latest issue and all addenda published when programming work is initiated.
   b. For other typical applications, first review those used for similar applications in other campus buildings to use as a starting point, then edit to reflect sequences specified herein. The intent is to have standard programming throughout the campus to the extent possible.
   c. Double check existing database to ensure program file names do not duplicate any existing file names.

5. If a BACnet/IP Broadcast Management Device (BBMD) router is required, check the existing Broadcast Distribution Tables (BDT) to ensure that a BBMD router is not already assigned to the relevant network before adding a new one.

6. Install building database and control programming on a temporary portable operator's terminal provided by the Contractor. The POT shall be used for start-up, testing, and commissioning. The POT shall remain the property of the Contractor after final completion of the project.

7. Once the building BAS has been fully commissioned and accepted by the College:
   a. Create a new backup of the existing campus database.
   b. Merge the new building database with the existing campus database.
   c. Confirm that no communication issues (in the building and across the campus) have resulted from the merge.
   d. Make another backup of the merged database.
   e. Load the merged database onto the campus Control System Server.
   f. Integrate graphic screens into the Central Plant graphics including adding appropriate hyperlinks so that the system operates as one integrated system.
   g. Confirm that the merge was successful by sample testing points and sequences
   h. Receive College approve of the final installation in writing.

8. Provide high level password for College operator access to the system only at this point; College will not have access to the system prior to system acceptance and integration.

1.4 USE OF PREMISES

A. BAS Contractor shall become fully informed of, and shall fully comply with, College's site security requirements and provisions.

B. BAS Contractor shall limit the storage of materials and equipment on-site to specific areas approved by the College. The College may also limit the type of material stored. At no time during the work under the contract shall the BAS Contractor place, or cause to be placed, any material or equipment at any location that would impede or impair access to or from the present facilities.

C. BAS Contractor shall send proper notices, make all necessary arrangements, and perform all services required in the care and maintenance of building utilities to the extent that these utilities may be affected and/or interrupted by the BAS installation work. Building utilities include telephone / telecommunications, electrical service, natural gas, central heating and cooling, water, and other utilities necessary for building operation and occupant comfort.

D. All work that has the potential for interrupting building usage, utilities, and/or maintenance services shall be scheduled to occur during evenings and/or weekends and coordinated with the College. This includes cutting and drilling work from which dissipated noise and vibration may impact the normal work of building occupants.

E. Work Schedule. The building will remain operational during construction, but some areas may be shut down as indicated in this Paragraph and the preliminary schedule provided with the Bid Package. Changes to systems that affect building operations must be minimal in impact and time out-of-service. The functions of the existing BAS must be migrated in a manner that keeps all systems operational throughout the duration of this work. All down-times must be scheduled at least a week in advance with approval of the College project manager.

   1. The building will be unoccupied from July 22-August 19, 2022. All work during this period may be during normal working hours. Outside this period, the

Contractor will need to work with the College to find times when individual rooms are unoccupied during normal hours, or the work must be executed during off-hours.

2. Air distribution systems serving classroom, offices, public spaces etc. shall be operational during normal business hours, except:
   a. Zonal systems may be shut off when rooms are scheduled to be unoccupied, even during normal business hours. Coordinate when rooms are scheduled to be unoccupied with the College project manager.
   b. AHUs may be shut off for occasional periods not exceeding 15 minutes and shall be operational for at least 45 minutes between outages.

3. Air distribution systems serving lab spaces with hoods shall be operational 24/7 except during scheduled unoccupied hours, when scheduled in advance with the College project manager, with following procedures:
   a. Doors to labs shall be opened (for makeup air).
   b. Hood sashes shall be closed.
   c. Hood exhaust may be shut off for no more than 30 minutes with at least 60 minutes between outages.
   d. Lab general exhaust shall be overridden closed.
   e. Lab exhaust fans shall continue to operate automatically. When lab exhaust fan controls are replaced, keep at least one fan operating continuously.

4. Chilled water plant shall be operational during normal business hours, except it may be shut off for occasional periods not exceeding 15 minutes and shall be operational for at least 45 minutes between outages. It may be shut off at any time when outdoor air temperature is less than 60ºF.

1.5 REUSE OF EXISTING SYSTEMS AND EQUIPMENT

A. Unless otherwise directed, the Controls Contractor is not responsible for the repairs or replacement of existing energy equipment and systems, valves, dampers, or actuators that are designated to be reused. Should the Contractor find existing equipment that requires maintenance, the College shall be notified immediately.

B. Note that phasing may be required to meet use-of-premises restrictions specified in Paragraph 1.4, which in turn may affect the ability to reuse equipment, such as control panels, control wiring etc.

C. Wiring and Raceway

1. All existing control conduit may be reused.

2. All Supervisory and Primary LAN wiring shall be new. Secondary LAN wiring may be reused at contractor's option.

3. Control wiring to controlled devices (e.g. actuators, VFDs), sensors (e.g. temperature) etc. may be reused:

4. Where wiring is reused, its integrity and suitability to the new application is the responsibility of the Contractor. Wiring shall be properly identified and tested. The cost to replace/repair defective wiring is outside the scope of this proposal.

5. Unused or redundant wiring and conduit shall be removed.

D. Temperature Sensors

1. Existing temperature sensors shall be replaced, except as specifically indicated in the Control Points section or this section.

2. Existing wells in piping for temperature sensors may be reused.

E. Other Sensors

1. Reuse existing sensors unless specifically called out to be new in Control Points lists.

F. Temperature Control Panels

1. The Contractor may reuse any existing local control panels to locate new equipment.

2. Controllers and other analog devices shall not be reused unless specifically called out to be new in Control Points lists.
   a. Salvage all Andover controllers in TCPs and return to College so that they might be reused on other existing buildings.

3. Power supplies, transformers, UPS, disconnect switches, and relays may be reused.

4. All unused existing equipment within these panels must be removed and shall not be reused.

5. All no longer used panels shall be demolished.

G. Starters and Variable Speed Drives

1. Reuse existing; repair of same is not part of this project.

2. Connect BACnet MS/TP to existing VFDs as an Alternate Bid only; see Paragraph 1.2H.3.)

H. Air Handling Units

1. AHU dampers may be reused.

2. All damper actuators shall be replaced.

3. Existing control valve bodies may be reused.

4. All valve actuators shall be replaced.

5. Airflow measuring stations shall be added or replaced.

I. VAV Zones

1. Demo the following:
   a. Damper actuator and controller
   b. Thermostat and associated wiring
   c. Discharge air temperature sensor
   d. HW Valve actuator

2. The following may be reused:
   a. VAV boxes and velocity pressure flow cross/ring
   b. Transformers and power wiring
   c. Control wiring where applicable and not shown to be demoed
   d. Reheat coils and HW valve bodies

3. The following shall be new:
   a. VAV controllers with integral actuators
   b. Wall thermostats in existing location with new cable to zone controller
   c. HW valve actuators

J. Lab Zones

1. Demo the following:
   a. Air valves (supply, hood exhaust, general exhaust) and controllers
   b. HMS Hood monitors and associated wiring
   c. Hood sidewall sensors and associated wiring
   d. Hood sash position sensors and associated wiring
   e. Thermostat and associated wiring
   f. Discharge air temperature sensor
   g. HW Valve actuator

2. The following may be reused:
   a. Hood ZPS presence sensors
   b. Transformers and power wiring
   c. Control wiring where applicable and not shown to be demoed
   d. Reheat coils and HW valve bodies

3. The following shall be new:
   a. AccuValve air valves with integral actuator and controller
   b. Hood monitors and associated wiring
   c. Hood sash position sensors and associated wiring
   d. Wall thermostats in existing location with new cable to zone controller
   e. HW valve actuators

K. Safeties and Fire Alarm Controls

1. The fire alarm system (FAS) is an independent system and not a part of this project.

2. Existing safeties in control circuits (duct smoke detectors, life safety system interlocks) are not to be bypassed and are to remain functional at all times during and after construction.

L. Instrumentation. Existing pressure gauges and thermometers on pumps, boilers, etc. are to remain as-is; repair or calibration of same are not part of this project.

1.6 REFERENCE STANDARDS

A. Nothing in Contract Documents shall be construed to permit Work not conforming to applicable laws, ordinances, rules, and regulations. When Contract Documents differ from requirements of applicable laws, ordinances, rules and regulations, comply with documents establishing the more stringent requirement.

B. The latest published or effective editions, including approved addenda or amendments, of the following codes and standard shall apply to the BAS design and installation as applicable.

C. State, Local, and City Codes

1. CBC − California Building Code

2. CMC − California Mechanical Code

3. CEC – California Electrical Code

4. Local City and County Codes

D. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)

1. ANSI/ASHRAE 135 – BACnet - A Data Communication Protocol for Building Automation and Control Networks

2. ANSI/ASHRAE Standard 135.1− Method of Test for Conformance to BACnet

3. ANSI/ASHRAE Standard 15 – Safety Standard for Refrigeration Systems

E. Electronics Industries Alliance

1. EIA-232 – Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange.

2. EIA-458 – Standard Optical Fiber Material Classes and Preferred Sizes.

3. EIA-485 – Standard for Electrical Characteristics of Generator and Receivers for use in Balanced Digital Multipoint Systems.

4. EIA-472 – General and Sectional Specifications for Fiber Optic Cable.

5. EIA-475 – Generic and Sectional Specifications for Fiber Optic Connectors and all Sectional Specifications.

6. EIA-573 – Generic and Sectional Specifications for Field Portable Polishing Device for Preparation Optical Fiber and all Sectional Specifications.

7. EIA-590 – Standard for Physical Location and Protection of Below-Ground Fiber Optic Cable Plant and all Sectional Specifications.

F. Underwriters Laboratories

1. UL 916 – Energy Management Systems.

G. National Electrical Manufacturers Association

1. NEMA 250 – Enclosure for Electrical Equipment.

H. Institute of Electrical and Electronics Engineers (IEEE)

1. IEEE 142 – Recommended Practice for Grounding of Industrial and Commercial Power Systems.

2. IEEE 802.3 – CSMA/CD (Ethernet – Based) LAN.

3. IEEE 802.4 – Token Bus Working Group (ARCnet – Based) LAN.

1.7 DEFINITIONS

A. Acronyms

AAC	Advanced Application Controller
AH	Air Handler
AHU	Air Handling Unit
AI	Analog Input
ANSI	American National Standards Institute
AO	Analog Output
ASC	Application Specific Controllers
ASCII	American Standard Code for Information Interchange
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
A-to-D	Analog-to-Digital
BACnet	Data Communications Protocol for Building Automation and Control Systems
BC	Building Controller
BIBB	BACnet Interoperability Building Blocks
BTL	BACnet Testing Laboratory
CAD	Computer Aided Drafting
CHW	Chilled Water
CHWR	Chilled Water Return
CHWS	Chilled Water Supply
COV	Change of Value
CSS	Control Systems Server

CU	Controller or Control Unit
CV	Constant Volume
CW	Condenser Water
CWR	Condenser Water Return
CWS	Condenser Water Supply
DBMS	Database Management System
DDC	Direct Digital Control
DHW	Domestic Hot Water
DI	Digital Input
DO	Digital Output
D-to-A	Digital-to-Analog
BAS	Building Automation System
EMT	Electrical Metallic Tubing
EP	Electro-Pneumatic
ETL	Edison Testing Laboratories
GUI	Graphical User Interface
HHD	Hand Held Device
HOA	Hand-Off-Automatic
HVAC	Heating, Ventilating and Air-Conditioning
HTTP	Hyper-Text Transfer Protocol
I/O	Input/output
IEEE	Institute of Electrical and Electronics Engineers
ISO	International Organization for Standardization
LAN	Local Area Network
LANID	LAN Interface Device
MAC	Medium Access Control
MHz	Megahertz
MS/TP	Master-Slave/Token-Passing
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NIST	National Institute of Standards and Technology
ODBC	Open Database Connectivity
OI	Operator Interface
OWS	Operator Workstation
P	Proportional
PC	Personal Computer
PI	Proportional-Integral
PICS	Protocol Implementation Conformance Statement
PID	Proportional-Integral-Derivative
POT	Portable Operators Terminal
PTP	Point-to-Point
RAM	Random Access Memory
SOO	Sequence of Operation
SQL	Standardized Query Language
SSL	Secure Socket Layers
TAB	Test, Adjust, and Balance
TDR	Time Delay Relay

UFT	Underfloor Fan Terminal Box
UL	Underwriters' Laboratories, Inc.
XML	Extensible Markup Language

B. Terms

Term	Definition
Accessible	Locations that can be reached with no more than a ladder to assist access and without having to remove permanent partitions or materials. Examples include inside mechanical rooms, mechanical equipment enclosures, instrument panels, and above suspended ceilings with removable tiles.
BACnet Interoperability Building Blocks	A BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBs are combined to build the BACnet functional requirements for a device in a specification.
BACnet/BACnet Standard	BACnet communication requirements as defined by the latest version of ASHRAE/ANSI 135 and approved addenda.
Change of Value	An event that occurs when a digital point changes value or an analog value changes by a predefined amount.
Client	A device that is the requestor of services from a server. A client device makes requests of and receives responses from a server device.
Concealed	Embedded in masonry or other construction, installed in furred spaces, within double partitions, above hung ceilings, in trenches, in crawl spaces, or in enclosures.
Continuous Monitoring	A sampling and recording of a variable based on time or change of state (such as trending an analog value, monitoring a binary change of state).
Contract Documents	Specifications, drawings, and other materials provided with request for bids.
Control Systems Server	A computer(s) that maintain(s) the systems configuration and programming database.
Controller	Intelligent stand-alone control device. Controller is a generic reference to BCs, AACs, and ASCs.
Direct Digital Control	Microprocessor-based control including Analog/Digital conversion and program logic.
Building Automation System	The entire integrated building management and control system.
Equal	Approximately equal in material types, weight, size, design, quality, and efficiency of specified product.
Exposed	Not installed underground or concealed.

Term	Definition
Furnish	To purchase, procure, acquire and deliver complete with related accessories.
Gateway	Bi-directional protocol translator connecting control systems that use different communication protocols.
Hand Held Device	Manufacturer's microprocessor based portable device for direct connection to a field Controller.
Inaccessible	Locations that do not meet the definition of accessible. Examples include inside furred walls, pipe chases and shafts, or above ceilings without removable tiles.
Indicated, shown or noted	As indicated, shown or noted on drawings or specifications.
Install	To erect, mount and connect complete with related accessories.
Instrumentation	Gauges, thermometers and other devices mounted in ductwork or piping that are not a part of the BAS.
College IT LAN	The Information Technology local area network furnished by the College, used for normal business-related communication and may be used for interconnecting some BAS controllers and gateways where specified.
LAN Interface Device	Device or function used to facilitate communication and sharing of data throughout the BAS.
Local Area Network	Computer or control system communications network limited to local building or campus.
Master-Slave/Token Passing	Data link protocol as defined by the BACnet standard.
Motor Controllers	Starters, variable speed drives, and other devices controlling the operation of motors.
Native BACnet Device	A device that uses BACnet for communication. A device may also provide gateway functionality and still be described as a Native BACnet device.
Native BACnet System	A network composed only of Native BACnet Devices without gateways.
Open Database Connectivity	An open standard application-programming interface for accessing a database developed. ODBC compliant systems make it possible to access any data from any application, regardless of which database management system is handling the data.
Open Connectivity	OPC is an interoperability standard developed for industrial applications. OPC compliant systems make it possible to access or exchange data from any application, regardless of which database management system is handling the data.

Term	Definition
Operator Interface	A device used by the operator to manage the BAS including OWSs, POTs, and HHDs.
Operator Workstation	The user's interface with the BAS system. As the BAS network devices are stand-alone, the OWS is not required for communications to occur.
College	The College or their designated representatives.
Piping	Pipe, tube, fittings, flanges, valves, controls, strainers, hangers, supports, unions, traps, drains, insulation and related items.
Points	All physical I/O points, virtual points, and all application program parameters.
Point-to-Point	Serial communication as defined in the BACnet standard.
Portable Operators Terminal	Laptop PC used both for direct connection to a controller and for remote dial up connection.
Primary LAN	High speed, peer-to-peer controller LAN connecting BCs, AACs, and ASCs as well as some gateways. See System Architecture below.
Protocol Implementation Conformance Statement	A written document that identifies the particular options specified by BACnet that are implemented in a device.
Provide	Furnish, supply, install and connect up complete and ready safe and regular operation of particular work referred to unless specifically noted.
Protocol Translator	A device that converts BACnet from one network protocol to another.
Reviewed, approved, or directed	Reviewed, approved, or directed by or to College's Representative.
Router	A device that connects two or more networks at the network layer.
Secondary LAN	LAN connecting some gateways and networked sensors. See System Architecture below.
Server	A device that is a provider of services to a client. A client device makes requests of and receives responses from a server device.
Standardized Query Language	SQL - A standardized means for requesting information from a database.
Supervisory LAN	Ethernet-based LAN connecting Primary LANs with each other and OWSs, CSS, and THS. See System Architecture below.
Supply	Purchase, procure, acquire and deliver complete with related accessories.

Term	Definition
Wiring	Raceway, fittings, wire, boxes and related items.
Work	Labor, materials, equipment, apparatus, controls, accessories and other items required for proper and complete installation.

1.8 QUALITY ASSURANCE

A. Materials and Equipment

1. Manufacturer's Qualifications: See 2.1 for approved manufacturers.

B. Installer

1. The following are approved BAS contractors:
   a. Air Systems. Marina Pelosi Marina.Pelosi@airsystemsinc.com
   b. Sunbelt. Andy Bruch abruch@sunbeltcontrols.com
   c. ASG: Tony Skibinski tskibinski@asgbms.com

2. BAS Contractor's Project Manager Qualifications: Individual shall specialize in and be experienced with direct digital control system installation for not less than 3 years. Project Manager shall have experience with the installation of the proposed direct digital control equipment product line for not less than 2 projects of similar size and complexity. Project Manager must have proof of having successfully completed the most advanced training offered by the manufacturer of the proposed product line.

3. BAS Contractor's Programmer Qualifications: Individual(s) shall specialize in and be experienced with direct digital control system programming for not less than 3 years and with the proposed direct digital control equipment product line for not less than 1.5 years. Programmers must show proof of having successfully completed the most advanced programming training offered by the vendor of the programming application on the proposed product line.

4. BAS Contractor's Lead Installation Technician Qualifications: Individual(s) shall specialize in and be experienced with direct digital control system installation for not less than 3 years and with the proposed direct digital control equipment product line for not less than 1.5 years. Installers must show proof of having successfully completed the installation certification training offered by the vendor of the proposed product line.

5. BAS Contractor's Service Qualifications: The installer must be experienced in control system operation, maintenance and service. BAS Contractor must document a minimum 5-year history of servicing installations of similar size and complexity. Installer must also document at least a 1-year history of servicing the proposed product line.

6. Installer's Response Time and Proximity

a. Installer must maintain a fully capable service facility within 50 miles of the subject Project. Service facility shall manage the emergency service dispatches and maintain the inventory of spare parts.
b. Installer must demonstrate the ability to meet the emergency response times listed in Paragraph 1.14B.1.

7. Electrical installation shall be by manufacturer-trained electricians
   a. Exception: Roughing in wiring and conduit and mounting panels may be subcontracted to any licensed electrician.

1.9 SUBMITTALS

A. No work may begin on any segment of this Project until the related submittals have been reviewed for conformity with the design intent and the Contractor has responded to all comments to the satisfaction of the College's Representative.

B. Submittal Schedule: Submittal schedule shall be as follows unless otherwise directed by the College's Representative:

1. Allow 10 working days for approval, unless College's Representative agrees to accelerated schedule.

2. Submittal Package 0 (Qualifications) shall be submitted with bid.

3. Submittal Package 1 (Hardware and Shop Drawings) shall be submitted in accordance with schedule established by the College in bid documents.

4. Submittal Package 2 (Programming and Graphics) and shall be submitted no less than 30 days before software is to be installed in field devices.

5. Submittal Package 3 (Pre-Functional Test Forms) shall be submitted no less than 30 days prior to conducting tests.

6. Submittal Package 4 (Pre-Functional Test Report) shall be submitted no less than 14 after conducting tests.

7. Submittal Package 5 (Post-Construction Trend Points List) shall be submitted 14 days prior to the start of the trend collection period.

8. Submittal Package 6 (Functional Test Report) shall be submitted no more than 7 days after conducting tests.

9. Submittal Package 7 (Training Materials) shall be submitted no less than 14 days prior to conducting first training class.

10. Submittal Package 8 (Post-Construction Trend Logs) shall be submitted after demonstration tests are accepted and systems are in full automatic operation.

C. Submission and Resubmission Procedure

1. Pre-Submittals. Electronic submittals indicated below shall be submitted unofficially via email directly to the Engineer for review and comment prior to

formal submission. Comments provided by the Engineer are not official and may be changed or additional comments may be provided on the formal submittal. The intent of pre-submittals is to reduce paperwork and review time.

2. Each submittal shall have a unique serial number that includes the associated specification section followed by a number for each sub-part of the submittal for that specification section, such as SUBMITTAL 250000-01.

3. Each resubmittal shall have the original unique serial number plus unique revision number such as SUBMITTAL 250000-01 REVISION 1.

4. Submit one copy of submittal in electronic format specified under each submittal package below. Submissions made in the wrong format will be returned without action.

5. Submittals shall have bookmarks for each subsection (e.g. Materials, Drawings) and for each drawing including drawing number and name.

6. College's Representative will return a memo or mark-up of submittal with comments and corrections noted where required.

7. Make corrections
   a. Revise initial submittal to resolve review comments and corrections.
   b. Clearly identify resubmittal by original submittal number and revision number.
   c. The cover page of resubmittals shall include a summary of prior comments and how they were resolved in the resubmittal.
   d. Indicate any changes that have been made other than those requested.

8. Resubmit revised submittals until no exceptions are taken.
   a. The cost of the Engineer's review of submittals after the second resubmittal will be borne by Contractor at Taylor Engineering standard billing rates.

9. Once submittals are accepted with no exceptions taken, provide
   a. Complete submittal of all accepted drawings and products in a single electronic file.
   b. Photocopies or electronic copies for coordination with other trades, if and as required by the General Contractor or College's Representative.

D. Submittals Packages

1. Submittal Package 0 (Qualifications)
   a. Provide Installer and Key personnel qualifications as specified in Paragraph 1.8B.
   b. Format: Word-searchable format per Paragraph 1.10C.3.

2. Submittal Package 1 (Hardware and Shop Drawings)
   a. Hardware
      1) Organize by specification section and device tags as tagged in these specifications.
      2) Do not submit products that are not used even if included in specifications.

3) Include a summary table of contents listing for every submitted device:
   a) Tab of submittal file/binder where submittal is located
   b) Device tag as tagged in these specifications (such as TS-1A, FM-1)
   c) Specification section number (down to the lowest applicable heading number)
   d) Whether device is per specifications and a listed product or a substitution
   e) Manufacturer
   f) Model number
   g) Device accuracy (where applicable)
   h) Accuracy as installed including wiring and A/D conversion effects (where applicable)
4) Submittal shall include manufacturer's description and technical data, such as performance data and accuracy, product specification sheets, and installation instructions for all control devices and software.
5) When manufacturer's cut-sheets apply to a product series rather than a specific product, the data specifically applicable to the Project shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawings shall clearly reference the specification or drawing that the submittal is to cover. General catalogs shall not be accepted as cut sheets to fulfill submittal requirements.
6) A BACnet Protocol Implementation Conformance Statement (PICS) for each type of controller and operator interface.
7) Format: Word-searchable format per Paragraph 1.10C.3.

b. Shop Drawings
1) System architecture one-line diagram indicating schematic location of all control units, workstations, LAN interface devices, gateways, etc. Indicate address and type for each control unit. Indicate media, protocol, baud rate, and type of each LAN.
2) Schematic flow diagram of each air and water system showing fans, coils, dampers, valves, pumps, heat exchange equipment and control devices. The schematics provided on Drawings shall be the basis of the schematics with respect to layout and location of control points.
3) All physical points on the schematic flow diagram shall be indicated with names, descriptors, and point addresses identified as listed in the point summary table.
4) Label each input and output with the appropriate range.
5) Device table (Bill of Materials). With each schematic, provide a table of all materials and equipment including:
   a) Device tag as indicated in the schematic and actual field labeling (use tag as indicated in these specifications where applicable and practical)
   b) Device tag as indicated in these specifications where applicable and if it differs from schematic device tag
   c) Description
   d) Proposed manufacturer and model number
   e) Range
   f) Quantity
6) With each schematic or on separate valve sheet, provide valve and actuator information including pipe size, valve size, C_v, design flow, target pressure drop, actual design pressure drop, manufacturer, model

number, close off rating, etc. Indicate normal positions of fail-safe valves and dampers.

7) Indicate all required electrical wiring. Electrical wiring diagrams shall include both ladder logic type diagram for motor starter, control, and safety circuits and detailed digital interface panel point termination diagrams with all wire numbers and terminal block numbers identified. Provide panel termination drawings on separate drawings. Ladder diagrams shall appear on system schematic. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
8) Details of control panels, including controllers, instruments, and labeling shown in plan or elevation indicating the installed locations.
9) Floor plans: None required.
10) Format
    a) Sheets shall be consecutively numbered.
    b) Each sheet shall have a title indicating the type of information included and the mechanical/electrical system controlled.
    c) Table of Contents listing sheet titles and sheet numbers.
    d) Legend and list of abbreviations.
    e) Schematics
        1. Word searchable pdf format.
        2. 21 inch x 15 inch or 17 inch x 11 inch.

c. Do not include sequence of controls on shop drawings or equipment submittals; they are included in Submittal Package 2.

3. Submittal Package 2 (Programming and Graphics)
    a. A detailed description of point naming convention conforming to Paragraph 3.12B to be used for all software and hardware points, integrated with existing database convention.
    b. A list of all hardware and software points identifying their full text names, device addresses and descriptions.
    c. Control Logic Documentation
        1) Submit control logic program listings (graphical programming) consistent with specified English-language Sequences of Operation for all control units.
        2) Control logic shall be annotated to describe how it accomplishes the sequence of operation. Annotations shall be sufficient to allow an operator to relate each program component (block or line) to corresponding portions of the specified Sequence of Operation.
        3) Include a MS Word file of the specified English-language Sequences of Operation of each control sequence updated to reflect any suggested changes made by the Contractor to clarify or improve the sequences. Changes shall be clearly marked. Also merge Guideline 36 sequences, where referenced, verbatim into the file; see Section 259000 Building Automation Sequences of Operation. SOO shall be fully consistent with the graphical programming.
        4) Include control settings, setpoints, throttling ranges, reset schedules, adjustable parameters and limits.
        5) Submit one complete set of programming and operating manuals for all digital controllers concurrently with control logic documentation.
    d. Graphic screens of all required graphics, provided in final colors.

e. Format
   1) Points list: Word-searchable format per Paragraph 1.10C.3.
   2) Programming: Native ALC Eikon.
   3) Control sequences: MS Word
   4) Programming and operating manual: Word-searchable format per Paragraph 1.10C.3.
   5) Graphics: Graphical electronic format (pdf, png, etc.).

4. Submittal Package 3 (Pre-Functional Test Forms)
   a. Provide pre-functional test forms as required by Paragraph 3.15B.2.a.
   b. Format: Word-searchable format per Paragraph 1.10C.3.

5. Submittal Package 4 (Pre-Functional Test Report)
   a. Provide Pre-Functional Test Report as required by Paragraph 3.15B.2.
   b. Format: Word-searchable format per Paragraph 1.10C.3.

6. Submittal Package 5 (Post-Construction Trend Points List)
   a. Provide a list of points being trended along with trend interval or change-of-value per Paragraph 3.15E.2.d.
   b. Format: See Paragraph 2.12C.3.

7. Submittal Package 6 (Functional Test Report)
   a. Provide completed functional test forms as required by Paragraph 3.15C.4.
   b. Format: Word-searchable format per Paragraph 1.10C.3.

8. Submittal Package 7 (Training Materials)
   a. Provide training materials as required by Paragraph 3.16.
   b. Format: Word-searchable format per Paragraph 1.10C.3.

9. Submittal Package 8 (Post-Construction Trend Logs)
   a. Provide trend logs as required by Paragraph 3.15E.
   b. Format: See Paragraph 2.12C.3.

1.10 COMPLETION REQUIREMENTS

A. Procedure

1. Until the documents required in this Section are submitted and approved, the system will not be considered accepted and final payment to Contractor will not be made.

2. Before requesting acceptance of Work, submit one set of completion documents for review and approval of College.

3. After review, furnish quantity of sets indicated below to College.

B. Completion Documents

1. Operation and Maintenance (O & M) Manuals. Provide in both paper and electronic format per Paragraph 1.10C.

a. Include the as-built version of all submittals (product data, shop drawings, control logic documentation, hardware manuals, software manuals, installation guides or manuals, maintenance instructions and spare parts lists) in maintenance manual. Submittal data shall be located in tabs along with associated maintenance information.
b. Engineering, Installation, and Maintenance Manual(s) that explain how to design and install new points, panels, and other hardware; preventive maintenance and calibration procedures; how to debug hardware problems; and how to repair or replace hardware.
c. Complete original issue documentation, installation, and maintenance information for all third-party hardware and software provided, including computer equipment and sensors.
d. A list of recommended spare parts with part numbers and suppliers.
e. Operators Manual with procedures for operating the control systems, including logging on/off, alarm handling, producing point reports, trending data, overriding computer control, and changing set points and other variables.
f. Programming Manuals with a description of the programming language, control block descriptions (including algorithms and calculations used), point database creation and modification, program creation and modification, and use of the programming editor.
g. Recommended preventive maintenance procedures for all system components, including a schedule of tasks (inspection, cleaning, calibration, etc.), time between tasks, and task descriptions.
h. A listing and documentation of all custom software for the Project created using the programming language, including the set points, tuning parameters, and point and object database.
i. English language control sequences updated to reflect final programming installed in the BAS at the time of system acceptance. See Section 259000 Building Automation Sequences of Operation.

2. Complete original issue electronic copy for all software provided, including operating systems, programming language, operator workstation software, and graphics software.

3. Complete electronic copy of BAS database, user screens, setpoints and all configuration settings necessary to allow re-installation of system after crash or replacement of server, and resume operations with the BAS in the same configuration as during College sign-off.

4. Project Record Drawings
   a. As-built versions of the submittal drawings in reproducible paper and electronic format per Paragraph 1.10C.
   b. As-built network architecture drawings showing all BACnet nodes including a description field with specific controller and device identification, description and location information.

5. Commissioning Reports. Completed versions of all Pre-functional, Functional, and Demonstration Commissioning Test reports, calibration logs, etc., per Paragraph 3.15A.9.

6. Copy of inspection certificates provided by the local code authorities.

7. Written guarantee and warranty documents for all equipment and systems, including the start and end date for each.

8. Training materials as required by Paragraph 3.16.

9. Contact information. Names, addresses, and 24-hour telephone numbers of contractors installing equipment, and the control systems and service representatives of each.

C. Format of Completion Documents

1. Provide the type and quantity of media listed in table below.

2. Project database, programming source files, and all other files required to modify, maintain, or enhance the installed system shall be provided in their source format and compiled format (where applicable).

3. Where electronic copies are specified, comply with the following:
   a. Provide in word-searchable electronic format; acceptable formats are MS Word, Adobe Acrobat (pdf), and HTML; submit other formats for review and approval prior to submission; scanned paper documents not acceptable.
   b. For submittals, provide separate file for each type of equipment.
   c. Control sequences shall be in MS Word.

	Document	Paper (binder or bound)	Electronic	
			Loaded onto Flash Drive	Loaded onto CSS
1.	O&M Manual	2	1	1
2.	Project database including all source files	–	1	1
3.	Project Record Drawings	2	1	1
4.	Control sequences	1	1	1
5.	Commissioning Reports	2	1	1
6.	Inspection Certificates	1	1	1
7.	Warranty documents	1	1	1
8.	Training materials	1 per trainee	1	1
9.	Contact information	1	1	–

D. Permanent On-site Documentation

1. In each panel, provide the following stored in clear plastic sleeve taped to the back of the panel door:
   a. 8.5x11 printout of as-built points list
   b. 21 inch x 15 inch or 17 inch x 11 inch set of as-built shop drawings for devices in panel

1.11 BAS DESIGN

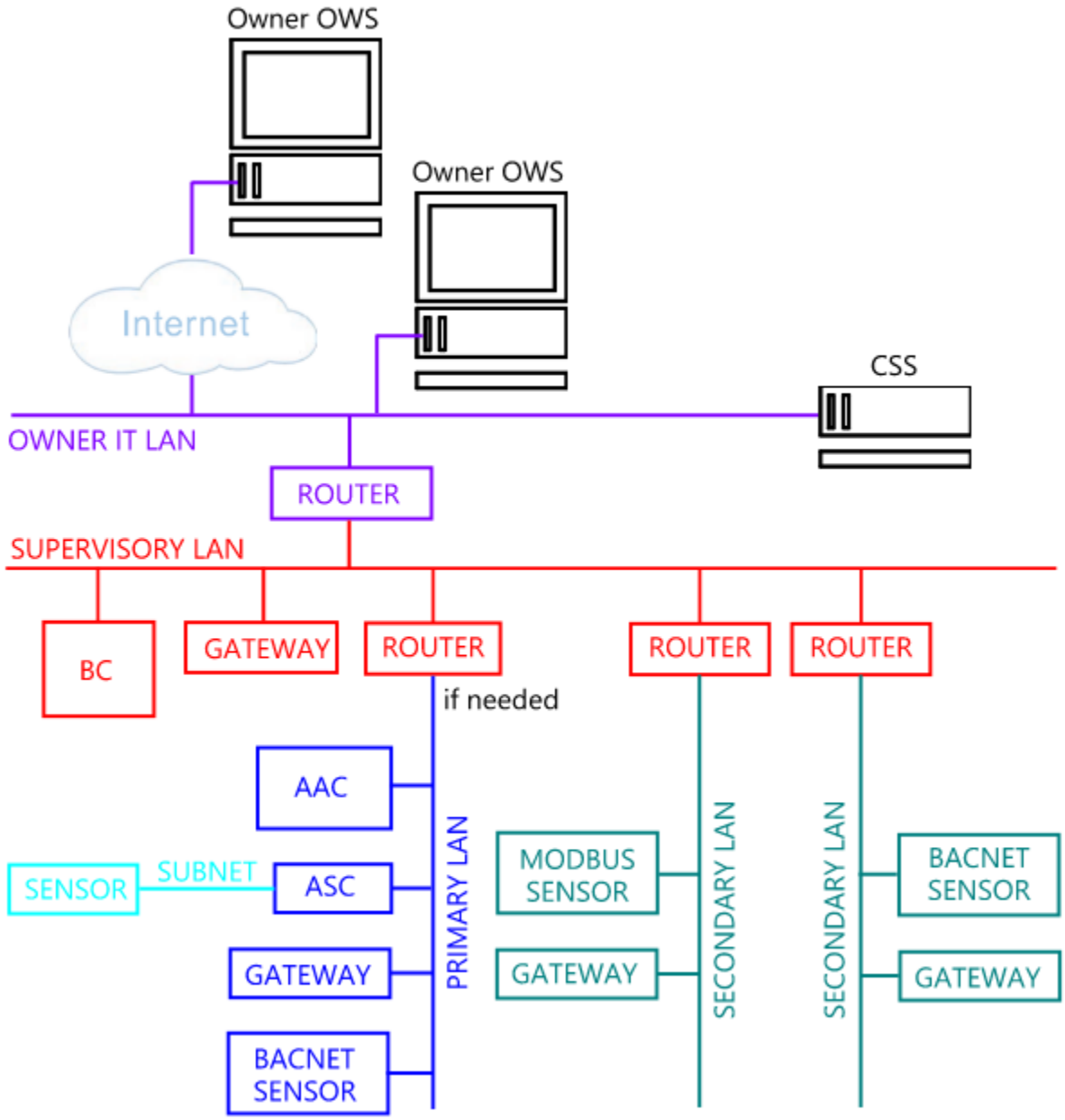
A. System Architecture

1. General
   a. The system provided shall incorporate hardware resources sufficient to meet the functional requirements specified in this Section. Include all items not specifically itemized in this Section that are necessary to implement, maintain, and operate the system in compliance with the functional intent of this Section.
   b. The system shall be configured as a distributed processing network(s) capable of expansion as specified herein.
   c. The existing Campus BAS consists of a control system server interconnected by a high speed College IT LAN to each campus building and facility. This project includes integrating building level BCs and other control devices into the campus system.
      1) Within the building, the BAS shall be standalone and not rely on any 3rd party networks, such as the College IT LAN, except as specifically allowed herein.
      2) To communicate with the central CSS (and internet via VPN), the building Supervisory LAN shall connect via router, provided under this Section, to the College IT LAN. Arrange with College IT administrators for final connection and IP addresses.
   d. All control products provided for this Project shall comprise an interoperable Native BACnet System. All control products provided for this Project shall conform to ANSI/ASHRAE Standard 135.
   e. Power-line carrier systems are not acceptable for BAS communications.

2. BAS Network Architecture
   a. College IT LAN. Ethernet-based, 100 or 1000 Mbps BACnet/IP network. Reuse existing connections to existing network controllers. No additional drops will be provided by the College.
   b. Supervisory LAN: The LAN shall be an Ethernet-based, 100 or 1000 Mbps network interconnecting the server and OWS(s) to BCs and certain gateways as specified herein. LAN shall be IEEE 802.3 Ethernet with switches and routers that support 100 Mbps minimum throughput. This network shall be BACnet/IP as defined in the BACnet standard, and shall share a common network number for the Ethernet backbone, as defined in BACnet.
   c. Primary LAN: High-speed, peer-to-peer communicating LAN used to connect AACs, ASCs, and certain gateways and sensors where specified herein. Acceptable technologies include and are limited to:
      1) Ethernet (IEEE802.3) per the Supervisory LAN
      2) ARCnet (IEEE802.4) for Alternate Bid Only; see Paragraph 1.2H.1.
   d. Secondary LAN: Network used only to connect certain gateways and sensors where specified herein. It shall not be used to interconnect BCs, AACs, and ASCs. Network speed versus the number of devices on the LAN shall be dictated by the response time and trending requirements. Acceptable technologies include but are not limited to:
      1) BACnet over Master Slave/ Token Passing (MS/TP)
      2) Modbus over RS-485 or IP

e. Subnets: Networks used to connect sensors and thermostats to AACs and ASCs. This network may as above for Secondary LANs or may be proprietary the manufacturer.

3. The figure below shows a schematic of the desired network architecture. Note that the CSS may be remote at the Brentwood campus as indicated in Paragraph 1.2H.2.



4. Operator Interfaces and Servers
   a. The Control Systems Server (CSS) is existing. See Paragraph 1.3C.6 for temporary CSS requirements.
   b. OWSs or POTs are either existing or will be provided by the College.
   c. Remote monitoring and control shall be through use of a web browser through the College IT LAN and via the internet through the College IT LAN.

5. Controllers. The BCs, AACs, and ASCs shall monitor, control, and provide the field interface for all points specified.

6. Gateways and Routers
   a. See Paragraph 2.4C for a list of gateways and routers.
   b. Where gateways are used, critical points shall be hardwired from the BAS to the controlled device, rather than using the gateway, to avoid problems with gateway failures, currently a common problem. Critical points are those that are essential for proper operation and are listed in points list as separate points. Where listed, these points shall be hardwired even when available through gateway.

B. System Performance

1. The communication speed between the controllers, LAN interface devices, and operator interface devices shall be sufficient to ensure fast system response time under any loading condition. This includes when system is collecting trend data for commissioning and for long term monitoring. (See Paragraph 3.15E.) In no case shall delay times between an event, request, or command initiation and its completion be greater than those listed herein, assuming no other simultaneous operator activity. Reconfigure LAN as necessary to accomplish these performance requirements. This does not apply to gateways and their interaction with non-BAS-vendor equipment.
   a. Object Command: The maximum time between an operator command via the operator interface to change an analog or binary point and the subsequent change in the controller shall be less than 5 seconds.
   b. Object Scan: All changes of state and change of analog values will be transmitted over the network such that any data used or displayed at a controller or workstation will have been current within the previous 10 seconds.
   c. Graphics Scan: The maximum time between an operator's selection of a graphic and it completely painting the screen and updating at least 10 points shall be less than 10 seconds.
   d. Alarm Response Time: The maximum time from when an object goes into alarm to when it is annunciated at the workstation or broadcast (where so programmed) shall not exceed 10 seconds for a Level 1 alarm, 20 seconds for alarm levels 2 and 3, and 30 seconds for alarm levels 4 and 5. All workstations on the onsite network must receive alarms within 5 seconds of each other.
   e. Program Execution Frequency: Custom and standard applications shall be capable of running as often as once every 5 seconds. Contractor shall be responsible for selecting execution times consistent with the mechanical process under control.
   f. Control Loop Performance: Programmable controllers shall be able to execute DDC PID control loops at a selectable frequency of at least once per second. The controller shall scan and update the process value and output generated by this calculation at this same frequency.

2. Sensor selection, wiring method, use of transmitters, A-to-D conversion bits, etc. shall be selected and adjusted to provide end-to-end (fluid to display) accuracy at or better than those listed in the following table.

Measured Variable	Reported Accuracy
Space drybulb temperature	±1ºF
Ducted Air drybulb temperature	±0.5ºF
Mixed Air drybulb temperature	±1ºF
Outside Air drybulb temperature	±0.5ºF
Chilled and Condenser Water Temperature	±0.2ºF
Hot Water Temperature	±0.5ºF
Water Flow	±1% of reading
Airflow (terminal)	±10% of reading
Airflow (measuring stations)	±5% of reading
Air Pressure (ducts)	±0.05 inches
Air Pressure (space)	±0.01 inches
Water Pressure	±2% of reading
Electrical power	1% of reading
Carbon Dioxide (CO_2)	±75 ppm

1.12 OWNERSHIP OF PROPRIETARY MATERIAL

A. All project-developed software and documentation shall become the property of the College. These include, but are not limited to:

1. Project graphic images
2. Record drawings
3. Project database
4. Project-specific application programming code
5. All documentation

1.13 WARRANTY

A. At the successful completion of the final testing, commissioning, and demonstration phase in accordance with the terms of this specification, if equipment and systems are operating satisfactorily to the College and if all completion requirements per Paragraph 1.10B have been fulfilled, the College shall certify in writing that the control system has been accepted. The date of acceptance shall be the start of the warranty period.

B. Guarantee all materials, equipment, apparatus and workmanship (including programming) to be free of defective materials and faulty workmanship for the following periods from date of acceptance:

1. BCs, AACs, and ASCs: two years
2. Valve and damper actuators: five years
3. All else: one year

C. Provide new materials, equipment, apparatus and labor to replace that determined by College to be defective or faulty.

D. Control system failures during the warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to the College. Contractor shall respond to the College's request for warranty service within 24 hours during normal business hours.

E. Operator workstation software, project-specific software, graphic software, database software, and firmware updates that resolve known software deficiencies shall be provided at no cost to the College during the warranty period.

F. Sequence of operation programming bugs (both due to programming misinterpretations and sequence errors) shall be corrected and any reasonable control sequence changes required to provide proper system operation shall be provided at no additional cost to the College during this period.

1.14 WARRANTY MAINTENANCE

A. The College reserves the right to make changes to the BAS during the warranty period. Such changes do not constitute a waiver of warranty. The Contractor shall warrant parts and installation work regardless of any such changes made by the College, unless the Contractor provides clear and convincing evidence that a specific problem is the result of such changes to the BAS.

B. At no cost to the College, provide maintenance services for software and hardware components during the warranty period as specified below:

1. Emergency Service: Any malfunction, failure, or defect in any hardware component or failure of any control programming that would result in property damage or loss of comfort control shall be corrected and repaired following notification by the College to the Contractor.
   a. Response by telephone or via internet connection to the BAS to any request for service shall be provided within two hours of the College's initial request for service.
   b. In the event that the malfunction, failure, or defect is not corrected, at least one technician, trained in the system to be serviced, shall be dispatched to the College's site within eight hours of the College's initial request for such services.

2. Normal Service: Any malfunction, failure, or defect in any hardware component or failure of any control programming that would not result in property damage or loss of comfort control shall be corrected and repaired following notification by the College to the Contractor.
   a. Response by telephone to any request for service shall be provided within eight working hours (contractor specified 40 hr. per week normal working period) of the College's initial request for service.
   b. In the event that the malfunction, failure, or defect is not, at least one technician, trained in the system to be serviced, shall be dispatched to the College's site within three working days of the College's initial request for such services, as specified.

3. College's Telephonic Request for Service: Contractor shall specify a maximum of three telephone numbers for College to call in the event of a need for service. At least one of the lines shall be attended continuously (24/7). Alternatively, pagers/SMS can be used for technicians trained in system to be serviced. One of the three paged/texted technicians shall respond to every call within 15 minutes.

4. Technical Support: Contractor shall provide technical support by telephone throughout the warranty period.

5. Documentation: Record drawings and software documentation shall be updated as required to reflect any and all changes made to the system or programming during the warranty period.

PART 2 PRODUCTS

2.1 PRIMARY BAS MANUFACTURER

A. Automated Logic Corp.

B. No Equal

2.2 GENERAL

A. Materials shall be new, the best of their respective kinds without imperfections or blemishes and shall not be damaged in any way.

B. To the extent practical, all equipment of the same type serving the same function shall be identical and from the same manufacturer.

C. All controllers, associated hardware (repeaters, routers, etc.), sensors, and control devices shall be fully operational and maintain specified accuracy at the anticipated ambient conditions of the installed location as follows:

1. Outdoors or in harsh ambient conditions: -20°C to 55°C (-4°F to 130°F), 10% RH to 90% RH noncondensing.

2. Conditioned spaces or mechanical rooms: 0°C to 40°C (32°F to 104°F), 10% RH to 80% RH noncondensing.

2.3 CONTROLLERS

A. Building Controller (BC)

1. ALC OptiFlex line

B. Advanced Application Controller (AAC)

1. ALC OptiFlex line

2. ALC ME or SE-series for Alternate Bid Only; see Paragraph 1.2H.1.

C. Application Specific Controller (ASC)

1. ALC OptiFlex line

2. ALC ZN-series for Alternate Bid Only; see Paragraph 1.2H.1.

2.4 COMMUNICATION DEVICES

A. Supervisory LAN Protocol Translators

1. ALC Optiflex line

B. BACnet Gateways & Protocol Translators

1. Gateways shall be provided to link non-BACnet control products to the BACnet inter-network. All of the functionality described in this Paragraph is to be provided by using the BACnet capabilities. Each Gateway shall have the ability to expand the number of BACnet objects of each type supported by 20% to accommodate future system changes.

2. Each Gateway shall provide values for all points on the non-BACnet side of the Gateway to BACnet devices as if the values were originating from BACnet objects. The Gateway shall also provide a way for BACnet devices to modify (write) all points specified by the Points List using standard BACnet services.

C. Gateway and Protocol Translators

Equipment/System	Interface			
	Type	Specified Under Division:	Location	Connect to this Network:
Variable Speed Drives (Alternate Bid only – See Paragraph 1.2H.3.)	BACnet/MSTP	(E)	Each VFD	Secondary
Chiller (Existing)	BACnet/IP or BACnet/MSTP per existing (verify)	(E)	Chiller Room	Supervisory or Secondary per existing
Power Monitoring (New)	Modbus RS-485	(E)	Electrical Room 138 (formerly 137)	Secondary
Refrigerant Monitor (New)	Modbus RS-485	(E)	Chiller Room	Secondary

2.5 BAS INTERFACE HARDWARE

A. Not required (existing or virtual server provided by College as Alternate per Paragraph 1.2H.2.)

2.6 AIR TUBING

A. Seamless copper tubing, Type L-ACR, ASTM B 88; with cast-bronze solder joint fittings, ANSI B1.18; or wrought-copper solder-joint fittings, ANSI B16.22; except brass compression-type fittings at connections to equipment. Solder shall be 95/5 tin antimony, or other suitable lead free composition solder.

B. Virgin polyethylene non-metallic tubing type FR, ASTM D 2737, and with flame-retardant harness for multiple tubing. Use compression or push-on brass fittings.

2.7 ELECTRIC WIRING AND DEVICES

A. Communication Wiring

1. Provide all communication wiring between Building Controllers, Protocol Translators, Gateways, AACs, ASCs and local and remote peripherals (such as operator workstations and printers).

2. Ethernet LAN: Use Fiber or Category ~~5e or~~ 6 of standard TIA/EIA 68 (10baseT). Network shall be run with no splices and separate from any wiring over 30 volts.

3. ARCnet and RS-485 LAN: Communication wiring shall be individually 100% shielded pairs per manufacturers recommendations for distances installed, with overall PVC cover, Class 2, plenum-rated run with no splices and separate from any wiring over 30 volts. Shield shall be terminated and wiring shall be grounded as recommended by BC manufacturer.

B. Analog Signal Wiring

1. Input and output signal wiring to all field devices, including, but not limited to, all sensors, transducers, transmitters, switches, current or voltage analog outputs, etc. shall be twisted pair, 100% shielded if recommended or required by controller manufacturer, with PVC cover. Gauge shall be as recommended by controller manufacturer.

2.8 NEW CONTROL CABINETS

A. Existing control cabinets may be reused. This section applies to new cabinets.

B. All control cabinets shall be fully enclosed with hinged door.

1. For panels in mechanical rooms and other spaces that are secure and accessible only to BAS/MEP operators, provide quarter-turn slotted latch.

2. For panels located in electrical rooms, IDF rooms, and other spaces that may be accessible by persons other than BAS/MEP operators, provide key-lock latch. A single key shall be common to all panels within each building. Provide 3 keys.

C. Construction

1. Indoor:
   a. Mechanical or electrical rooms etc.: NEMA 1
   b. Air plenums: NEMA 12

2. Outdoor: NEMA 4

D. Interconnections between internal and face-mounted devices shall be pre-wired with color-coded stranded conductors neatly installed in plastic troughs or tie-wrapped. Terminals for field connections shall be UL Listed for service, individually identified per control-interlock drawings, with adequate clearance for field wiring. All control tubing and wiring shall be run neatly and orderly in open slot wiring duct with cover. Control terminations for field connection shall be individually identified per control Shop Drawings.

E. Provide ON/OFF power switch with over-current protection for control power sources to each local panel.

F. For new and existing panels, provide with

1. Framed, plastic-encased point list for all points in cabinet.

2. Nameplates for all devices on face.

2.9 SENSORS AND MISCELLANEOUS FIELD DEVICES

A. The listing of several sensors or devices in this section does not imply that any may be used. Refer to points list in Paragraph 2.13 Points List for device specification. Only where two or more devices are specifically listed in points list (such as “FM-1 or FM-4”) may the Contractor choose among listed products.

B. Existing valve bodies may be reused at Contractor’s option.

C. Control Valves

1. Manufacturers
   a. Belimo
   b. No equal

2. Modulating Characterized Ball Valves
   a. Valves shall be specifically designed for modulating duty in control application with guaranteed average leak-free life span over 200,000 full stroke cycles.
   b. Industrial quality with nickel plated forged brass body and female NPT threads.
   c. Blowout proof stem design, glass-reinforced Teflon thrust seal washer and stuffing box ring with minimum 600 psi rating (2-way valves) or 400 psi rating (3-way valves). The stem packing shall consist of 2 lubricated O-rings designed for modulating service and requiring no maintenance.
   d. Valves suitable for water or low-pressure steam shall incorporate an anti-condensation cap thermal break in stem design.
   e. Close off rating: Bubble-tight shutoff greater or equal to 125% of pump shut-off head.
   f. Ball: stainless steel
   g. Stem: stainless steel
   h. Characterizing disk held securely by a keyed ring providing equal percentage characteristic

3. Minimum valve assembly pressure ratings
   a. Chilled water: 125 psi at 60ºF
   b. Hot water: 125 psi at 200ºF
   c. Condenser water: 125 psi at 100ºF

4. Valve Selection
   a. Valve type
      1) Modulating 2-way valves: characterized ball type
   b. Valve Characteristic
      1) 2-way valves: equal percentage or modified equal percentage.
   c. Valve Sizing
      1) Modulating Water: Size valve to achieve the following full-open pressure drop
         a) Minimum pressure drop: equal to half the pressure drop of coil or exchanger.
         b) Maximum pressure drop
            1. Hot water at coils: 2 psi
            2. Chilled water at coils: 5 psi
         c) Flow coefficient (C_v) shall not be less than 1.0 (to avoid clogging) unless protected by strainer. Verify in field that a strainer has been provided.
         d) Valve size shall match as close as possible the pipe size where C_v is available in that size.

D. Control Dampers

1. Reuse existing.

E. Actuators

1. Manufacturers
   a. Belimo
   b. No equal

2. Warranty: Valve and damper actuators shall carry a manufacturer's 5-year warranty.

3. Electric Actuators
   a. Entire actuator shall be UL or CSA approved by a National Recognized Testing Laboratory.
   b. Enclosure shall meet NEMA 4X weatherproof requirements for outdoor applications.
   c. Dampers. The actuator shall be direct coupled over the shaft, enabling it to be mounted directly to the damper shaft without the need for connecting linkage. The clamp shall be steel of a V-bolt design with associated V-shaped, toothed cradle attaching to the shaft for maximum strength and eliminating slippage via cold weld attachment. Single bolt or set screw type fasteners are not acceptable. Aluminum clamps are unacceptable.
   d. Valves. Actuators shall be specifically designed for integral mounting to valves without external couplings.

e. Actuator shall have microprocessor-based motor controller providing electronic cut off at full open so that no noise can be generated while holding open. Holding noise level shall be inaudible.
f. Noise from actuator while it is moving shall be inaudible through a tee-bar ceiling.
g. Actuators shall provide protection against actuator burnout using an internal current limiting circuit or digital motor rotation sensing circuit. Circuit shall insure that actuators cannot burn out due to stalled damper or mechanical and electrical paralleling. End switches to deactivate the actuator at the end of rotation or use of magnetic clutches are not acceptable.
h. Modulating Actuators. Actuators shall accept a 0 to 10 VDC or 0 to 20 mA control signal and provide a 2 to 10 VDC or 4 to 20 mA operating range. Actuators shall have positive positioning circuit so that controlled device is at same position for a given signal regardless of operating differential pressure. Actuators that internally use a floating actuator with an analog signal converter are not acceptable.
i. Where indicated on Drawings or Points List, actuators shall include
   1) 2 to 10 VDC position feedback signal
   2) Limit (end) position switches
j. All 24 VAC/DC actuators shall operate on Class 2 wiring and shall not require more than 10 VA for AC. Actuators operating on 120 VAC power shall not require more than 10 VA. Actuators operating on 230 VAC power shall not require more than 11 VA.
k. All modulating actuators shall have an external, built-in switch to allow the reversing of direction of rotation.
l. Actuators shall be provided with a conduit fitting an a minimum three-foot electrical cable and shall be pre-wired to eliminate the necessity of opening the actuator housing to make electrical connections.
m. Where fail-open or fail-closed (fail-safe) position is required by Paragraph 2.9E.4, an internal mechanical, spring return mechanism shall be built into the actuator housing. Electrical capacitor type fail-safe are also acceptable. All fail-safe actuators shall be capable of both clockwise or counterclockwise spring return operation by simply changing the mounting orientation.
n. Actuators shall be capable of being mechanically and electrically paralleled to increase torque where required.
o. All non-spring return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring return actuators with more than 60 inch-pound torque capacity shall have a manual crank for this purpose.
p. Actuators shall be designed for a minimum of 60,000 full cycles at full torque and be UL 873 listed.
q. Actuators shall provide clear visual indication of damper/valve position.

4. Normal and Fail-Safe Position
   a. Except as specified otherwise herein, the normal position (that with zero control signal) and the fail-safe position (that with no power to the actuator) of control devices and actuators shall be as indicated in table below. “Last” means last position. Actuators with a fail-safe position other than “Last” must have spring or electronic fail-safe capability.

Device	Normal Position	Fail-Safe Position
Outside air damper	CLOSED	CLOSED
Return air damper	OPEN	OPEN
Exhaust/relief air damper	CLOSED	CLOSED
AHU heating coil valves	OPEN	LAST
AHU cooling coil valves	CLOSED	LAST
Hot water reheat coil valves	CLOSED	LAST
Minimum flow bypass valves	OPEN	LAST
VAV box dampers	OPEN	LAST
Laboratory hood exhaust air valves	OPEN	LAST
Laboratory supply air valves	OPEN	LAST
Laboratory general exhaust valves	CLOSED	LAST
Laboratory fume hood exhaust minimum airflow damper	CLOSED	CLOSED

5. Valve Actuator Selection
   a. Modulating actuators for valves shall have minimum rangeability of 50 to 1.
   b. Tight closing against 125% of system pump shut-off head.
   c. Modulating duty against 90% of system pump shut-off head.

6. Damper Actuator Selection
   a. Actuators shall be direct coupled. For multiple sections, provide one actuator for each section; linking or jack-shafting damper sections shall not be allowed.
   b. Provide sufficient torque as velocity, static, or side seals require per damper manufacturer's recommendations and the following:
      1) Torque shall be a minimum 5 inch-pound per square foot for opposed blade dampers and 7 inch-pound per square foot for parallel blade dampers.
      2) The total damper area operated by an actuator shall not exceed 80% of the manufacturer's maximum area rating.

F. General Field Devices

1. Provide field devices for input and output of digital (binary) and analog signals into controllers (BCs, AACs, ASCs). Provide signal conditioning for all field devices as recommended by field device manufacturers and as required for proper operation in the system.

2. It shall be the Contractor's responsibility to assure that all field devices are compatible with controller hardware and software.

3. Field devices specified herein are generally two-wire type transmitters, with power for the device to be supplied from the respective controller. If the controller provided is not equipped to provide this power, or is not designed to work with two-wire type transmitters, or if field device is to serve as input to more than one controller, or where the length of wire to the controller will unacceptably affect the accuracy, provide a transmitter and necessary regulated DC power supply, as required.

4. For field devices specified hereinafter that require signal conditioners, signal boosters, signal repeaters, or other devices for proper interface to controllers, furnish and install proper device, including 120V power as required. Such devices shall have accuracy equal to, or better than, the accuracy listed for respective field devices.

5. Accuracy: As used in this Section, accuracy shall include combined effects of nonlinearity, non-repeatability and hysteresis. Sensor accuracy shall be at or better than both that specifically listed for a device and as required by Paragraph 1.11B.2.

G. Temperature Sensors (TS)

1. General
   a. Unless otherwise noted, sensors may be platinum RTD, thermistor, or other device that is commonly used for temperature sensing and that meets accuracy, stability, and resolution requirements.
   b. When matched with A/D converter of BC, AAC, or ASC, sensor range shall provide a resolution of no worse than 0.3ºF (0.16 °C) (unless noted otherwise herein).
   c. Sensors shall drift no more than 0.3ºF and shall not require calibration over a five-year period.
   d. Manufacturers
      1) Mamac
      2) Kele Associates
      3) Building Automation Products Inc.
      4) Automated Logic Corp.
      5) Or equal

2. Duct temperature sensors: Shall consist of sensing element, junction box for wiring connections and gasket to prevent air leakage or vibration noise.
   a. TS-1A: Single point (use where not specifically called out to be averaging in points list). Sensor probe shall be 304 stainless steel.
   b. TS-1B: Averaging. Sensor length shall be at least 1 linear foot for each 2 square feet of face area up to 25 feet maximum. Sensor probe shall be bendable aluminum.

3. Water Temperature Sensors
   a. TS-2A: Well mounted immersion sensor, ¼" stainless steel probe, double encapsulated sensor, with enclosure suitable for location.
   b. All piping immersion sensors shall be in one-piece machined brass or stainless steel wells that allow removal from operating system, with lagging extension equal to insulation thickness where installed in insulated piping. Wells shall be rated for maximum system operating pressure, temperature and fluid velocity. The well shall penetrate the pipe by the lesser of approximately half the pipe diameter or eight inches. The use of direct immersion or strap-on type sensors is not acceptable.

4. Room Sensors
   a. Thermostat tags refer to the following:

Type:	Tag

Model	ZS2 Plus
Temperature only	TS-3C
With CO_2	TS-3CC

1) Display
   a) LCD display of all sensors, temperature setpoint adjustment buttons, and schedule override button
2) CO2 Sensor
   a) 400 to 1250 PPM/ ±30PPM or 3% of reading, whichever is greater.
   b) The sensor shall include automatic background calibration (ABC) logic to compensate for the aging of the infrared source and shall not require recalibration for a minimum of 5 years, guaranteed. If sensor is found to be out of calibration, supplier shall recalibrate at no additional cost to the College within 5 years of purchase date.
   c) Meet Title 24 requirements including calibration interval
   d) Provide where CO_2 sensor called for in the VAV box schedule herein.
3) For room sensors connected to terminal box controllers (such as at VAV boxes) that require calibration: Include a USB port or some other means for connection of POT for terminal box calibration.

5. TS-4: Outdoor Air Sensor
   a. Thermistor with sun shield, utility box, and watertight gasket to prevent water seepage.

6. Temperature Transmitters: Where required by the Controller or to meet specified end-to-end accuracy requirements, sensors as specified above shall be matched with transmitters outputting 4-20 mA linearly across the specified temperature range. Transmitters shall have zero and span adjustments, an accuracy of 0.1°F when applied to the sensor range.

H. Pressure Transmitters (PT)

1. PT-1: Water, General Purpose
   a. Fast-response stainless steel sensor
   b. Two-wire transmitter, 4-20 mA output with zero and span adjustments
   c. Accuracy
      1) Overall Accuracy (at constant temp) ±0.5% full scale, includes non-linearity, repeatability, and hysteresis
   d. Long Term Stability 0.5% FS per year
   e. Pressure Limits
      1) Rated pressure: see points list
      2) Proof pressure = 3x rated pressure
      3) Burst pressure = 5x rated pressure
   f. Manufacturers
      1) Setra 209
      2) Kele & Associates P51 Series
      3) Or equal

I. Differential Pressure Transmitters (DPT)

1. DPT-1: Water, General Purpose
   a. Fast-response capacitance sensor

b. Two-wire transmitter, 4-20 mA output with zero and span adjustments
c. Accuracy
   1) Overall Accuracy (at constant temp) ±0.25% full scale (FS).
   2) Non-Linearity, BFSL ±0.22% FS.
   3) Hysteresis 0.10% FS.
   4) Non-Repeatability 0.05% FS.
d. Long Term Stability 0.5% FS per year
e. Only 316 stainless steel in contact with fluid
f. Pressure Limits
   1) 0 to 100 psid range: 250 psig maximum static pressure rating, 250 psig maximum overpressure rating.
   2) 100 to 300 psid range: 450 psig maximum static pressure rating, 450 psig maximum overpressure rating.
g. Include brass 5-valve assembly for single sensor devices. See Paragraph 3.11E.7.
h. Manufacturers
   1) Setra 209 or 230
   2) Modus W30
   3) Or equal

2. DPT-2: Not used

3. DPT-3: Air, Duct Pressure:
   a. General: Loop powered two-wire differential capacitance cell-type transmitter.
   b. Output: two wire 4-20 mA output with zero adjustment.
   c. Overall Accuracy: ±1% of range (not of maximum range/scale)
   d. Switch selectable range:
      1) ≥ 0.5 inches water column
      2) ≤10 inches water column
      3) Select range as specified in points list or, if not listed for specified setpoint to be between 25% and 75% full-scale.
   e. Housing: Polymer housing suitable for surface mounting.
   f. Static Sensing Element: Pitot-type static pressure sensing tips similar to Dwyer model A-301, Davis Instruments, or equal, with connecting tubing.
   g. DPT-3A: Include LCD display of reading.
   h. DPT-3B: Same as DPT-3 except with stainless steel pitot-type static pressure sensing tips similar to Dwyer model A-301-SS, or equal.
   i. Manufacturers.
      1) Setra
      2) Modus
      3) Dwyer
      4) Or equal

4. DPT-4: Air, Low Differential Pressure
   a. General: Loop powered, two-wire differential capacitance cell type transmitter.
   b. Output: Two-wire 4-20 mA output with zero adjustment.
   c. Overall Accuracy
      1) General: ±1% FS
      2) Underfloor: ±0.5% FS

3) Minimum outdoor air damper DP used for minimum outdoor airflow: ±0.25% FS

d. Range
1) Fixed (non-switch selectable)
2) Minimum Range: 0, -0.1, -0.25, -0.5, or -1.0 inches water column
3) Maximum Range: +0.1, 0.25, 0.5, or 1.0 inches water column
4) Range shall be as specified in points list or, if not listed, selected such that specified setpoint is between 25% and 75% full-scale.

e. Housing: Polymer housing suitable for surface mounting

f. Static Sensing Element
1) Ambient sensor: Dwyer A-306 or 420, BAPI ZPS-ACC-10, or equal
2) Space sensor:
a) Wall plate: Kele RPS-W, BAPI ZPS-ACC-01, Dwyer A-417 or 465 or equal
b) Ceiling or wall probe: BAPI ZPS-ACC06, Dwyer A-419A, Veris AA05 or equal
3) Filter or duct pressure sensor: Dwyer A-301 or equal
4) Plenum pressure sensor: Dwyer A-421 or equal

g. DPT-4A: Include LCD display of reading

h. Manufacturers
1) Setra 267
2) Modus
3) Air Monitor
4) Paragon
5) Or equal

5. DPT-5: VAV Velocity Pressure
a. General: Loop powered two-wire differential capacitance cell type transmitter.
b. Output: Two-wire, 4-20 mA output with zero adjustment.
c. Flow transducer (including impact of A-to-D conversion) shall be capable of stably controlling to a setpoint of 0.004 inches differential pressure or lower, shall be capable of sensing 0.002 inches differential pressure or lower, and shall have a ±0.001 inches or lower resolution across the entire scale.
d. Calibration software shall use a minimum of two field measured points, minimum and maximum airflow, with curve fitting airflow interpolation in between.
e. Range: 0 to 1 in.w.c.
f. Housing: Polymer housing suitable for surface mounting.
g. Manufacturer
1) Automated Logic
2) No equal

J. Differential Pressure Switches (DPS)

1. Reuse existing

K. Current Switches (CS-1)

1. Clamp-on or solid-core

2. Range: as required by application

3. Trip Point: Automatic or adjustable
   a. Exception: Fixed setpoint (Veris H-600 or equal) may be used on direct drive constant speed fans that do not have backdraft or motorized shutoff dampers.

4. Switch: Solid state, normally open, 1 to 135 Vac or Vdc, 0.3 Amps. Zero off state leakage

5. Lower Frequency Limit: 6 Hz

6. Trip Indication: LED

7. Approvals: UL, CSA

8. May be combined with relay for start/stop

9. Where used for single-phase devices, provide the CS/CR in a self-contained unit in a housing with override switch. Kele RIBX, Veris H500, or equal

10. Manufacturers
    a. Veris Industries H-608/708/808/908
    b. Senva C-2320L
    c. RE Technologies SCS1150A-LED
    d. Or equal

L. Current Transformers (CT-1)

1. Clamp-On Design Current Transformer (for Motor Current Sensing)

2. Range: 1-10 amps minimum, 20-200 amps maximum

3. Trip Point: Adjustable

4. Output: 0-5 Vdc or 0-10 Vdc,

5. Accuracy: ±0.2% from 20 to 100 Hz.

6. Amperage range sizing and switch settings in accordance with the following and per manufacturer's instructions:

Motor HP	120V	277V	480V
≤1/2	0-10A	0-10A	–
3/4 – 1.5	–	0-10A	0-10A
2 – 5	–	–	0-10A
7.5 – 10	–	–	0-20A
15 – 20	–	–	0-30A
25 – 30	–	–	0-40A

7. Manufacturers
   a. Veris Hx22 series
   b. Kele SC100

c. Or equal

M. Flow Meter (FM)

1. FM-1: Magnetic Flow Tube Flow Meters (Alternate Bid only)
   a. General Requirements
      1) Sensor shall be a magnetic flow meter, which utilizes Faraday's Law to measure volumetric fluid flow through a pipe. The flow meter shall consist of 2 elements, the sensor and the electronics. The sensor shall generate a measuring signal proportional to the flow velocity in the pipe. The electronics shall convert this EMF into a standard current output.
      2) Electronic replacement shall not affect meter accuracy (electronic units are not matched with specific sensors).
      3) Provide a four-wire, externally powered, magnetic type flow transmitter with adjustable span and zero, integrally mounted to flow tube. Output signal shall be a digital pulse proportional to the flow rate (to provide maximum accuracy and to handle abrupt changes in flow). Standard 4-20 mA or 0-10 Vdc outputs may be used on HVAC applications provided accuracy is as specified.
         a) On applications where the output is wired to a BTU meter but flow is required also as a direct input to the DDC system, e.g. for minimum flow control loop, provide a secondary analog output for the DDC system.
      4) Flow Tube
         a) ANSI class 150 psig steel
         b) ANSI flanges
         c) Lined with
            1. Heating hot water, glycol: PTFE, PFA, or ETFE liner rated for ≤-4°F to ≥212ºF fluid temperature
            2. Chilled, condenser, domestic hot and cold water: Polypropylene, Ebonite, PTFE, PFA, or ETFE liner rated for ≤32°F to ≥140ºF fluid temperature
      5) Electrode and grounding material
         a) 316L Stainless steel or Hastelloy C
         b) Electrodes shall be fused to ceramic liner and not require O-rings.
      6) Electrical Enclosure: NEMA 4
      7) Approvals
         a) UL or CSA
         b) NSF Drinking Water approval for domestic water applications
      8) Performance
         a) Accuracy shall be:
            1. ±0.4% of reading from 3.3 to 33 ft/s
            2. ±0.75% of reading from 1.3 to 3.3 ft/s
            3. ±0.0075 ft/s at flow rates less than 1 ft/s
         b) Stability: 0.1% of rate over six months.
         c) Meter repeatability shall be ± 0.1% of rate at velocities > 3 feet per second.
         d) Calibration: The sensor must be factory calibrated on an internationally accredited (such as NAMAS) water flow rig with accuracy better than 0.1%. Calibration shall be NIST traceable.
   b. Manufacturers

1) Onicon F-3100 series
2) Siemens/Danfoss Magflo 3100
3) Krohne Optiflux 4000
4) Sparling TigermagEP FM656
5) Or equal

2. FM-2: Magnetic Insertion Type Flow Meters
   a. Magnetic Faraday point velocity measuring device.
   b. Insertion type complete with hot-tap isolation valves to enable sensor removal without water supply system shutdown.
   c. 4-20 mA transmitter proportional to flow or velocity.
   d. Accuracy: ± 1% of reading from 0.25 to 20 fps
   e. Flow range: 0.25 to 20 fps
   f. Each sensor shall be individually calibrated and tagged accordingly against the manufacturer's primary standards which must be accurate to within 0.1% and traceable to the U.S. National Institute of Standards and Technology (NIST).
   g. Manufacturers:
      1) Onicon FSM-3
      2) Or equal

3. FM-3B: Mass Flow Meter (Alternate Bid only)
   a. Thermal mass flow gas meter designed for measurement of widely varying flow rates of low pressure natural gas
   b. Precision platinum resistance temperature detectors protected by a platinum-iridium sheath mounted in 316 SS probe
   c. Operating temperature range: -40°F to +140°F
   d. 4-20mA, 0-5 Vdc, or 0-10 Vdc output proportional to mass flow
   e. NIST-traceable factory calibration
   f. ±1% FS accuracy
   g. Rangeability at ±1% accuracy: Minimum 40 to 1
   h. Glass enclosed 8 digit totalizer, re-zeroed with on-board device
   i. Manufacturer
      1) Sierra Instruments 620S or 620S BT
      2) Or equal

4. FM-4: Not used

5. FM-5: Not Used

6. FM-6: Domestic and makeup water meters (Alternate Bid only)
   a. 2 inches and smaller: Multi-jet water meter
      1) Multi-jet velocity type meter
      2) Magnetic drive – no gearing exposed to water
      3) 125 psi cast bronze body with integral strainer
      4) Meet all requirements of AWWA C-708 Multi-Jet Meter
      5) Accuracy: ±1.5% of reading
      6) Hall affect low voltage pulse output, with configurable volume per pulse set to 1 gallon per pulse or smallest value the controller will accept
      7) Odometer-type gallons totalizer dial face with cover
      8) Designed for vertical or horizontal piping

9) For potable water: NSF-61 certified and in compliance with California Proposition 65
10) Manufacturers:
    a) SeaMetrics MJE or MJHE
    b) Elster Amco M700
    c) Master Meter
    d) Equal

b. 2.5 inches and larger: Compound-type water meter
1) Shall consist of a combination of a turbine-type, mainline meter for measuring high rates of flow and a bypass meter of an appropriate size for measuring low rates of flow. The compound meter shall have an automatic valve mechanism for diverting low rates of flow through the bypass meter.
2) Comply with ANSI and AWWA C702 standards.
3) Comply with NSF/ANSI Standard 61, ANNEX G.
4) Maximum operating pressure of 150 psi and maximum operating temperature of 120°F continuous (220°F peak).
5) Low voltage pulse output, with configurable volume per pulse set to 1 gallon per pulse or smallest value the controller will accept
6) Odometer-type gallons totalizer dial face with cover
7) Manufacturers:
    a) Badger Recordall Series Meter
    b) Neptune
    c) Or equal
8) Or equal

N. Airflow Measuring Stations (AFMS)

1. General. AFMS provided under this Section shall be licensed to bear the AMCA Certified Rating Seal for Airflow Measuring Stations. Ratings shall be based on tests and procedures performed in accordance with AMCA Publication 611 and comply with requirements of the AMCA Certified Ratings Program.

2. AFMS-1. Not used.

3. AFMS-2. Not used.

4. AFMS-3. Not used.

5. AFMS-4
    a. Differential pressure type with uniframe DP sensor
        1) Provide quantity of DP sensors per manufacturer's recommendations
    b. Station mounted with expanded metal screen
    c. Analog outputs for "standard" airflow (0.075 lb_{da}/ft3 density) and temperature
    d. Manufacturers
        1) Air Monitor OAM-II mounted on outside of outdoor air louver
        2) No known equal

O. Electric Control Components

1. Control Relays: All control relays shall be UL listed, with contacts rated for the application, and mounted in minimum NEMA-1 enclosure for indoor locations, NEMA-4 for outdoor locations.
   a. Control relays for use on electrical systems of 120 volts or less shall have, as a minimum, the following:
      1) AC coil pull-in voltage range of +10%, -15% or nominal voltage.
      2) Coil sealed volt-amperes (VA) not greater than 4 VA.
      3) Silver cadmium Form C (SPDT) contacts in a dustproof enclosure, with 8 or 11 pin type plug.
      4) Pilot light indication of power-to-coil and coil retainer clips.
   b. Relays used for across-the-line control (start/stop) of 120V motors, 1/4 HP, and 1/3 HP, shall be rated to break minimum 10 Amps inductive load.
   c. Relays used for stop/start control shall have low voltage coils (30 VAC or less), and shall be provided with transient and surge suppression devices at the controller interface.

2. Control Transformers and Power Supplies
   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. Mount in minimum NEMA-1 enclosure.
   b. Transformer shall be proper size for application. Limit connected loads to 80% of rated capacity.
   c. 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.
   d. Separate power transformer shall be used for controllers and for actuators and other end devices that use half wave rectification.
   e. 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.
   f. Line voltage units shall be UL Recognized and CSA Approved.

2.10 LABORATORY AIR VALVES

A. Materials

1. Airflow control valve shall be constructed as follows:
   a. Supply and General Exhaust
      1) Body: 20 gauge galvanized or 16 gauge aluminum with continuous welded seam
      2) Damper: 16 gauge galvanized or aluminum
      3) Shafts, support brackets, and springs (where used): 316 stainless steel
      4) Bearings: Teflon, polyester, or polyphenylene sulfide composite
   b. Fume Hood Exhaust
      1) Body: 20 gauge 304 stainless steel or galvanized steel with baked phenolic coating with continuous welded seam

2) Damper: 16 gauge stainless steel or galvanized steel with baked phenolic coating
3) Shafts, support brackets, and springs (where used): 316 stainless steel
4) Bearings: Teflon, polyester, or polyphenylene sulfide composite
5) No aluminum or galvanized steel exposed to airstream

2. Include flange option to match existing or adapt existing to accept draw bands with clamps on each duct connection.

3. Include factory thermal insulation kit for all supply air valves, flexible closed-cell elastomeric type, vapor sealed, thickness per code.

4. For general exhaust, leakage through valve assembly when fully closed shall not exceed 10 cfm at 3 in.w.c. Provide blade seals ("-S" version) as required to meet this limit.

B. Variable Volume Airflow Control Valve

1. Minimum turndown:
   a. Fume hood air valves: 5 to 1
   b. Others: 8 to 1
   c. Shut-off feature: any air valves scheduled to have a 0 cfm minimum shall have full shut-off capability when sent a 0 cfm setpoint.

2. Closed Loop Control
   a. Control damper with fast-acting electric actuator
      1) Fail position. Loss of control power shall cause valves to fail in the last position prior to power loss.
   b. Airflow indicator/sensor accurate to within ±5% of reading over entire turndown range with an analog output (0-10 Vdc) signal. Velocity sensors shall not be affected by dust, temperature, pressure, or humidity. The sensors shall be passive in nature, with no active parts within the air stream. Pitot, thermal anemometer, and other devices mounted in airstream are not acceptable on fume hood air valves. Vortex shedding type is acceptable.
      1) Factory calibrated.
   c. Robust closed loop controller using airflow sensor to control the damper to maintain an airflow setpoint provided by an external analog input (0-10 Vdc) signal with the range, speed, and accuracy specified herein.
   d. Analog output (0-10 Vdc) signal to the damper actuator or a feedback signal from the actuator indicating damper position.
   e. Dry contact input for presence sensor configured to drop maximum hood exhaust setpoint to 60% of design maximum value.

3. Sash Position Sensor
   a. For air valves controlling fume hood exhaust
   b. Output: 0-10000 Ohms proportional to sash position or as required by air valve controller
   c. Linearity: 0.1%
   d. Accuracy: 3%
   e. Ambient conditions: 60°F to 100°F, 0% to 95% RH
   f. Range: as required to match hood

g. Vertical, horizontal, or combination to match hood
h. Manufacturer: Same as air valve controller

4. Fume Hood Monitor
   a. Designed to integrate with air valve controller
   b. LCD with velocity indication
   c. Visual and audible low and high velocity alarms with message display and mute button
   d. Button to activate and deactivate emergency purge that causes air valve to operate at full airflow regardless of sash position
   e. Manufacturer: Same as air valve controller

C. Manufacturer

1. AccuValve AVC-6000

2. No equal

2.11 CALIBRATION & TESTING INSTRUMENTATION

A. Provide instrumentation required to verify readings, calibrate sensors, and test the system and equipment performance.

B. All equipment used for testing and calibration shall be NIST/NBS traceable and calibrated within the preceding 6-month period. Certificates of calibration shall be submitted.

C. Test equipment used for testing and calibration of field devices shall be at least twice as accurate as respective field device (for example if field device is ±0.5% accurate, test equipment shall be ±0.25% accurate over same range).

2.12 SOFTWARE

A. General

1. Upgrade CSS software to the latest version of ALC WebCTRL.

B. Licensing

1. Include licensing and hardware keys for all software packages at all workstations (OWSs and POTs) and servers.

2. Within the limitations of the server, provide licenses for any number of users to have web access to the CSS at any given time.

3. All operator interface, programming environment, networking, database management and any other software used by the Contractor to install the system or needed to operate the system to its full capabilities shall be licensed and provided to the College.

4. All operator software, including that for programming and configuration, shall be available on all workstations. Hardware and software keys to provide all rights shall be installed on all workstations.

C. Graphical User Interface Software

1. Graphics
   a. The GUI shall make extensive use of color in the graphic pane to communicate information related to setpoints and comfort. Animated graphics and active setpoint graphic controls shall be used to enhance usability.
   b. Graphics tools used to create Web Browser graphics shall be non-proprietary and provided and installed on each OWS.
   c. Graphical display shall be 1280 x 1024 pixels or denser, 256 color minimum.
   d. Links
      1) Graphics shall include hyperlinks which when selected (clicked on with mouse button) launch applications, initiate other graphics, etc.
      2) Screen Penetration: Links shall be provided to allow user to navigate graphics logically without having to navigate back to the home graphic. See additional discussion in Paragraph 3.12E.
      3) Information Links
         a) On each MEP system and subsystem graphic, provide links to display in a new window the information listed below.
            1. English-language as-built control sequence associated with the system. See Paragraph 1.10B.
            2. O&M and submittal information for the devices on the graphic. See Paragraph 1.10B.
         b) The display shall identify the target of the link by file name/address.
         c) Information shall be displayed in electronic format that is text searchable.
         d) Window shall include software tools so that text, model numbers, or point names may be found. Source documents shall be read-only (not be editable) with this software.
   e. Point Override Feature
      1) Every real output or virtual point displayed on a graphic shall be capable of being overridden by the user (subject to security level access) by mouse point-and-click from the graphic without having to open another program or view.
      2) When the point is selected to be commanded
         a) Dialog box opens to allow user to override the point (Operator Mode) or release the point (Automatic Mode). Operator Mode will override automatic control of the point from normal control programs.
         b) Dialog box shall have buttons (for digital points) or a text box or slide bar (for analog points) to allow user to set the point's value when in operator mode. These are grayed out when in automatic mode.
         c) When dialog box is closed, mode and value are sent to controller.
         d) Graphic is updated upon next upload scan of the actual point value.
      3) A list of points that are currently in an operator mode shall be available through menu selection.
   f. Point override status (if a digital point is overridden by the supervised manual override per Paragraph 2.3A or if a point is in operator mode per Paragraph

2.12C.1.e) shall be clearly displayed on graphics for each point, such as by changing color or flag.

g. The color of symbols representing equipment shall be able to change color or become animated based on status of binary point to graphically represent on/off status.

2. Alarms
   a. ALC WebCTRL Enterprise Integration advanced alarm package configured as indicated below.

3. Trends
   a. ALC WebCTRL Enterprise Integration trend package configured as indicated below.
   b. Trend Data Storage
      1) The database shall allow applications to access the data while the database is running. The database shall not require shutting down in order to provide read-write access to the data. Data shall be able to be read from the database without interrupting the continuous storage of trend data being carried by the BAS using SQL queries.
      2) Data shall be stored in an SQL compliant database format and shall be available through the College's intranet or internet (with appropriate security clearance) without having to disable BAS access to the database.
      3) The database shall not be inherently limited in size, e.g. due to software limitations or lack of a correct license. Database size shall be limited only by the size of the provided storage media (hard drive size).

4. Security Access
   a. Standard ALC WebCTRL security package

5. Report Software
   a. ALC WebCTRL Enterprise Integration advanced reporting package.
   b. Standard reports. Prepare the following standard reports, accessible automatically without requiring definition by user.
      1) Tenant or department after-hour usage. System must be capable of monitoring tenant override requests and generating a monthly report showing the daily total time in hours that each tenant has requested after-hours HVAC services.
      2) Monthly and annual energy usage and cost. See Utility cost calculation in Paragraph 3.11K~~3.12~~.
      3) Alarm events and status.
      4) Points in Hand (Operator Override) via Workstation command (including name of operator who made the command) or via supervised HOA switch at output, including date and time.

D. Control Programming Software

1. Standard ALC WebCTRL Eikon programming.

E. Miscellaneous Software

1. Provide a context-sensitive, on-line help system to assist the operator in operating and editing the system. On-line help shall be available for all applications and shall provide relevant data for the application or object that help is being called from.

2. Provide software for viewing (but not editing) electronic versions of as-built shop drawings of
   a. Mechanical, electrical, and plumbing systems in Adobe pdf format
   b. BAS drawings in Adobe pdf format

2.13 CONTROL POINTS

A. Table Column Definitions

1. Point description

2. Type (number in point schedule after each type refers to tag on schematics)
   a. AO: analog output
   b. AI: analog input
   c. DO: digital or binary output
   d. DI: digital or binary input

3. Device description
   a. See Paragraph 2.9 for device definition.

4. Trend Logging
   a. Commissioning: Where listed, point is to be trended at the basis listed for commissioning and performance verification purposes.
   b. Continuous: Where listed, point is to be trended at the basis listed continuously, initiated after system acceptance, for the purpose of future diagnostics.
   c. Trend Basis
      1) Where range of engineering units is listed, trend on a change of value (COV) basis (in other words record time stamp and value when point value changes by engineering unit listed).
      2) Where time interval is listed, trend on a time basis (in other words record time stamp and value at interval listed). All points relating to a specific piece of equipment shall be trended at the same initiation time of day so data can be compared in text format.

5. Calibration
   a. F = factory calibration only is required (no field calibration)
   b. HH = field calibrate with handheld device. See Paragraph 3.15B.6.a.2)

B. Note that points lists below are for each system of like kind. Refer to drawings for quantity of each.

C. Points mapped through gateways and network interfaces. Note that points listed herein are intended to indicate the level of effort required for point mapping for bid purposes; the points lists are not exclusive and exhaustive. The exact point names and types may vary since the points available vary by equipment manufacturer and

model. A final list of available points must be obtained from the manufacturer during the shop drawing development phase. If the available points differ from the points lists herein, the desired points to be mapped shall be confirmed by the Engineer prior to issuing Submittal Package 2. Unless the quantity of points is significantly different from those shown herein, the changes shall be made at no additional costs to the College.

1. Variable speed drives (Alternate Bid only – See Paragraph 1.2H.3.)

Description	Type	Device	Trend Logging		Calibration
			Commissioning	Continuous	
Fault reset	DO	Through network	COV	COV	–
On/off status	DI	Through network	COV	COV	–
Fault (critical alarm)	DI	Through network	COV	COV	–
Minor alarm	DI	Through network	COV	COV	–
Fault text	AI	Through network (convert code to plain English text)	COV	COV	–
Alarm text	AI	Through network (convert code to plain English text)	COV	COV	–
Keypad in hand/auto	DI	Through network	COV	COV	–
Minimum frequency setpoint	AO	Through network	±5%	±5%	–
Maximum frequency setpoint	AO	Through network	±5%	±5%	–
Acceleration rate	AO	Through network	±5%	±5%	–
Deceleration rate	AO	Through network	±5%	±5%	–
Actual frequency	AI	Through network	1 min	15 min	–
DC bus voltage	AI	Through network	±10%	±10%	F
AC output voltage	AI	Through network	±10%	±10%	F
Current	AI	Through network	15 min	60 min	F
VFD temperature	AI	Through network	60 min	60 min	F
Power, kW	AI	Through network	1 min	15 min	F
Energy, MWh	AI	Through network	15 min	60 min	–

2. Chillers:
   a. See existing interface. Map across all points currently mapped to Andover. See Andover "dump" files included in bid package. That includes on/off – all chiller control shall be through the existing BACnet interface.

3. Electrical Power Monitor
   a. New connection to existing GE EPM 5100

Description	Type	Device	Trend Logging		Calibration
			Commissioning	Continuous	
kW	AI	Through network	15 min	15 min	–
Volts (each phase)	AI	Through network	±10%	±10%	–
Power factor	AI	Through network	±10%	±10%	–
Amps (each phase)	AI	Through network	–	–	–

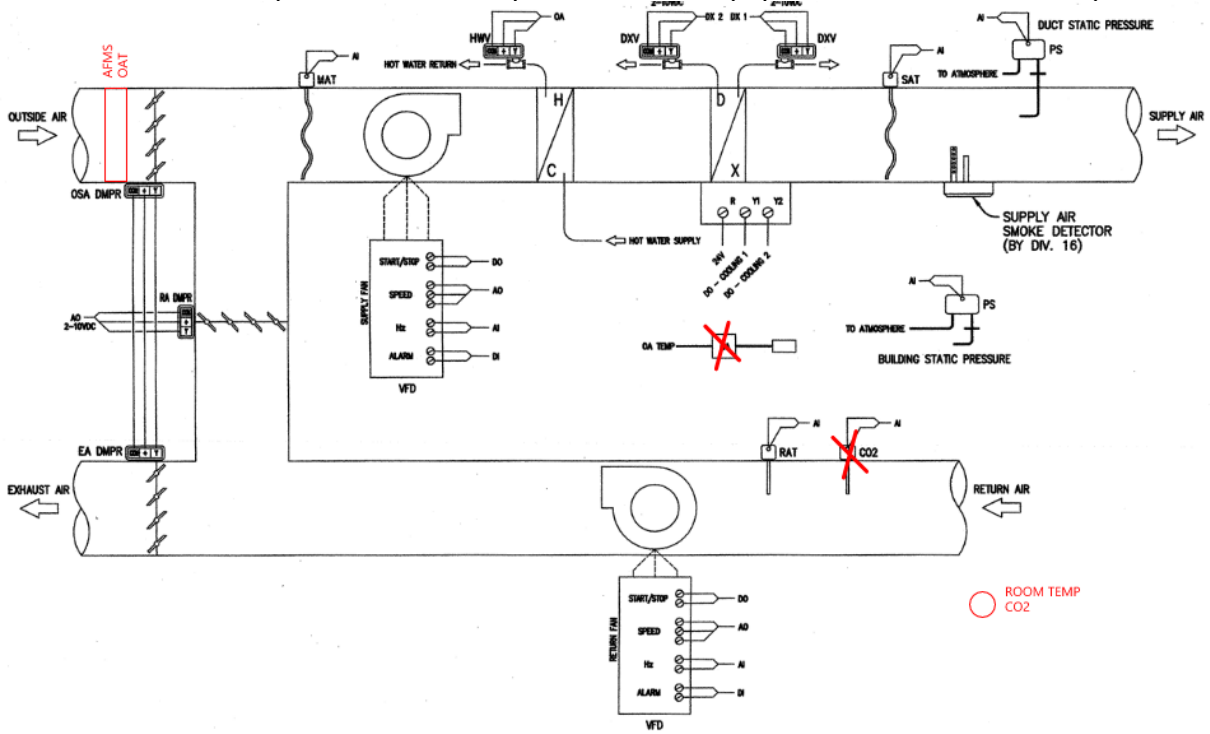
4. Refrigerant Monitor
   a. New connection to existing Chillgard refrigerant monitor

Description	Type	Device	Trend Logging		Calibra-tion
			Comm-issioning	Contin-uous	
Alarm Setpoint – caution	AO	Through network	±100 PPM	±100 PPM	–
Alarm Setpoint – warning	AO	Through network	±100 PPM	±100 PPM	–
Alarm Setpoint – alarm	AO	Through network	±100 PPM	±100 PPM	–
Temperature Tolerance	AO	Through network	±1°F	±1°F	–
Unit failure/trouble alarm	DI	Through network	COV	COV	–
Alarm state (0 to 4)	AI	Through network	COV	COV	–
Refrigerant concentration	AI	Through network	±50 PPM	±50 PPM	F

D. Hardwired Points

1. VAV Air Handler AC-1 (TCP-1)

   a. Schematic
      1) Eliminated points
         a) Duct mounted CO_2 sensor (replaced with wall mounted)
         b) Outdoor air temperature sensor (replaced with AFMS sensor)

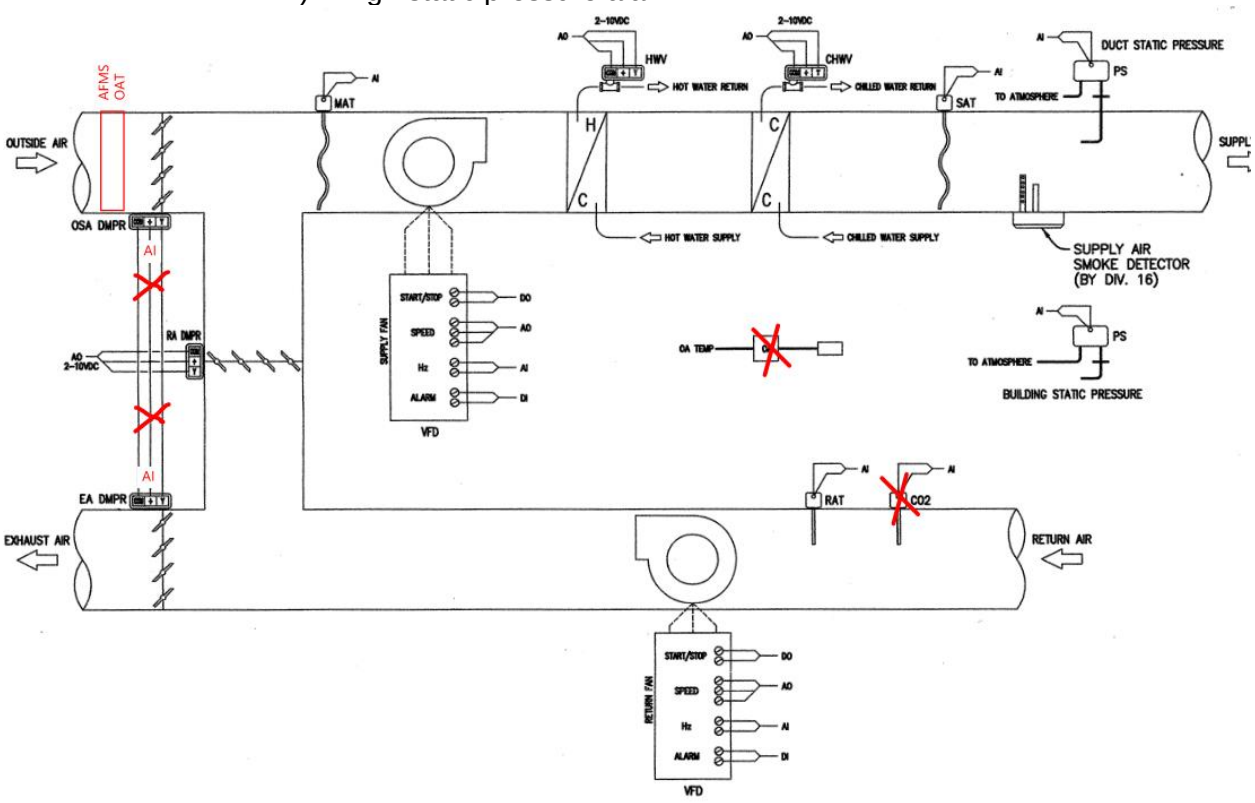


   b. Points

Description	Type	Device	New Device	New Point	Trend Logging		Cali-bra-tion
					Comm-issioning	Contin-uous	
SF Start/Stop	DO	(E) VFD contact			COV	COV	–
RF Start/Stop	DO	(E) VFD contact			COV	COV	–
SF Speed	AO	(E) VFD contact			1 min	15 min	–
RF Speed	AO	(E) VFD contact			1 min	15 min	–
HW valve	AO	(E) 2-way valve with new actuator	X		1 min	15 min	–
Economizer dampers	AO	(E) dampers with new actuators	X		1 min	15 min	–
Cool stage 1	DO	(E) DX contact			COV	COV	–
Cool stage 2	DO	(E) DX contact			COV	COV	–
SF fault	DI	(E) VFD contact			COV	COV	–
RF fault	DI	(E) VFD contact			COV	COV	–
SF speed feedback	AI	(E) VFD contact			1 min	15 min	–
RF speed feedback	AI	(E) VFD contact			1 min	15 min	–
Building static pressure	AI	Reuse existing			1 min	15 min	F
Mixed air temperature	AI	TS-1B	X		1 min	15 min	F
Supply air temperature	AI	TS-1B	X		1 min	15 min	F
Return air temperature	AI	TS-1A	X		1 min	15 min	F
Supply air static pressure	AI	Reuse existing			1 min	15 min	F
Outdoor airflow	AI	AFMS-4 airflow output	X	X	1 min	15 min	HH
Outdoor temperature	AI	AFMS-4 outdoor air temperature mounted behind louver	X		1 min	15 min	F
Room temperature	AI	TS-3CC located in front of classroom – confirm location via RFI	X	?	1 min	15 min	F
CO_2	AI	TS-3CC. Abandon (E) duct CO_2 sensor	X	X	1 min	15 min	F

2. AH-2, 3 (TCP-2, 3)

a. Schematic
   1) Eliminated points
      a) Damper end switch
      b) Isolation damper – lock damper wide open
      c) CO_2 sensor
      d) Outdoor air temperature sensor (replaced with AFMS sensor)
      e) Low static pressure alarm
      f) High static pressure alarm

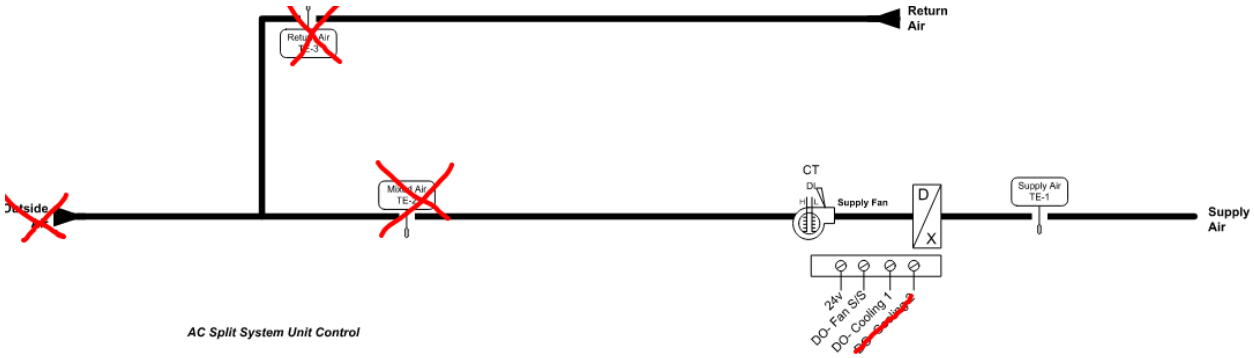


b. Points

Description	Type	Device	New Device	New Point	Trend Logging		Calibration
					Commissioning	Continuous	
SF Start/Stop	DO	(E) VFD contact			COV	COV	–
RF Start/Stop	DO	(E) VFD contact			COV	COV	–
SF Speed	AO	(E) VFD contact			1 min	15 min	–
RF Speed	AO	(E) VFD contact			1 min	15 min	–
HW valve	AO	(E) 2-way valve with new NEMA 4 actuator	X		1 min	15 min	–
CHW valve	AO	(E) 2-way valve with new NEMA 4 actuator	X		1 min	15 min	–
Return dampers	AO	(E) dampers with new actuators	X		1 min	15 min	–

Description	Type	Device	New Device	New Point	Trend Logging		Cali-bra-tion
					Comm-issioning	Contin-uous	
Relief dampers	AO	(E) dampers with new actuators	X	X	1 min	15 min	–
Outdoor air dampers	AO	(E) dampers with new actuators	X	X	1 min	15 min	–
SF fault	DI	(E) VFD contact			COV	COV	–
RF fault	DI	(E) VFD contact			COV	COV	–
Dirty filter	DI	(E) Magnehelic switch			COV	COV	–
Smoke detector	DI	(E) Smoke detector contact			COV	COV	–
SF speed feedback	AI	(E) VFD contact			1 min	15 min	–
RF speed feedback	AI	(E) VFD contact			1 min	15 min	–
Building static pressure	AI	DPT-4A using existing plate sensor	X		1 min	15 min	F
Return fan discharge pressure	AI	DPT-3A installed at discharge of RF	X	X	1 min	15 min	F
Mixed air temperature	AI	TS-1B	X		1 min	15 min	F
Supply air temperature	AI	TS-1B	X		1 min	15 min	F
Return air temperature	AI	TS-1A	X		1 min	15 min	F
Supply air static pressure	AI	DPT-3A	X		1 min	15 min	F
Outdoor airflow	AI	AFMS-4 airflow output. Demo Ebtron sensor	X	X	1 min	15 min	HH
Outdoor temperature	AI	AFMS-4 outdoor air temperature mounted behind louver	X		1 min	15 min	F

3. ACS/CU-1, 2
   a. Schematic
      1) Eliminated points
         a) Mixed air temperature
         b) Return air temperature

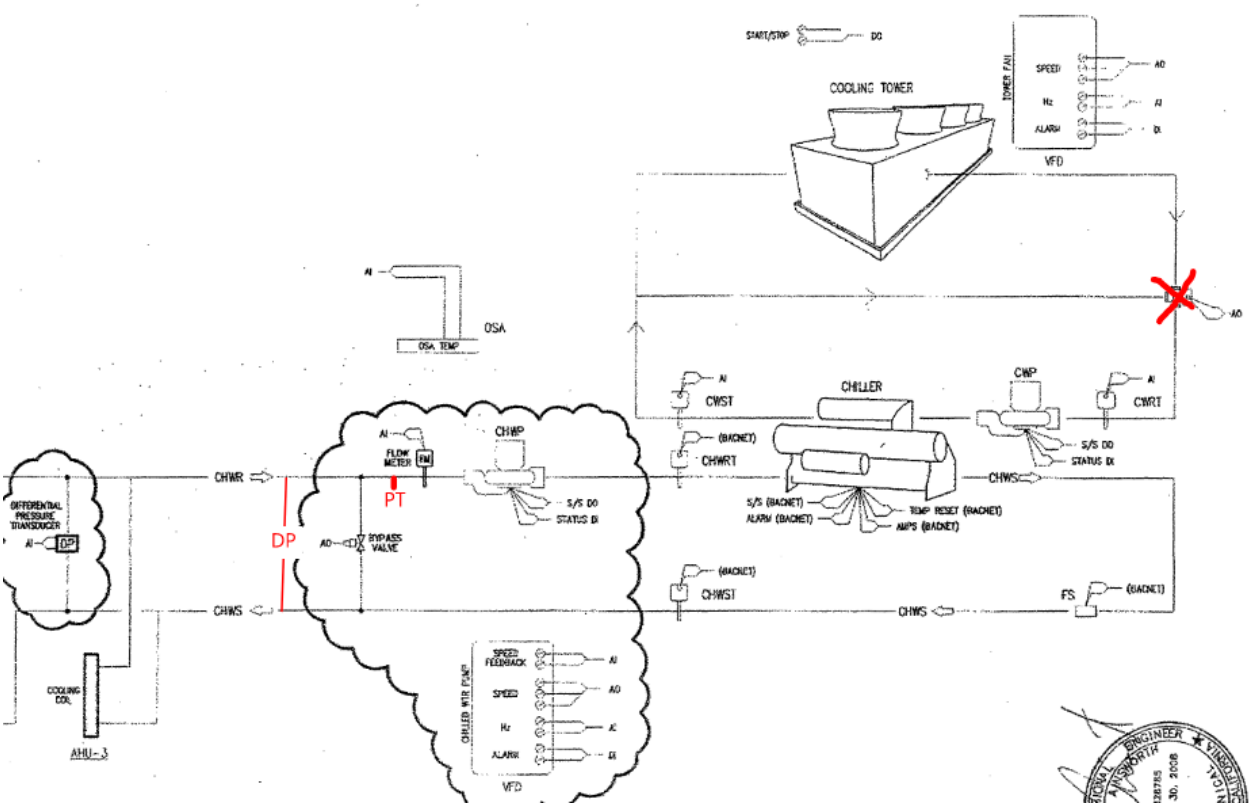


b. Points

Description	Type	Device	New Device	New Point	Trend Logging		Calibra-tion
					Comm-issioning	Contin-uous	
Start Fan	DO	(E) Contact			COV	COV	–
Cooling	DO	(E) Contact			COV	COV	–
Supply fan status	DI	(E) Current switch			COV	COV	–
Supply air temperature	AI	TS-1A	X		1 min	15 min	F
~~Zone Temperature Setpoint Adjustment~~	~~AI~~	~~TS-3C~~			~~15 min~~	~~60 min~~	~~F~~
Zone Temperature	AI	TS-3~~C~~A	X		1 min	15 min	F

4. Chiller Plant (TCP-4)

   a. Schematic
      1) Eliminated points
         a) Tower bypass. Lock valve in 100% to tower position; remove actuator and control wiring
         b) Refrigerant alarm (if it exists – now through Modbus)
      2) Notes
         a) CH-1 is entirely controlled via BACnet interface
         b) Verify EF-7 is hardwired to refrigerant monitor Alarm (Evacuate) start contact to run at full speed. Fan is not controlled by the BAS.



b. Chiller Plant Points

Description	Type	Device	New Device	New Point	Trend Logging		Cali-bra-tion
					Comm-issioning	Contin-uous	
CHW pump Start/Stop	DO	(E) VFD contact			COV	COV	–
CT fan Start/Stop	DO	(E) VFD contact			COV	COV	–
CW pump Start/Stop	DO	(E) starter contact			COV	COV	–
CW Pump Status	DI	CS-1 or CT-1	X	X	COV	COV	See 3.11 F
EF-7	DI	(E) current switch	X	X	COV	COV	–
Cooling tower high level alarm	DI	Contact on level sensor at tower (just being installed by others)		X	COV	COV	–
Cooling tower low level alarm	DI	Ditto		X	COV	COV	–
CHW pump fault	DI	(E) VFD contact			COV	COV	–
CT Fan fault	DI	(E) VFD contact			COV	COV	–
CHW pump speed feedback	AI	(E) VFD contact			1 min	15 min	–

Description	Type	Device	New Device	New Point	Trend Logging		Cali-bra-tion
					Comm-issioning	Contin-uous	
CT fan speed feedback	AI	(E) VFD contact			1 min	15 min	–
CHW pump speed	AO	(E) VFD contact			1 min	15 min	–
CT fan speed	AO	(E) VFD contact			1 min	15 min	–
CHW Bypass valve	AO	Modulating valve, sized for 200 gpm minimum flow at ~10 psi DP, in place of existing butterfly valve. Size same as pipe size or close as possible with reducers as required	X	X	1 min	5 min	–
CWS temperature from tower	AI	TS-2A	X		5 min	15 min	F
CWR temperature to tower	AI	TS-2A	X		5 min	15 min	F
CHW supply flow	AI	FM-2 in place of existing insertion turbine	X		5 min	15 min	F
CHW differential pressure at plant	AI	DPT-1, 0 to 40 psi, located at plant	X	X	5 min	15 min	F
CHW differential pressure at AH-2	AI	DPT-1, 0 to 20 psi, located at AH-2, connected to AH-2 TCP – reading transmitted via network	X	X	5 min	15 min	F
CHW system gauge pressure	AI	PT-1, 0 to 60 psi located near expansion tank connection to CHWR	X	X	15 min	1 hr	F
Outdoor air temperature	AI	TS-4	X		5 min	15 min	F
DCW flow (alternate bid only)	AI pulse	1.5” FM-6 or FM-1	X	X	±0.5 gpm	±0.5 gpm	F

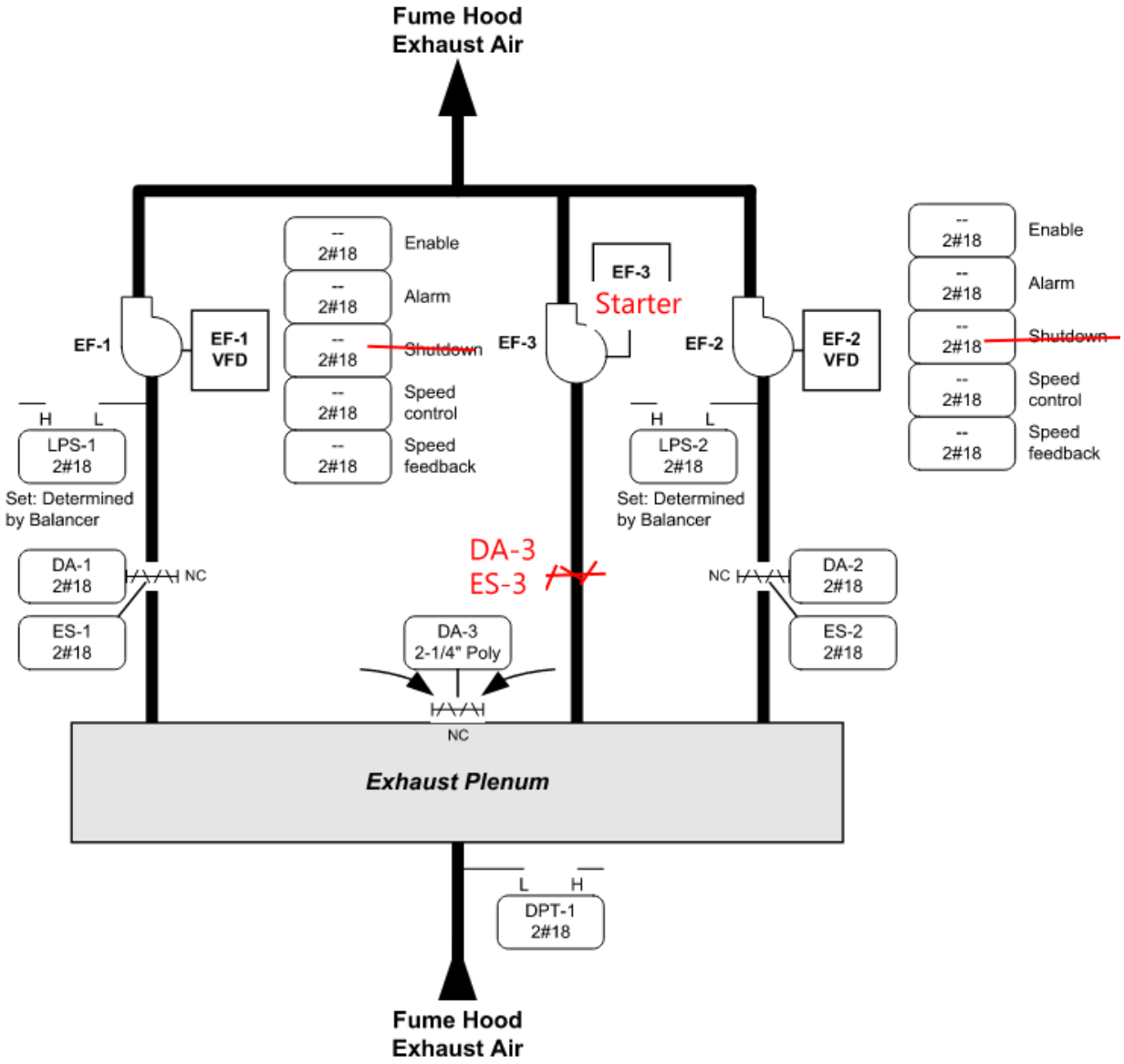
c. New Fan-Coil Points

Description	Type	Device	New Device	New Point	Trend Logging		Cali-bra-tion
					Comm-issioning	Contin-uous	
FC fan Start/Stop	DO	Starter contact		X	COV	COV	–
FC fan Status	DI	CS-1 or CT-1	X	X	COV	COV	See 3.11 F
Space temperature	AI	TS-3A	X	X	1 min	15 min	–
CHW valve	AO	(E) 2-way valve		X	1 min	15 min	–

5. Science building monitoring (TCP-MON)
   a. Verify all points in the field

Description	Type	Device	New Device	New Point	Trend Logging		Cali-bra-tion
					Comm-issioning	Contin-uous	
DWP-1 fail	DI	(E) fail contact			COV	COV	–
DWP-2 fail	DI	(E) fail contact			COV	COV	–
DWP-3 fail	DI	(E) fail contact			COV	COV	–
DWP-1 status	DI	(E) CS			COV	COV	–
DWP-2 status	DI	(E) CS			COV	COV	–
DWP-3 status	DI	(E) CS			COV	COV	–
ATS common alarm	DI	(E) alarm contact			COV	COV	–
ATS normal	DI	(E) contact			COV	COV	–
DCW pressure	AI	(E) DPT			15 min	15 min	–

6. Exhaust Air Systems (TCP-5)
   a. LEF Schematic



b. LEF Points

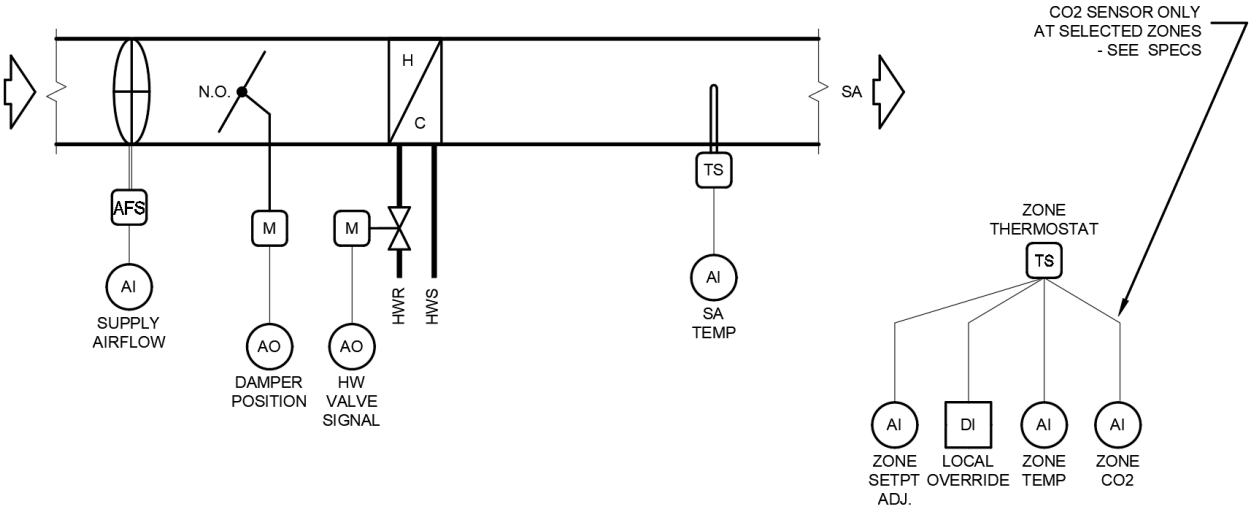
Description	Type	Device	New Device	New Point	Trend Logging		Calibration
					Commissioning	Continuous	
EF-1 start/stop	DO	(E) VFD contact			COV	COV	–
EF-2 start/stop	DO	(E) VFD contact			COV	COV	–
EF-3 start/stop	DO	(E) starter contact			COV	COV	–
EF-1 damper	DO	(E) damper with new actuator	X		COV	COV	–
EF-2 damper	DO	(E) damper with new actuator	X		COV	COV	–
EF-3 damper	DO	(E) damper with new actuator	X		COV	COV	–

Description	Type	Device	New Device	New Point	Trend Logging		Cali-bra-tion
					Comm-issioning	Contin-uous	
Bypass damper	AO	(E) damper with new actuator	X		1 min.	±5%	–
EF-1 fault	DI	(E) VFD contact			COV	COV	–
EF-2 fault	DI	(E) VFD contact			COV	COV	–
EF-3 fan status	DI	(E) current switch			COV	COV	–
EF-1 damper open status	DI	Actuator end switch	X		COV	COV	–
EF-2 damper open status	DI	Actuator end switch	X		COV	COV	–
EF-3 damper open status	DI	Actuator end switch	X		COV	COV	–
EF-1 low pressure switch	DI	(E) DPS			COV	COV	–
EF-2 low pressure switch	DI	(E) DPS			COV	COV	–
EF-1 speed feedback	AI	(E) VFD contact			1 min	15 min	–
EF-2 speed feedback	AI	(E) VFD contact			1 min	15 min	–
Exhaust Plenum static	AI	DPT-3B transmitter, 0 to 5”	X		1 min	15 min	F

c. Other EF Points

Description	Type	Device	New Device	New Point	Trend Logging		Cali-bra-tion
					Comm-issioning	Contin-uous	
EF-4 start/stop	DO	(E) starter contact			COV	COV	–
EF-4 fan status	DI	(E) current switch			COV	COV	–
EF-5 start/stop	DO	(E) starter contact	X	X	COV	COV	–
EF-5 fan status	DI	CS-1 or CT-1	X	X	COV	COV	See 3.11 F
EF-8 start/stop	DO	(E) starter contact			COV	COV	–
EF-8 fan status	DI	(E) current switch			COV	COV	–

7. VAV Box with Reheat
   a. Schematic



b. Revised setpoints: Use the following setpoints instead of those shown on original design drawings. Provide CO_2 sensors in zones indicated. "Old room#" refers to the numbers on design drawings.

Tag	Old Room#	Current Room#	Room Name	Vcool-max	Vmin	Vheat-max	Vocc-min	Varea-min	CO2
2.1	124	124	Corridor	475	AUTO	240	140	140	-
2.2	124	124	Corridor	1550	AUTO	915	125	125	-
2.3	133	139	Cadaver	1020	AUTO	1020	0	1020	-
2.4	132	133	Anatomy Lab	2585	AUTO	2585	0	2585	-
2.5	142	132	Bio Classroom	1995	AUTO	675	675	155	YES
2.6	131	131	Bio Classroom	1910	AUTO	575	540	140	YES
2.7	130	129	Bio Classroom	1910	AUTO	575	540	140	YES
2.10	125	125	Micro Prep/Stock	640	AUTO	640	0	640	-
2.13	144	142	Plant Study	230	AUTO	115	15	15	-
2.14	146	143	Storage	280	AUTO	140	0	15	-
2.15	147	144	Study	345	AUTO	175	120	20	YES
2.16	126	147	Storage	165	AUTO	85	0	15	-
2.17	241	241	Corridor	430	AUTO	215	70	70	-
2.18	234, 244	234, 232	Corridor, office	420	AUTO	210	85	85	-
2.19	227	227	Corridor	740	AUTO	370	125	125	-
2.20	237	242	Storage	125	AUTO	65	0	15	-
2.23	232-233	231-233	Office, Intrument Rm	665	AUTO	300	75	70	-
2.24	231	229	Science Classroom	2065	AUTO	620	480	145	YES
2.25	230	227	Science Classroom	2220	AUTO	665	480	145	YES
2.26	229	225	Tiered Classroom	1825	AUTO	900	900	240	YES
2.28	243	236	Instrument	265	AUTO	135	15	30	-
2.29	245	230	Engineering Lab	1255	AUTO	445	240	170	-

Tag	Old Room#	Current Room#	Room Name	Vcool-max	Vmin	Vheat-max	Vocc-min	Varea-min	CO2
2.30	246	228	Prep/stock	880	AUTO	440	30	160	-
2.31	247	238	Storage	290	AUTO	145	0	10	-
2.32	248	240	Optics	195	AUTO	100	30	35	-
2.33	249	226	Physics	980	AUTO	490	360	175	YES
3.1	101	101	Lobby	1515	AUTO	745	285	285	-
3.2	102	103	Auto-tutorial	1590	AUTO	525	525	160	YES
3.3	102	104	Auto-tutorial	1590	AUTO	525	525	160	YES
3.4	103	105	Group Study	190	AUTO	95	90	20	YES
3.5	104	104	Group Study	490	AUTO	245	120	45	YES
3.6	152	102	Bio Classroom	740	AUTO	720	720	130	YES
3.7	149	110	Storage	180	AUTO	90	15	30	-
3.8	109-110		Corridor/RRs	785	AUTO	435	0	160	-
3.9	111	124	Resource Room	180	AUTO	90	60	30	-
3.10	112	111	Office	260	AUTO	130	15	40	-
3.11	113-115	113-115	Office	425	AUTO	215	45	45	-
3.12	116-118	116-118	Office	420	AUTO	210	45	45	-
3.13	119-121	119-121	Office	420	AUTO	210	45	45	-
3.14	122	122	Storage	475	AUTO	240	15	45	-
3.15	201	201	Lobby	1000	AUTO	445	170	170	-
3.16	203	202	Tech/Media (Quiet)	1925	AUTO	600	600	175	YES
3.17	203	202	Tech/Media (Noisy)	590	AUTO	295	240	80	YES
3.18	204		Astronomy	150	AUTO	75	60	15	YES
3.19	205		Seminar	160	AUTO	90	90	20	YES
3.20	206		Seminar	95	AUTO	75	75	20	YES
3.21	208	206	Seminar	120	AUTO	90	90	30	YES
3.22	210	208	Seminar	180	AUTO	90	90	35	YES
3.23	207	207	Corridor	615	AUTO	305	110	110	-
3.24	211-212		Corridor/RRs	850	AUTO	480	0	165	-
3.25	226	223	Resource Room	200	AUTO	100	60	35	-
3.26	225	222	Conference	235	AUTO	120	120	40	YES
3.27	215	211	Office	175	AUTO	90	15	15	-
3.28	216-217	213-214	Office	490	AUTO	245	30	25	-
3.29	218-220	215-217	Office	735	AUTO	300	45	45	-
3.30	221-223	218-220	Office	735	AUTO	300	45	45	-
3.31	224	221	Office	735	AUTO	300	45	45	-

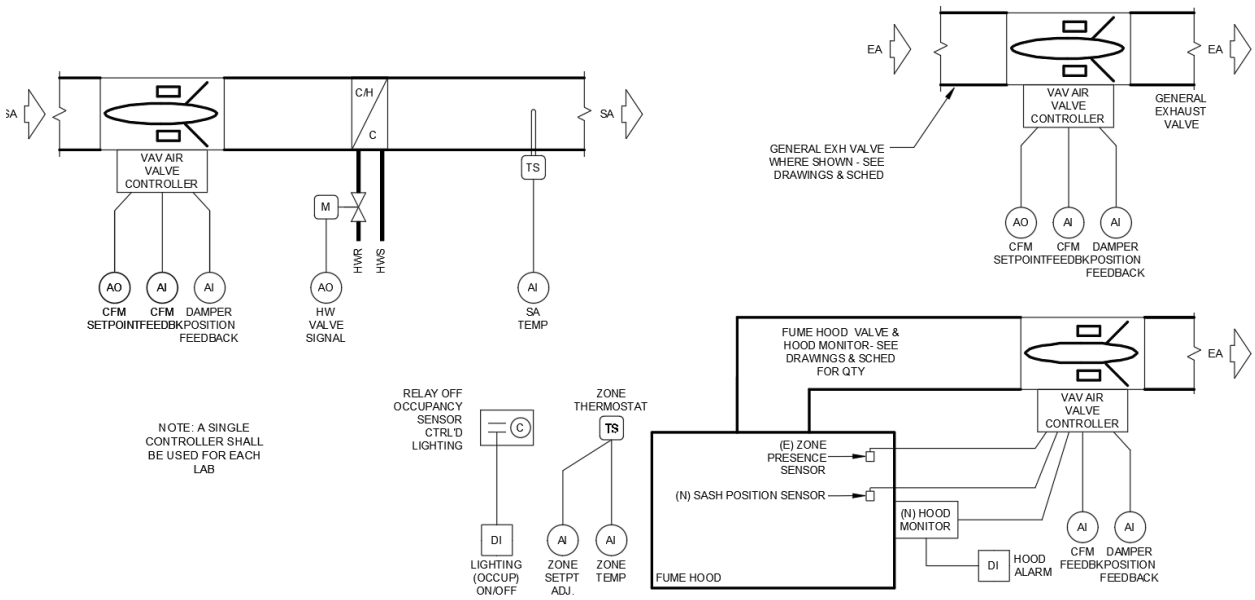
c. Points

Description	Type	Device	New Device	New Point	Trend Logging		Calibration
					Commissioning	Continuous	
VAV Box Damper Position	AO	Modulating analog actuator	X		1 min	15 min	–
HW valve signal	AO	(E) 2-way valve body with new actuator	X		1 min.	15 min	
Local Override	DI	TS-3C or TS-3CC	X		COV	COV	–
Supply Airflow	AI	DPT-5 connected to existing box manufacturer supplied flow cross	X		1 min	15 min	HH
Supply air temperature	AI	Existing	X		1 min	15 min	F
Zone Temperature Setpoint Adjustment	AI	TS-3C or TS-3CC	X		15 min	60 min	F
Zone Temperature	AI	TS-3C or TS-3CC	X		1 min	15 min	F
Zone CO_2 concentration	AI	TS-3CC where indicated in schedule above	X	X	1 min	15 min	F

d. Auxiliary Points

Description	Type	Device	New Device	New Point	Trend Logging		Calibration
					Commissioning	Continuous	
Electrical room 138 temperature	AI	(E) thermistor tied to VAV 2.4			1 min	15 min	

8. Lab Zones
   a. Use one controller per lab so that network operation does not affect lab performance.
   b. Schematic



c. Revised setpoints. Use the following setpoints instead of those shown on original design drawings. "Old room#" refers to the numbers on design drawings. See original design schedule for hood maximum and minimum setpoints, which shall be configured into the new hood air valves.

Tag	Old Room #	Current Room#	Room Name	Vmax	Vcool-max	Vmin-occ	Vmin-unocc	Voffset	Vgex-max	Vol-ume	Hood Valve Qty	Cabinet Valve Qty
2.8	143	130	Majors Bio Lab	1680	1680	1530	970	-150	1570	16800	1	0
2.9	129	127	Microbio Lab	1770	1770	1620	1030	-150	1670	17700	1	0
2.11	148	126	General Bio Lab	1650	1650	1500	950	-150	1535	16500	1	0
2.12	145	128	Bio prep	750	750	600	350	-150	535	7500	1	1
2.21	236	237	Chem Prep	1520	1190	950	585	-150	740	11010	2	0
2.22A -D	235	235	Organic Chem Lab	10400	4750	1435	905	-150	0	15830	17	0
2.27	242	234	General Chem Lab	3640	1875	1460	925	-150	525	16100	5	0

d. Points

Description	Type	Device	New Device	New Point	Trend Logging		Calibra-tion
					Comm-issioning	Contin-uous	
Hood alarm (any hood)	DI	Connect to new hood monitor alarm contact, in parallel if more than one hood	X	X	COV	COV	–
Occupancy	DI	Relay connected to light fixture controlled by occupancy sensor	X	X	COV	COV	–

Description	Type	Device	New Device	New Point	Trend Logging		Calibra-tion
					Comm-issioning	Contin-uous	
Presence sensor	DI	Reuse (E) Zone presence sensor & power supply			COV	COV	–
Supply airflow setpoint	AO	To air valve	X		1 min	15 min	–
General exhaust airflow setpoint	AO	To air valve	X		1 min	15 min	–
HW valve position	AO	(E) 2-way valve body with new actuator	X		1 min.	15 min	
Supply Airflow	AI	Air valve CFM feedback	X		1 min	15 min	F
Supply Damper position	AI	Air valve damper position feedback	X		1 min	15 min	F
General Exhaust Airflow	AI	Air valve CFM feedback	X		1 min	15 min	F
General Exhaust Damper position	AI	Air valve damper position feedback	X		1 min	15 min	F
Hood Exhaust Airflow (each hood)	AI	Air valve CFM feedback	X		1 min	15 min	F
Hood Exhaust Damper position (each hood)	AI	Air valve damper position feedback	X		1 min	15 min	F
Supply air temperature	AI	TS-1A	X		1 min	15 min	F
Zone Temperature Setpoint Adjustment	AI	TS-3C	X		15 min	60 min	F
Zone Temperature	AI	TS-3C	X		1 min	15 min	F

9. Plumbing Equipment Room 123

Description	Type	Device	New Device	New Point	Trend Logging		Calibra-tion
					Comm-issioning	Contin-uous	
Industrial HW pump	DO	(E) starter contact			COV	COV	–
Domestic HW pump	DO	(E) starter contact			COV	COV	–
Industrial HW pump status	DI	(E) current switch			COV	COV	–
Domestic HW pump status	DI	(E) current switch			COV	COV	–
IHW supply temperature	AI	TS-2A	X		1 min	15 min	F

Description	Type	Device	New Device	New Point	Trend Logging		Calibra-tion
					Comm-issioning	Contin-uous	
DHW supply temperature	AI	TS-2A	X		1 min	15 min	F
DCW flow (alternate bid only)	AI pulse	4” FM-6 or FM-1	X	X	±0.5 gpm	±0.5 gpm	F
Natural gas flow (alternate bid only)	AI pulse	2” FM-3B	X	X	±0.5 gpm	±0.5 gpm	F

PART 3 EXECUTION

3.1 INSTALLATION - GENERAL

A. Install systems and materials in accordance with manufacturer’s instructions, roughing-in drawings and details indicated on Drawings.

B. Coordinate Work and Work schedule with other trades prior to construction.

C. Examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 DELIVERY, STORAGE, AND HANDLING

A. Provide factory-shipping cartons for each piece of equipment and control device. Maintain cartons during shipping, storage and handling as required to prevent equipment damage, and to eliminate dirt and moisture from equipment.

B. Store equipment and materials inside and protect from weather.

3.3 IDENTIFICATION

A. General

1. Manufacturers’ nameplates and UL or CSA labels to be visible and legible after equipment is installed.

2. Identifiers shall match record documents.

3. All plug-in components shall be labeled such that removal of the component does not remove the label.

B. Wiring and Tubing

1. All wiring and cabling, including that within factory-fabricated panels, shall be labeled at each end within 2 inches of termination with the BAS address or termination number.

2. Permanently label or code each point of field terminal strips to show the instrument or item served.

3. All pneumatic tubing shall be labeled at each end within 2 inches of termination with a descriptive identifier.

C. Equipment and Devices

1. Valve and damper actuators: None required.

2. Sensors: Provide 1 inch x 3 inches x 1/8 inches black micarta or lamacoid labels with engraved white lettering, ¼ inches high. Indicate sensor identifier and function (for example “CHWS Temp”).

3. Panels
   a. Provide 2 inches x 5 inches 1/8 inches black micarta or lamacoid labels with engraved white lettering, ½ inches high. Indicate panel identifier and service.
   b. Provide permanent tag indicating the electrical panel and circuit number from which panel is powered.

4. Identify room sensors relating to terminal box or valves with indelible marker on sensor hidden by cover.

3.4 CUTTING, CORING, PATCHING AND PAINTING

A. Provide canning for openings in concrete walls and floors and other structural elements prior to their construction.

B. Penetrations through rated walls or floors shall be filled with a listed material to provide a code compliant fire-stop.

C. All damage to and openings in ductwork, piping insulation, and other materials and equipment resulting from Work in this Section shall be properly sealed, repaired, or re-insulated by experienced mechanics of the trade involved. Repair insulation to maintain integrity of insulation and vapor barrier jacket. Use hydraulic insulating cement to fill voids and finish with material matching or compatible with adjacent jacket material.

D. At the completion of Work, all equipment furnished under this Section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be repaired and repainted to original finish.

3.5 CLEANING

A. Clean up all debris resulting from its activities daily. Remove all cartons, containers, crates, and other debris generated by Work in this Section as soon as their contents have been removed. Waste shall be collected and legally disposed of.

B. Materials stored on-site shall be protected from weather and stored in an orderly manner, neatly stacked, or piled in the designated area assigned by the College’s Representative.

C. At the completion of work in any area, clean all work and equipment of dust, dirt, and debris.

D. Use only cleaning materials recommended by the manufacturer of the surfaces to be cleaned and on surfaces recommended by the cleaning material manufacturer.

3.6 CONTROLLERS

A. General

1. Install systems and materials in accordance with manufacturer's instructions, specifications roughing-in drawings and details indicated on Drawings.

2. Regardless of application category listed below, each Control Unit shall be capable of performing the specified sequence of operation for the associated equipment. Except as listed below, all physical point data and calculated values required to accomplish the sequence of operation shall reside within the associated CU. Listed below are point data and calculated values that shall be allowed to be obtained from other CUs via LAN.
   a. Global points such as outdoor air temperature
   b. Requests, such as heat/cool requests, used to request operation or for setpoint reset from zones to systems and systems to plants
   c. Modes, such as system modes, used to change operating logic from plants to systems and systems to zones

3. Where associated control functions involve functions from different categories identified below, the requirements for the most restrictive category shall be met.

B. Controller Application Categories

1. Controllers shall comply with the application table below (X under controller type indicates acceptable controller type).

Application Category	Examples	Acceptable Controller		
		ASC	AAC	BC
0	Monitoring of variables that are not used in a control loop, sequence logic, or safety, such as status of sump pumps or associated float switches, temperatures in monitored electrical rooms.	X	X	X
1	Constant speed exhaust fans and pumps	X	X	X
2	VAV Zones Unitary AC and HP units	X		
3	Air Handling Units Lab Exhaust Fans Lab Zones		X (note 1)	X
4	Chilled Water Plant		X (note 1)	X

Application Category	Examples	Acceptable Controller		
		ASC	AAC	BC
Notes: 1. Controller may be used only if all control functions and physical I/O associated with a given unit resides in one AAC/ASC 2. There shall be at least one BC in the system.				

2. ASC Installation
   a. ASCs that control equipment located above accessible ceilings shall be mounted on the equipment in an accessible enclosure and shall be rated for plenum use if ceiling attic is used as a return air plenum.
   b. ASCs that control equipment mounted in a mechanical room may either be mounted in or on the equipment, or on the wall of the mechanical room at an adjacent, accessible location.
   c. ASCs that control equipment mounted outside or in occupied spaces shall either be located in the unit or in a proximate mechanical/utility space.

3. AAC and BC Installation
   a. AACs/BCs shall be located in a temperature control cabinets constructed per Paragraph 2.8.

3.7 COMMUNICATION DEVICES

A. General

1. Install systems and materials in accordance with manufacturer's instructions, roughing-in drawings and details indicated on Drawings.

2. Provide all interface devices and software to provide an integrated system.

B. LANID and LAN Routers

1. Provide as required

2. Connect networks to both sides of device

3. Thoroughly test to ensure proper operation

4. Interruptions or fault at any point on any Primary LAN shall not interrupt communications between other nodes on the network. If a LAN is severed, two separate networks shall be formed and communications within each network shall continue uninterrupted. The system shall automatically monitor the operation of all network devices and annunciate any device that goes off-line because it is failing to communicate.

C. Gateways and Protocol Translators to Equipment Controllers

1. See Paragraph 2.4C for network connection of Gateways and Protocol Translators.

2. Wire to networks on both sides of device.

3. Map across all monitoring and control points listed in Paragraph 2.13C.

4. Thoroughly test each point to ensure that mapping is accurate.

5. Initiate trends of points as indication in Paragraph 2.13C.

3.8 CONTROL AIR TUBING

A. Sensor air tubing shall be sized by the Contractor.

B. All control air piping shall be concealed except in equipment rooms or unfinished areas.

C. Installation methods and materials

1. Concealed and Inaccessible: Use copper tubing or FR plastic in metal raceway. Exception: Room thermostat drops in stud walls in areas with lay-in ceiling may be FR plastic tubing.

2. Concealed and Accessible tubing (including ceiling return air plenums) shall be copper tubing or FR plastic tubing, subject to the following limitations
   a. FR tubing shall be enclosed in metal raceway when required by local code.
   b. Quantity of FR tubing per cubic foot of plenum space shall not exceed manufacturer's published data for Class 1 installation.

3. Exposed to view or damage: Use hard-drawn copper or FR plastic in metal raceway.
   a. Where copper tubing is used, a section 12 inches or less of FR plastic tubing is acceptable at final connection to control device.

D. Mechanically attach tubing to supporting surfaces. Sleeve through concrete surfaces in minimum 1 inch sleeves, extended 6 inches above floors and 1 inch below bottom surface of slabs.

E. Pneumatic tubing shall not be run in raceway containing electrical wiring.

F. Where FR tubing exits the end of raceway or junction box, provide a snap-in nylon bushing. Where pneumatic tubing exits control panels, provide bulkhead fittings. Where copper tubing exits junction boxes or panels, provide bulkhead fittings.

G. All tubing shall be number coded on each end and at each junction for easy identification.

H. All control air piping shall be installed in a neat and workmanlike manner parallel to building lines with adequate support.

I. Piping above suspended ceilings shall be supported from or anchored to structural members or other piping or duct supports. Tubing shall not be supported by or anchored to electrical raceways or ceiling support systems.

J. Brass-barbed fittings shall be used at copper-to-FR tubing junctions. Plastic slipped-over copper tubing is not acceptable.

K. Number-code or color-code tubing, except local individual room control tubing, for future identification and servicing of control system. Code shall be as indicated on approved installation drawings.

3.9 CONTROL POWER

A. Power wiring and wiring connections required for Work in this Section shall be provided under this Section. Do not exclude this work – there is no other electrical contractor. Subcontract electrical work if required.

B. Existing 120V power connections may be reused.

C. Extend power to all new BAS devices, including 120V power to panels, from an acceptable power panel.

D. General requirements for obtaining power include the following:

1. Electrical service to controls panels and control devices shall be provided by isolated circuits, with no other loads attached to the circuit, clearly marked at its source. The location of the breaker shall be clearly identified in each panel served by it.

2. Obtain power from a source that feeds the equipment being controlled such that both the control component and the equipment are powered from the same panel. Where equipment is powered from a 460V source, obtain power from the electrically most proximate 120V source fed from a common origin.

3. Where control equipment is located inside a new equipment enclosure, coordinate with the equipment manufacturer and feed the control with the same source as the equipment. If the equipment's control transformer is large enough and of the correct voltage to supply the controls, it may be used. If the equipment's control transformer is not large enough or not of the correct voltage to supply the controls, provide separate transformer(s).

4. Where a controller controls multiple systems on varying levels of power reliability (normal, emergency, or interruptible), the controller, and any associated switches and devices necessary its operation, shall be powered by the highest level of reliability served.

E. Unless transformers are provided with equipment, Contractor shall provide transformers for all low voltage control devices including non-powered terminal units such as VAV boxes. Transformer(s) shall be located in control panels in readily accessible locations such as Electrical Rooms.

F. Power line filtering. Provide transient voltage and surge suppression for all workstations and BCs either internally or as an external component.

3.10 CONTROL AND COMMUNICATION WIRING

A. Control and Signal Wiring

1. Line Voltage Wiring
   a. All line-voltage wiring shall meet NEC Class 1 requirements.
   b. All Class 1 wiring shall be installed in UL Listed approved raceway per NEC requirements and shall be installed by a licensed electrician.
   c. Class 1 wiring shall not be installed in raceway containing pneumatic tubing.

2. Low Voltage Wiring
   a. All low-voltage wiring shall meet NEC Class 2 requirements. (Low-voltage power circuits shall be sub-fused when required to meet Class 2 current-limit.)
   b. Class 2 wiring shall be installed in UL Listed approved raceway as follows:
      1) Where located in unconcealed or inaccessible locations, such as:
         a) Equipment rooms
         b) Exposed to weather
         c) Exposed to occupant view
         d) Inaccessible locations such as concealed shafts and above inaccessible ceilings
      2) Class 2 wiring shall not be installed in raceway containing Class 1 wiring.
   c. Class 2 wiring need not be installed in raceway as follows:
      1) Where located in concealed and easily accessible locations, such as:
         a) Inside mechanical equipment enclosures and control panels
         b) Above suspended accessible ceilings (e.g. lay-in and spline)
         c) Above suspended drywall ceilings within reach of access panels throughout
         d) In shafts within reach of access panels throughout
         e) Nonrated wall cavities
      2) Wiring shall be UL Listed for the intended application. For example, cables used in floor or ceiling plenums used for air transport shall be UL Listed specifically for that purpose.
      3) Wiring shall be supported from or anchored to structural members neatly tied at 10 foot intervals and at least 1 foot above ceiling tiles and light fixtures. Support or anchoring from straps or rods that support ductwork or piping is also acceptable. Cables shall not be supported by or anchored to ductwork, electrical raceways, piping, or ceilings.
      4) Install wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations.
   d. Boxes and panels containing high-voltage wiring and equipment shall not be used for low-voltage wiring except for the purpose of interfacing the two (for example relays and transformers).

3. All wire-to-device connections shall be made at a terminal block or terminal strip. All wire-to-wire connections shall be at a terminal block.

4. All field wiring shall be properly labeled at each end, with self-laminating typed labels indicating device address, for easy reference to the identification schematic. All power wiring shall be neatly labeled to indicate service, voltage, and breaker source.

5. Use coded conductors throughout with different colored conductors.

6. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.

7. Maximum allowable voltage for control wiring shall be 120 V. If only higher voltages are available, the Contractor shall provide step-down transformers.

8. All wiring shall be installed as continuous lengths, with no splices permitted between termination points.

9. Size of raceway and size and type of wire shall be the responsibility of the Contractor, in keeping with the manufacturer's recommendation and NEC requirements.

10. Include one pull string in each raceway 1 inch or larger.

11. Control and status relays are to be located in designated enclosures only. These enclosures include packaged equipment control panel enclosures unless they also contain Class 1 starters.

12. Conceal all raceways, except within mechanical, electrical, or service rooms. Install raceway to maintain a minimum clearance of 6 inches from high-temperature equipment (for example steam pipes or flues).

13. Secure raceways with raceway clamps fastened to the structure and spaced according to code requirements. Raceways and pull boxes may not be hung on flexible duct strap or tie rods. Raceways may not be run on or attached to ductwork.

14. Install insulated bushings on all raceway ends and openings to enclosures. Seal top end of all vertical raceways.

15. Terminate all control or interlock wiring.

16. Maintain updated as-built wiring diagrams with terminations identified at the jobsite.

17. Flexible metal raceways and liquid-tight, flexible metal raceways shall not exceed 3 feet in length and shall be supported at each end. Flexible metal raceway less than ½ inches electrical trade size shall not be used. In areas exposed to moisture liquid-tight, flexible metal raceways shall be used.

18. Raceway must be rigidly installed, adequately supported, properly reamed at both ends, and left clean and free of obstructions. Raceway sections shall be joined with couplings per code. Terminations must be made with fittings at boxes and ends not terminating in boxes shall have bushings installed.

19. Shielded cable shield shall be grounded only at one end. Signal wiring shield shall be grounded at controller end only unless otherwise recommended by the controller manufacturer.

B. Communication Wiring

1. Adhere to the requirements of Paragraph 3.10A in addition to this Paragraph.

2. Communication and signal wiring may be run without conduit in concealed, accessible locations as permitted by Paragraph 3.10A only if noise immunity is ensured. Contractor is fully responsible for noise immunity and rewire in conduit if electrical or RF noise affects performance.

3. All cabling shall be installed in a neat and workmanlike manner. Follow all manufacturers' installation recommendations for all communication cabling.

4. Do not install communication wiring in raceway and enclosures containing Class 1 or other Class 2 wiring.

5. Maximum pulling, tension, and bend radius for cable installation as specified by the cable manufacturer shall not be exceeded during installation.

6. Verify the integrity of the entire network following the cable installation. Use appropriate test measures for each particular cable.

7. All runs of communication wiring shall be unspliced length when that length is commercially available.

8. All communication wiring shall be labeled to indicate origination and destination data.

9. Grounding of coaxial cable shall be in accordance with NEC regulations Article on Communications Circuits, Cable and Protector Grounding.

10. Power-line carrier signal communication or transmission is not acceptable.

3.11 SENSORS AND MISCELLANEOUS FIELD DEVICES

A. Install sensors in accordance with the manufacturer's recommendations.

B. Mount sensors rigidly and adequately for the environment within which the sensor operates.

C. Sensors used as controlled points in control loops shall be hardwired to the controller to which the controlled device is wired and in which the control loop shall reside.

D. Temperature Sensors

1. Room temperature sensors and thermostats shall be installed with back plate firmly secured to the wall framing or drywall anchors.
   a. For sensors mounted in exterior walls or columns, use a back plate insulated with foam and seal all junction box openings with mastic sealant.
   b. For sensors on exposed columns, use Wiremold or equal enclosures that are the smallest required to enclose wiring (e.g. Wiremold 400 BAC or equal) and Wiremold or equal junction boxes that are the narrowest required to enclose the temperature sensor and wiring connections (e.g. Wiremold 2348S/51 or

equal). Color or raceway and boxes shall be per the architect; submit for approval prior to installation.

2. All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.

3. Averaging sensors shall be installed in a serpentine manner vertically across duct. Each bend shall be supported with a capillary clip. Where located in front of filters (such as mixed air sensors), access for filter removal shall be maintained.

4. Temperature sensors downstream of coils shall be located as far from the coil fins as possible, 6 inches minimum. Temperature sensors upstream of coils shall be a minimum of 6 inches away from the coil fins. No part of the sensor or its support elements or conduit shall be in contact with the coil, coil framing or coil support elements. Discharge temperature sensors on VAV boxes shall be mounted as far from the coil as possible but upstream of the first diffuser with the probe located as near as possible to the center of the duct both vertically and horizontally.

5. All pipe-mounted temperature sensors shall be installed in wells. For small piping, well shall be installed in an elbow into pipe length. Install the sensor in the well with a thermal-conducting grease or mastic. Use a closed-cell insulation patch that is integrated into the pipe insulation system to isolate the top of the well from ambient conditions but allow easy access to the sensor. Install a test plug adjacent to all wells for testing and calibration.

6. Unless otherwise noted on Drawings or Points List, temperature sensors/thermostats, humidity sensors/humidistats, CO_2 sensors, and other room wall mounted sensors shall be installed at same centerline elevation as adjacent electrical switches, 4 feet above the finished floor where there are no adjacent electrical switches, and within ADA limitations.

7. Unless otherwise noted on Drawings or Points List, install outdoor air temperature sensors on north wall where they will not be influenced by building exhaust, exfiltration, or solar insolation. Do not install near intake or exhaust air louvers.

E. Differential Pressure Sensors

1. Supply Duct Static Pressure
   a. Mount transmitter in temperature control panel near or in BAS panel to which it is wired.
   b. Low pressure port of the pressure sensor
      1) Pipe to either
         a) Building pressure (high) signal of the building static pressure transmitter.
         b) Open to a conditioned space inside the building
         c) Open to the BAS panel in which the DPT is mounted provided the panel is inside the building envelope and not in an air plenum.
   c. High-pressure port of the pressure sensor

1) Pipe to the duct using a static pressure tip located as indicated on Drawings; if no location is indicated, locate at end of duct riser or main as far out in the system as possible but upstream of all smoke and fire dampers.
2) Install pressure tips securely fastened with tip facing upstream in accordance with manufacturer's installation instructions.

2. Return Fan Discharge Plenum Pressure
   a. Mount transmitter in temperature control panel near or in BAS panel to which it is wired.
   b. Low pressure port of the pressure sensor
      1) Pipe to either
         a) Building pressure (low) signal of the building static pressure transmitter.
         b) Separate ambient static pressure probe located on the outside of the relief damper through a high-volume accumulator or otherwise protected from wind fluctuations.
   c. High-pressure port of the pressure sensor
      1) Pipe to the duct using a static pressure tip located at the discharge of the return fan.
      2) Install pressure tips securely fastened with tip facing upstream in accordance with manufacturer's installation instructions.

3. Building Static Pressure
   a. Mount transmitter in temperature control panel near or in BAS panel to which it is wired.
   b. Low pressure port of the pressure sensor
      1) Pipe to the ambient static pressure probe located on the outside and at high point of the building through a high-volume accumulator or otherwise protected from wind fluctuations.
   c. High-pressure port of the pressure sensor
      1) Pipe to either
         a) Behind a BAS temperature sensor cover in an interior zone (provided sensor has openings to allow ambient air to freely flow through it)
         b) Wall plate sensor or wall/ceiling probe sensor as scheduled
      2) Do not locate near elevators, exterior doors, atria, or (for ceiling sensor applications) near diffusers.

4. Filter Differential Pressure
   a. Reuse existing

5. All pressure transducers, other than those controlling VAV boxes, shall be located where accessible for service without use of ladders or special equipment. If required, locate in field device panels and pipe to the equipment monitored or ductwork.

6. The piping to the pressure ports on all pressure transducers (both air and water) shall contain a capped test port located adjacent to the transducer.

7. Piping differential pressure transducers shall have one of the following:

a. Five valve manifold, brass, two valves to allow removal of sensor without disrupting the hydronic system, an equalizing valve to allow the sensor to be zeroed and to prevent sensor from experiencing full static (as opposed to differential), and two valves used as air vents that also can be used as test plugs for calibration.
b. For sensors using two separate sensors, install test plugs on each connection for calibration and also used as vents.

F. Current Switches and Current Transformers for Motor Status Monitoring

1. For CTs, create a software binary point for fan status triggered at a setpoint determined below and ~10% deadband.

2. Adjust the setpoint so that it is below minimum operating current and above motor no load current. For fans with motorized discharge dampers, adjust so that fan indicates off if damper is closed while fan is running. For pumps, adjust so that pump indicates off if valve is closed while pump is running.

G. Airflow Measuring Stations: Install per manufacturer's recommendations for unobstructed straight length of duct both upstream and downstream of sensor, except those installations specifically designed for installation in fan inlet. For installations in fan inlets, provide on both inlets of double inlet fans and provide inlet cone adapter as recommended by AFMS manufacturer.

H. Fluid Flow Meters: Install per manufacturer's recommendations for unobstructed straight length of pipe both upstream and downstream of sensor. Commission per the manufacturer's startup and commissioning recommendations. Complete all manufacturer's startup documentation and include this in prefunctional commissioning report.

I. Actuators

1. Type: All actuators shall be electric.

2. Mount and link control damper actuators per manufacturer's instructions.

3. Dampers
a. To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close the damper, and then tighten the linkage, or follow manufacturer's instructions to achieve same effect.
b. Check operation of damper-actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
c. Provide all mounting hardware and linkages for actuator installation.

4. Control Valves: Install so that actuators, wiring, and tubing connections are accessible for maintenance. Where possible, mount the valve so that the position indicator is visible from the floor or other readily accessible location. However, do not install valves with stem below horizontal or down. The preferred location for the valve and actuator is on lowest point in the valve train assembly

for ease of access and inspection. If this is on the coil supply piping, the control valve may be located there even if schematics (and standard practice) show valves located on the coil return piping. This comment applies to both 2−way valves and 3-way valves (which would become diverting valves rather than mixing valves in this location).

J. Laboratory Fume Hoods:

1. Install fume hood monitor in knock-out opening provided with hood in place of existing monitor.

2. Install sash sensors on each VAV fume hood in place of existing sash sensor. Reel-type sash sensors and their stainless steel cables shall be hidden from view. Bar-type sash sensors shall be affixed to the individual sash panels.

3. Configure hood air valve with maximum and minimum setpoints as indicated on original Mechanical Drawings. Setpoint when presence sensor indicates no occupancy shall be 60% of maximum airflow.

K. Laboratory Air Valves:

1. Connect air valves to existing flanges or adapt existing to accept a drawband connection on each duct.

2. Any duct fittings required shall match existing material, joining, and sealing methods.

3.12 SOFTWARE INSTALLATION

A. System Configuration

1. Thoroughly and completely configure BAS system software, supplemental software, network software etc. on servers.

B. Point Structuring and Naming

1. The intent of this Paragraph is to require a consistent means of naming points across the BAS. The following requirement establishes a standard for naming points and addressing Buildings, Networks, Devices, Instances, etc.

2. Point Summary Table
   a. The term “Point” includes all physical I/O points, virtual points, and all application program parameters.
   b. With each schematic, provide a Point Summary Table listing
      1) Building number and abbreviation
      2) System type
      3) Equipment type
      4) Point suffix
      5) Full point name (see Point Naming Convention Paragraph)
      6) Point description
      7) Ethernet backbone network number

8) Network number
9) Device ID
10) Device MAC address
11) Object ID (object type, instance number)
12) Engineering units
13) Device make and model number; include range of device if model number does not so identify.
14) Device physical location description; include floor and column line intersection to one decimal place (for example line 6.2 and line A.3).

c. Point Summary Table shall be provided in both hard copy and in a relational database electronic format (ODBC-compliant).
d. Coordinate with the College's representative and compile and submit a proposed Point Summary Table for review prior to any object programming or Project startup.
e. The Point Summary Table shall be kept current throughout the duration of the Project by the Contractor as the Master List of all points for the Project. Project closeout documents shall include an up-to-date accurate Point Summary Table. The Contractor shall deliver to the College the final Point Summary Table prior to final acceptance of the system. The Point Summary Table shall be used as a reference and guide during the commissioning process.

3. Point Naming Convention
   a. All point names shall adhere to the format as established below, unless otherwise agreed to by the College. New categories and descriptors may be created with approval of the College.
   b. Format:
      1) Building.Category.System.EquipmentTag.Component.Property.
      2) Example: 001.HVAC.Heatplant.B-1.HWS.Temperature

Building	Category	System	Equipment Tag	Component	Property	Typical units
Campus/ Building number	ELCT	Lighting Plug Generator Misc	(from equipment schedules)	SWITCH PHOTO CB CWS CWR HWS HWR CHWS CHWR OA SA RA EA GAS FLUID	Command Status Light Power Voltage Current ValvePos DamperPos Temperature Humidity Pressure Flow Energy Speed Signal	On/off On/off Footcandles Watts Volts Amps %open %open °F %RH Psig, "H_2O Cfm, gpm Btu %, Hz %
	HVAC	Airhandling Exhaust Heatplant Coolplant Misc				
	PLMB	Domwater Air Natgas N2 O2 Irrigation Waste Misc				
	MISC	Weather				

4. Device Addressing Convention
   a. BACnet network numbers and Device Object IDs shall be unique throughout the network.
   b. All assignment of network numbers and Device Object IDs shall be coordinated with the College to ensure there are no duplicate BACnet device instance numbers.
   c. Each Network number shall be unique throughout all facilities and shall be assigned in the following manner: VVVNN, where: VVV = 0-999 for BACnet Vendor ID, NN = 00 - 99 for building network.
   d. Each Device Object Identifier property shall be unique throughout the system and shall be assigned in the following manner: VVVNNDD , where: VVV = number 0 to 999 for BACnet Vendor ID , NN = 00 - 99 for building network, DD = 01-99 for device address on a network.
   e. Coordinate with the College or a designated representative to ensure that no duplicate Device Object IDs occur.
   f. Alternative Device ID schemes or cross-project Device ID duplication if allowed shall be approved before Project commencement by the College.

5. I/O Point Physical Description
   a. Each point associated with a hardware device shall have its BACnet long-name point description field filled out with:
      1) The device manufacturer and model number. Include range of device if model number does not so identify.
      2) For space sensors, include room number in which sensor is located.

C. Point Parameters

1. Provide the following minimum programming for each analog input
   a. Name
   b. Address
   c. Scanning frequency or COV threshold
   d. Engineering units
   e. Offset calibration and scaling factor for engineering units
   f. High and low value reporting limits (reasonableness values), which shall prevent control logic from using shorted or open circuit values.
   g. Default value to be used when the actual measured value is not reporting. This is required only for points that are transferred across the Primary or Secondary networks and used in control programs residing in control units other than the one in which the point resides. Events causing the default value to be used shall include failure of the control unit in which the point resides or failure of any network over which the point value is transferred.

2. Provide the following minimum programming for each analog output
   a. Name
   b. Address
   c. Engineering units
   d. Offset calibration and scaling factor for engineering units
   e. Output Range
   f. Default value to be used when the normal controlling value is not reporting.

3. Provide the following minimum programming for each digital input

a. Name
b. Address
c. Engineering units (on/off, open/closed, freeze/normal, etc.)
d. Debounce time delay
e. Message and alarm reporting as specified
f. Reporting of each change of state, and memory storage of the time of the last change of state
g. Totalization of on-time (for all motorized equipment status points), and accumulated number of off-to-on transitions.

4. Provide the following minimum programming for each digital output
   a. Name
   b. Address
   c. Output updating frequency
   d. Engineering units (on/off, open/closed, freeze/normal, etc.)
   e. Direct or Reverse action selection
   f. Minimum on-time
   g. Minimum off-time
   h. Status association with a DI and failure alarming (as applicable)
   i. Reporting of each change of state, and memory storage of the time of the last change of state.
   j. Totalization of on-time (for all motorized equipment status points), and accumulated number of off-to-on transitions.
   k. Default value to be used when the normal controlling value is not reporting.

D. Site-Specific Application Programming

1. All site specific application programming shall be written in a manner that will ensure programming quality and uniformity. Contractor shall ensure:
   a. Programs are developed by one programmer, or a small group of programmers with rigid programming standards, to ensure a uniform style.
   b. Programs for like functions are identical, to reduce debugging time and to ease maintainability.
   c. Programs are thoroughly debugged before they are installed in the field.

2. Massage and tune application programming for a fully functioning system. It is the Contractor's responsibility to request clarification on sequences of operation that require such clarification.

3. All site-specific programming shall be fully documented and submitted for review and approval
   a. Prior to downloading into the panel (see Submittal Package 2, Paragraph 1.9.)
   b. At the completion of functional performance testing, and
   c. At the end of the warranty period (see Warranty Maintenance, Paragraph 1.14).

4. All programming, graphics and data files must be maintained in a logical system of directories with self-explanatory file names. All files developed for the Project will be the property of the College and shall remain on the workstations/servers at the completion of the Project.

E. Graphic Screens

1. All site specific graphics shall be developed in a manner that will ensure graphic display quality and uniformity among the various systems.

2. Graphics shall conform to 4CD ALC standards. See Sample Graphics herein and also recently completed projects such as CCC Science Building. Existing Andover graphics are unacceptable so do not use them as templates.

3. Schematics of MEP systems
   a. Schematics shall be 2-D or 3-D and shall be based substantially on the schematics provided herein.
   b. All relevant I/O points and setpoints being controlled or monitored for each piece of equipment shall be displayed with the appropriate engineering units. Include appropriate engineering units for each displayed point value. Verbose names (English language descriptors) shall be included for each point on all graphics; this may be accomplished by the use of a pop-up window accessed by selecting the displayed point with the mouse.
   c. Animation or equipment graphic color changes shall be used to indicate on/off status of mechanical components.
   d. Indicate all adjustable setpoints and setpoint high and low limits (for automatically reset setpoints), on the applicable system schematic graphic or, if space does not allow, on a supplemental linked-setpoint screen.

4. Displays shall show all points relevant to the operation of the system, including setpoints.

5. The current value and point name of every I/O point and setpoint shall be shown on at least one graphic and in its appropriate physical location relative to building and mechanical systems.

6. Show weather conditions (local building outside air temperature and humidity) in the upper left hand corner of every graphic.

7. CAD Files: The architectural drawings will be made available to the Contractor in AutoCAD format upon request for use in developing backgrounds for specified graphic screens, such as floor plans and schematics. However the College does not guarantee the suitability of these drawings for the Contractor’s purpose.

8. Provide graphics for the following as a minimum
   a. Site homepage: Background shall be a campus map, approximately to scale. Include links to each building, central plant, etc.
   b. Building homepage: Background shall be a building footprint, approximately to scale, oriented as shown on the campus homepage. Include links to each floor and mechanical room/area, and to summary graphics described below. Include real-time site utility data such as building electrical demand and domestic cold water flow shown roughly on the map where the utilities connect to the site.
   c. Electricity demand limiting
      1) Demand limit. Include entries for sliding window interval and a table of Off-Peak, On-Peak or Partial-Peak demand time periods, both Summer

and non-Summer, with three adjustable demand level limits for each and adjustable deadband.
2) Electricity demand calculation. For each month, show actual peak kW and kWh for each time-of-day rate period. Show side-by-side as month-this-year and month-last-year, and month-to-date and year-to-date data.

d. Each occupied floor plan, to scale
1) HVAC: Floor plan graphics shall show heating and cooling zones throughout the buildings in a range of colors, which provide a visual display of temperature relative to their respective setpoints. The colors shall be updated dynamically as a zone's actual comfort condition changes. In each zone, provide links to associated terminal equipment.
2) If multiple floor plans are necessary to show all areas, provide a graphic building key plan. Use elevation views or plan views as necessary to graphically indicate the location of all of the larger scale floor plans. Link graphic building key plan to larger scale partial floor plans. Provide links from each larger scale graphic floor plan screen to the building key plan and to each of the other graphic floor plan screens.

e. Each equipment floor/area plan: To scale, with links to graphics of all BAS controlled/monitored equipment.

f. Each air handler: Provide link to associated HW and CHW plants where applicable.

g. Each trim & respond reset: Next to the display of the setpoint that is being reset, include a link to page showing all trim & respond points (see Guideline 36) plus the current number of requests, current setpoint, and status indicator point with values "trimming," "responding," or "holding." Include a graph of the setpoint trend for the last 24 hours. Trim & respond points shall be adjustable from the graphic except for the associated device.

h. Each zone terminal
1) See Sample Graphics – VAV Reheat Zone
2) Include a non-editable graphic (picture) showing the design airflow setpoints from the design drawings adjacent to the editable airflows setpoints. The intent is that the original setpoints be retained over time despite "temporary" adjustments that may be made over the years.

i. Each lab zone terminal:
1) Provide link to associated air handling unit where applicable and to floor plan where terminal is located.
2) Include supply air temperature from AHU serving terminal unit.
3) Include a non-editable graphic (picture) showing the design airflow setpoints from the design drawings adjacent to the editable airflows setpoints. The intent is that the original setpoints be retained over time despite "temporary" adjustments that may be made over the years.
4) Include room air change rate calculated from zone volume and either supply airflow rate if differential is positive, or exhaust airflow rate if differential is negative.

j. Electrical power monitoring system: Show side-by-side kWh and peak demand as month-this-year and month-last-year, and month-to-date and year-to-date data.

k. Water meters (alternate bid): Show side-by-side gallons and peak demand gpm as month-this-year and month-last-year, and month-to-date and year-to-date data.

l. Energy Monitoring Dashboard: Show kWh, kW, Gallons, Therms for each of the end uses being metered on a Day, Month and Year chart. Use the standard District template from ALC as the template – see Sample Graphics herein.
m. Central plant equipment including chilled water system, cooling tower system, etc.: The flow path shall change on the diagram (by changing piping line color or width) to show which piping has active flow into each chiller, tower, etc. as valve positions change.
n. Summary graphics: Provide a single text-based page (or as few as possible) for each of the following summary screens showing key variables listed in columns for all listed equipment. Include hyperlinks to each zone imbedded in the zone tag:
    1) Air handling units: operating mode; on/off status; supply air temperature; supply air temperature setpoint; fan speed; duct static pressure; duct static pressure setpoint; outdoor air and return air damper position; coil valve positions; etc. (all key operating variables); Cooling CHWST Reset current requests, cumulative %-request-hours, and request Importance Multiplier; Heating HWST Reset current requests, cumulative %-request-hours, and request Importance Multiplier (if HW coil)
    2) Zone Groups
        a) Separate zone terminal summary for each Zone Group.
        b) See Sample Graphics –Zone Group Summary herein
    3) Lab Zone terminal units: operating mode; supply airflow rate; supply airflow rate setpoint; zone temperature; active heating setpoint; active cooling setpoint; supply air temperature; supply air temperature setpoint; fume hood status; exhaust airflow rate; Supply Static Pressure Reset current requests, cumulative %-request-hours, and request Importance Multiplier; Exhaust Static Pressure Reset current requests, cumulative %-request-hours, and request Importance Multiplier; Cooling SAT Reset current requests, cumulative %-request-hours, and request Importance Multiplier; CHWST Reset current requests, cumulative %-request-hours, and request Importance Multiplier; HWST Reset current requests, cumulative %-request-hours, and request Importance Multiplier.
o. For all equipment with runtime alarms specified, show on graphic adjacent to equipment the current runtime, alarm setpoint (adjustable), alarm light, date of last runtime counter reset, and alarm reset/acknowledge button which resets the runtime counter.
p. For all controlled points used in control loops, show the setpoint adjacent to the current value of the controlled point.
q. All other BAS controlled/monitored equipment.
r. On all system graphics, include a “note” block that allows users to enter comments relevant to system operation.
s. All equipment shall be identified on the graphic screen by the unit tag as scheduled on the drawings.

F. Alarm Configuration

1. Program alarms and alarm levels per Sequence of Operations.

2. Each programmed alarm shall appear on the alarm log screen and shall be resettable or acknowledged from those screens. Equipment failure alarms shall

be displayed on the graphic system schematic screen for the system that the alarm is associated with (for example, fan alarm shall be shown on graphic air handling system schematic screen). For all graphic screens, display values that are in a Level 1 or 2 condition in a red color, Level 3 and higher alarm condition in a blue color, and normal (no alarm) condition in a neutral color (black or white).

3. For initial setup, Contractor shall configure alarms as follows:

	Level 1	**Level 2**	**Level 3**	**Level 4**
Criticality	Critical	Not Critical	Not Critical	Not Critical
Acknowledgement	Required	Required	Not Required	Not Required
Acknowledgement of Return to Normal	Not Required	Not Required	Not Required	Not Required
Email to building engineer(s)	Y	Y	Y	N
SMS text to building engineer(s)	Y	Y	N	N
Pop-up dialog box on OWS	Y	Y	N	N
Remove from alarm log	After Acknowledged	After Acknowledged	After 2 weeks	After 2 weeks

3.13 SEQUENCES OF OPERATION

A. See Section 259000 Building Automation Sequences of Operation.

3.14 TESTING, ADJUSTING, AND BALANCING

A. Testing, adjusting, and balancing (TAB) shall be performed in complete accordance with AABC or NEBB National Standards for Field Measurements and Instrumentation as applicable to air distribution and hydronic systems.

B. AC-1

1. Airflow Readings
   a. Total supply air quantities shall be determined at all of the following where applicable
      1) Pitot traverse in the supply duct downstream, positive pressure side of the fan
      2) Pitot traverse at coil or filter bank
      3) Totaling the readings of individual terminals as read through the BAS
   b. Total return air quantities shall be determined at all of the following where applicable
      1) Pitot traverse in the return air duct entering air handler
   c. Outside air quantities shall be determined by all of the following where applicable
      1) Subtracting pitot traverses of supply and return ducts
      2) Outdoor airflow sensor reading as read through the BAS

2. Adjust fan speed using manual adjustment of variable speed drive for testing only. Do not change or adjust sheaves.

3. Outside air flow measuring station calibration
   a. Test Conditions
      1) Override the economizer to 100% outdoor air, i.e. configure the outdoor air damper to be 100% open and the return air damper to be 0% open.
      2) Start supply fan and run it slowly from 20% speed up to 100% speed, in 20% increments with a pause at each step to allow time for the VAV boxes to communicate. At each 20% increment, measure and report:
         a) Sum of VAV box airflows as displayed on BAS AHU graphic
         b) Airflow measurement station airflow reading
         c) Traverse across supply air duct, filter bank, or other location where the most accurate airflow reading is possible
   b. Plot the speed vs. all three measured airflows. They should be linear and the three readings should be within 10% of each other.
   c. Coordinate with BAS installer to adjust calibration coefficients. Report coefficients in air balance report.

4. Design condition test
   a. Test with system operating at design fan and minimum outside air flow conditions described above and report the following on a schematic of the system:
      1) Tags of all equipment
      2) Manufacturer and model of all fans and motors
      3) Motor horsepower, rpm, volts, phase, full load amps
      4) Sheave data at motor and fan; belt data
      5) Fan airflow rate at all locations measured, as listed above
      6) Final measured fan speed and amps
      7) Amps and kilowatts from variable speed drives
      8) Variable speed drive speed in hertz
      9) Static pressures measured at
         a) Return air plenum
         b) Downstream of return fan
         c) Mixed air plenum
         d) Downstream of filter
         e) Downstream of coil
         f) Discharge of supply fans
         g) At static pressure sensor
      10) Concurrent airflow rate readings from BAS airflow sensors as applicable
      11) Concurrent fan data
         a) Volts and amps
         b) Amps and kilowatts from variable speed drive
         c) Variable speed drive speed in hertz
         d) Entering and leaving fan static pressure
         e) Flow rate

C. AHU-2, AHU-3

1. Airflow Readings
   a. Total supply air quantities shall be determined at all of the following where applicable
      1) Pitot traverse in the supply duct downstream, positive pressure side of the fan

2) Pitot traverse at coil or filter bank
3) Totaling the readings of individual terminals as read through the BAS

b. Total return air quantities shall be determined at all of the following where applicable
1) Pitot traverse in the return air duct entering air handler

c. Outside air quantities shall be determined by all of the following where applicable
1) Subtracting pitot traverses of supply and return ducts
2) Outdoor airflow sensor reading as read through the BAS

2. Adjust fan speed using manual adjustment of variable speed drive for testing only. Do not change or adjust sheaves.

3. Supply fan maximum DP setpoint
a. Establish maximum static pressure setpoint (Max_DSP) in conjunction with the BAS installer as follows. All adjustments made via the BAS, not field measurements except as noted.
b. Test Conditions
1) Set all boxes/air valves to operate at maximum airflow setpoints; allow controls to stabilize.
2) To account for diversity, shut off boxes, starting with boxes whose dampers are the most closed, as indicated by the BAS, and upstream of the DP sensor, until the airflow as indicated in BAS equals scheduled design airflow rate.
c. Procedure
1) Manually lower fan speed slowly while observing VAV box/air valve airflow rates downstream of the static pressure sensor. Stop lowering speed when one or more VAV box/air valve airflow rates drops 10 percent below maximum airflow rate setpoint.
2) Once flow condition in previous step is achieved, note the BAS system static pressure reading at the duct static pressure sensor.
a) This reading becomes the maximum static pressure setpoint.
b) Using pressure taps at differential pressure sensor and handheld digital pressure sensor, verify accuracy of BAS reading.
d. Convey to the BAS installer
1) Static pressure setpoints
2) Any discrepancy between BAS differential pressure reading and handheld measurement
e. Report
1) Static pressure setpoint
2) Tag of VAV boxes/air valves that dropped below design maximum airflow rate in tests above. These are the critical boxes, those requiring the largest static pressure.

4. Return fan
a. Test 1: 100% Outdoor Air
1) Test Conditions
a) Supply fan at design supply air rate per Paragraph 3.14C.3.b
b) Economizer in 100% outdoor air position
c) All doors and windows closed in area served by air handler
d) All exhaust fans on in area served by air handler

e) Relief damper fully open

2) Procedure

a) Measure building pressure using BAS sensor.

b) Manually adjust return fan speed at variable speed drive to achieve 0.05" building pressure.

1. Fan speed may exceed 60 Hz if necessary. Do not change or adjust sheaves.

c) At the above conditions

1. Measure fan inlet and outlet pressures.
2. Outlet pressure also shall be measured with BAS. This pressure is the return fan static pressure setpoint for Test 1.

b. Test 2: Design Minimum Outdoor Air

1) Test conditions: Per Paragraph 3.14C.5.a.

2) Procedure

a) Measure return airflow rate across return air damper and minimum outdoor air rate across minimum outdoor air damper

b) Manually adjust return fan speed at variable speed drive by 5Hz.

c) Repeat these two steps until return air rate drops below design return air rate by 5%, then increase return fan speed 5Hz.

d) At the above conditions

1. Measure fan inlet and outlet pressures.
2. Outlet pressure also shall be measured with BAS. This pressure is the return fan static pressure setpoint for Test 2.

c. Convey to the BAS installer

1) Return fan static pressure setpoints:

a) RFSPmin = Test 2 Outlet Pressure

b) RFSPmax = Larger of Test 1 and Test 2 Outlet Pressures

2) Return fan maximum speed if greater than 60 Hz.

d. Report

1) Amps and kilowatts from variable speed drive

2) Variable speed drive required speed in hertz

3) Inlet and outlet static pressure

4) Building static pressure

5. Outside air flow measuring station calibration

a. Test Conditions

1) Command all VAV boxes to design conditions per Paragraph 3.14C.3.b.

2) Override the economizer to 100% outdoor air, i.e. configure the outdoor air damper to be 100% open and the return air damper to be 0% open.

3) Start supply fan and run it slowly from 20% speed up to 100% speed, in 20% increments with a pause at each step to allow time for the VAV boxes to communicate. At each 20% increment, measure and report:

a) Sum of VAV box airflows as displayed on BAS AHU graphic

b) Airflow measurement station airflow reading

c) Traverse across supply air duct, filter bank, or other location where the most accurate airflow reading is possible

b. Plot the speed vs. all three measured airflows. They should be linear and the three readings should be within 10% of each other.

c. Coordinate with BAS installer to adjust calibration coefficients. Report coefficients in air balance report.

6. Design condition test
    a. Test with system operating at design fan and minimum outside air flow conditions described above and report the following on a schematic of the system:
        1) Tags of all equipment
        2) Manufacturer and model of all fans and motors
        3) Motor horsepower, rpm, volts, phase, full load amps
        4) Sheave data at motor and fan; belt data
        5) Fan airflow rate at all locations measured, as listed above
        6) Final measured fan speed and amps
        7) Amps and kilowatts from variable speed drives
        8) Variable speed drive speed in hertz
        9) Static pressures measured at
            a) Return air plenum
            b) Downstream of return fan
            c) Mixed air plenum
            d) Downstream of filter
            e) Downstream of coil
            f) Discharge of supply fans
            g) At static pressure sensor
        10) Concurrent airflow rate readings from BAS airflow sensors, including sum of VAV box airflow rates
        11) Concurrent fan data
            a) Volts and amps
            b) Amps and kilowatts from variable speed drive
            c) Variable speed drive speed in hertz
            d) Entering and leaving fan static pressure
            e) Flow rate, summed from BAS terminals
            f) Fan airflow sensor reading from BAS (sum of VAV box airflow rates)

D. VAV boxes

1. Use default airflow calibration coefficients. No TAB required.

E. Laboratories

1. Supply and General Exhaust Air Valves. Use factory airflow calibration. No TAB required.

2. Fume Hoods
    a. Test only; balancing is dynamic via the controls
    b. Ensure airflow valves are fully operational and airflow setpoint to controller is set to scheduled design rates as scheduled herein.
    c. Adjust sash to and provide velocity readings for each of the following based on design open position, 18-inch:
        1) 100%
        2) 33%
    d. Test and report
        1) Velocity and airflow rate at hood face
        2) Traverse of exhaust duct to hood
        3) Concurrent feedback from exhaust air valves through BAS

e. If BAS feedback and measured airflow rates differ by more than 10%, direct the air valve supplier to make required corrections and recalibration. Do not adjust calibration without approval of air valve supplier.
f. ASHRAE 110 testing not required since it was recently completed when presence sensor was added.

3. Emergency Exit Tests
   a. Applies only to these labs:
      1) Room 235 (17 hood)
      2) Room 242 (5 hoods)
   b. Procedure:
      1) Simulate failure of supply air to the lab by fully shutting off all supply air valves.
      2) Test door opening force. If more than 15 pounds, gradually reduce minimum hood exhaust setpoints uniformly for all hoods until 15 pounds is reached.
   c. Report
      1) Initial door opening force at design hood exhaust rates
      2) Percent of design hood exhaust rates needed to reduce door opening force to 15 pounds
      3) Initials of BAS installer to indicate that percent hood multiplier was transmitted to them and included in control sequences

F. Chilled Water and Hot Water Distribution Systems

1. Coil Test & Balance, HW and CHW system
   a. System is self-balancing. Two-way control valves at coils prevent each coil from being over-supplied with water, other than minor excursions during transients such as cool-down or warm-up. Conventional balancing (throttling of balancing valves) will increase pump energy use by not allowing aggressive differential pressure setpoint reset. Hence, adjust all balancing valves on any coil or pump to be 100% open regardless of current balancing valve position.
   b. Report with all control and balancing valves 100% open to coil and pumps operating at full speed
      1) Coils with modulating two-way control valves
         a) Terminal tag
         b) Control valve model number and serial number
         c) Pressure drop across coil
         d) Flow as measured by calibrated balancing valve (where applicable).
         e) Balancing valve position (should be 100% open)
      2) Pumps
         a) Tag
         b) Manufacturer and model of pump and motor
         c) Motor horsepower, volts, phase, full load amps
         d) Pump shut-off head from curves, measured shut-off head, and resulting impeller diameter from pump curve
         e) At test condition specified
            1. Volts and amps
            2. Calculated brake horsepower
            3. Entering and leaving gage pressure and difference in feet

4. Flow rate deduced from pump curve
5. For pump with variable speed drive
   a. Speed (Hz)
   b. Kilowatts

f) Include pump curve from manufacturer's website.

2. Variable Speed Drive Setpoint Determination
   a. No TAB required. See Section 259000.

3.15 SYSTEM COMMISSIONING

A. Sequencing. The following list outlines the general sequence of events for submittals and commissioning:

1. Submit Submittal Package 0 (Qualifications) and receive approval.
2. Submit Submittal Package 1 (Hardware and Shop Drawings) and receive approval.
3. Initiate installation of BAS hardware, devices and wiring.
4. Develop point database and application software.
5. Simulate sequencing and debug programming off-line to the extent practical.
6. Submit Submittal Package 2 (Programming and Graphics) and receive approval.
7. Complete installation of BAS hardware, devices and wiring.
8. Install point database and application software in field panels.
9. Submit Submittal Package 3 (Pre-Functional Test Forms) and receive approval.
10. Perform BAS Pre-functional Tests (start up, calibration and tuning) and submit completed forms as Submittal Package 4 (Pre-Functional Test Report) for approval.
11. Receive BAS Pre-functional Test Report approval and approval to schedule Functional Tests.
12. Field test application programs prior to functional testing.
13. Submit Package 5 (Post-Construction Trend Points List) in format specified for review and approval.
14. Receive approval of successful Trend Log configuration, or reconfigure as required.
15. Prepare and initiate commissioning Trend Logs.

16. Perform and record functional tests and submit Submittal Package 6 (Functional Test Report) for approval.

17. Submit Package 7 (Training Materials) and receive approval.

18. Receive BAS Functional Test Report approval and approval to schedule Demonstration Tests.

19. Perform Demonstration Tests to Commissioning Provider and College's Representatives and submit Demonstration Test Report.

20. Receive acceptance of Demonstration Tests.

21. Train College personnel on BAS operation and maintenance.

22. Substantial Completion

23. Submit Package 8 (Post-Construction Trend Logs) in format specified for review and approval.

24. Receive approval of successful Trend Log tests, or retest as required.

25. Complete all items in Completion Requirements per Paragraph 1.10B.

26. Provide administration level password access to the College.

27. Final Acceptance

28. Begin Warranty Period.

29. Prepare and initiate continuous Trend Logs per Paragraph 2.13A.4.

30. Update all software as specified.

31. End of Warranty Period

B. Pre-functional tests

1. General
   a. Inspect the installation of all devices. Review the manufacturer's installation instructions and validate that the device is installed in accordance with them.
   b. Verify proper electrical voltages and amperages, and verify that all circuits are free from faults.
   c. Verify integrity/safety of all electrical connections.
   d. Verify that shielded cables are grounded only at one end.
   e. Verify that all sensor locations are as indicated on drawings and are away from causes of erratic operation.

2. Test Documentation
   a. Prepare forms to document the proper startup of the BAS components.
   b. All equipment shall be included on test forms including but not limited to

1) Wiring: End-to-end checkout of all wiring at terminations. Power to all controllers and actuators. Confirmation of emergency power where specified.
2) Digital Outputs: Proper installation, normal position, response to command at CU
3) Digital Inputs: Proper installation, device test, response at CU
4) Analog Outputs: Proper installation of devices, verification of maximum and minimum stroke.
5) Analog Inputs: Proper installation of sensors, calibration
6) Panels: Confirmation of location, power source (electrical circuit used), confirmation of emergency power where specified.
7) Alarms and Safeties: Verification of alarm routing to all specified devices and correct hierarchy. Example: confirm alarm routing to cell phones, email, servers, remote workstations. Confirm that appropriate alarm levels are routed to appropriate devices.
8) Loop Tuning: Document setting of P/I parameters for all loops, chosen setpoints, time delays, loop execution speed.
9) Network Traffic: Document speed of screen generation, alarm and signal propagation in system with all required commissioning trends active.

c. Each form shall have a header or footer where the technician performing the test can indicate his/her name and the date of the test.
d. Submit blank forms for approval in Submittal Package 3.
e. Complete work, document results on forms, and submit for approval as Submittal Package 4 (Pre-Functional Test Report).

3. Digital Outputs
   a. Verify that all digital output devices (relays, solenoid valves, two-position actuators and control valves, magnetic starters, etc.) operate properly and that the normal positions are correct.

4. Digital Inputs
   a. Adjust setpoints, where applicable.
      1) For current switches used as status on fans, adjust current setpoint so that fan status is OFF when fan discharge damper (if present) is fully closed and when belt is broken (temporarily remove belt).
      2) For current switches used as status on pumps, adjust current setpoint so that pump status is OFF when pump is dead-headed (temporarily close discharge valve).
      3) For differential pressure sensors on pumps and fans, set so that status is on when pump operating with all valves open (out on its curve).

5. Analog Outputs
   a. Verify start and span are correct and control action is correct.
   b. Check all control valves and automatic dampers to ensure proper action and closure. Make any necessary adjustments to valve stem and damper blade travel.
   c. Check all normal positions of fail-safe actuators.
   d. For outputs to reset other manufacturer's devices (for example, chiller setpoint) and for feedback from them, calibrate ranges to establish proper parameters.

6. Analog Input Calibration
   a. Sensors shall be calibrated as specified on the points list. Calibration methods shall be one of the following:
      1) Factory: Calibration by factory, to standard factory specifications. Field calibration is not required.
      2) Handheld: Field calibrate using a handheld device with accuracy meeting the requirements of Paragraph 2.10.
   b. The calibrating parameters in software (such as slope and intercept) shall be adjusted as required. A calibration log shall be kept and initialed by the technician indicating date and time, sensor and hand-held readings, and calibration constant adjustments and included in the Pre-functional Test Report.
   c. Inaccurate sensors must be replaced if calibration is not possible.

7. Alarms and Interlocks
   a. A log shall be kept and initialed by the technician indicating date and time, alarm/interlock description, action taken to initiate the alarm/interlock, and resulting action, and included in the Pre-functional Test Report.
   b. Check each alarm separately by including an appropriate signal at a value that will trip the alarm.
   c. Test fire and life safety systems alarm contacts if and only if changes were made to FAS contacts and wiring.
   d. Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.
   e. Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action.

8. Variable Frequency Drive Minimum Speed
   a. Minimum speed for VFD-driven fans and pumps shall be determined in accordance with this Paragraph. Tests shall be done for each piece of equipment, except that for multiple pieces of identical equipment used for identical applications, only one piece of equipment need be tested with results applied to all. Note that for fans and pumps, there is no minimum speed required for motor cooling. Power drops with cube of speed, causing motor losses to be minimal at low speeds.
   b. Determine minimum speed setpoint as follows:
      1) Start the fan or pump.
      2) Manually set speed to 6 Hz (10%) unless otherwise indicated in control sequences.
      3) Observe fan/pump in field to ensure it is visibly rotating.
         a) If not, gradually increase speed until it is.
      4) The speed at this point shall be the minimum speed setpoint for this piece of equipment.
      5) Record minimum speeds in log and store in software point as indicated in Guideline 36.

9. Tuning
   a. Tune all control loops to obtain the fastest stable response without hunting, offset or overshoot. Record tuning parameters and response test results for each control loop in the Pre-functional Test Report. Except from a startup, maximum allowable variance from set point for controlled variables under

normal load fluctuations shall be as follows. Within 3 minutes of any upset (for which the system has the capability to respond) in the control loop, tolerances shall be maintained (exceptions noted)

Controlled Variable	Control Accuracy
Duct Pressure	±0.1 inches w.g.
Building and relief plenum	±0.01 inches w.g.
Airflow and water flow	±10%
Space Temperature	±1.5ºF
Condenser Water Temperature	±2ºF
Chilled Water Temperature	±1ºF
Duct Temperature	±2ºF
Water Differential Pressure	±1.5 psi
Others	±2 times reported accuracy

10. Interface and Control Panels
    a. Ensure devices are properly installed with adequate clearance for maintenance and with clear labels in accordance with the Record Drawings.
    b. Ensure that terminations are safe, secure and labeled in accordance with the Record Drawings.
    c. Check power supplies for proper voltage ranges and loading.
    d. Ensure that wiring and tubing are run in a neat and workman-like manner, either bound or enclosed in trough.
    e. Check for adequate signal strength on communication networks.
    f. Check for standalone performance of controllers by disconnecting the controller from the LAN. Verify the event is annunciated at Operator Interfaces. Verify that the controlling LAN reconfigures as specified in the event of a LAN disconnection.
    g. Ensure that buffered or volatile information is held through power outage.
    h. With all system and communications operating normally, sample and record update and annunciation times for critical alarms fed from the panel to the Operator Interface.
    i. Check for adequate grounding of all BAS panels and devices.

11. Operator Interfaces
    a. Verify that all elements on the graphics are functional and are properly bound to physical devices or virtual points, and that hot links or page jumps are functional and logical.
    b. Verify that the alarm logging, paging, emailing etc. are functional and per requirements.

C. Functional Tests

1. Test schedule shall be coordinated with the Commissioning Provider (Taylor Engineers) and College's Representative.

2. Functional tests may be witnessed by College's Representative at the College's option.

3. All approved Functional Tests shall be conducted by the Contractor with results confirmed and signed by the Contractor's start-up technician.

4. Test documentation
   a. Commissioning Provider will prepare functional testing forms after Submittal Package 2 has been reviewed and approved. Tests will be designed to test all sequences in a formal manner with simulations and expected outcomes.
   b. Review tests and recommend changes that will improve ease of testing or avoid possible system damage, etc. and provide to Commissioning Provider.
   c. Complete work, document results on forms, and submit for approval as Submittal Package 6 Functional Test Report. Tutorials for using the functional test Excel workbook can be found here.

D. Demonstration Test

1. Demonstration tests consist of a small representative sample of functional tests and systems randomly selected by the Commissioning Provider. Tests will be designed to occur over no longer than 2 working days.

2. Schedule the demonstration with the Commissioning Provider and College's Representative at least 1 week in advance. Demonstration shall not be scheduled until the Functional Test Report has been approved.

3. The Contractor shall supply all personnel and equipment for the demonstration, including, but not limited to, instruments, ladders, etc. Contractor-supplied personnel shall be those who conducted the Functional tests or who are otherwise competent with and knowledgeable of all project-specific hardware, software, and the HVAC systems.

4. The system will be demonstrated following procedures that are the same or similar to those used in the Pre-Functional and Functional Tests. The Commissioning Provider will supply the test forms at the site at the start of the tests.

5. Demonstration tests may be witnessed by College's Representative at the College's option.

6. Contractor shall conduct tests as directed by and in the presence of the Commissioning Provider and complete test forms. Commissioning Provider will document the test results as the Demonstration Test Report after tests are complete.

7. Demonstration Tests shall be successfully completed and approved prior to Substantial Completion.

E. Trend Log Tests

1. Trends shall be fully configured to record and store data to the server for the points and at the interval listed in Paragraph 2.12 as follows:
   a. Commissioning: Configure trends prior to functional testing phase. Retain configuration until post-construction commissioning trend review has been

completed successfully and accepted by the College's representative. Trends shall be deactivated after acceptance.

b. Continuous: After system acceptance, configure trends for the purpose of long term future diagnostics. Configure trends to overwrite the oldest trends at the longest interval possible without filling the server hard disk beyond 80%.

2. Post-Construction Trend Test
   a. Trend logging shall not commence until Demonstration Tests are successfully completed.
   b. Hardware Points. Contractor shall configure points to trend as indicated in the Commissioning Trend column listed in Paragraph 2.12 points.
   c. Software Points. Include the following in trends of systems and zones whose hardware points are being trended as called for above. Time interval shall be the same as associated hardware point.
      1) All setpoints and limits that are automatically reset, such as supply air temperature and fan static pressure setpoints, plus the points that are driving the reset, such as zone level cooling and static pressure requests
      2) All setpoints that are adjustable by occupants
      3) Outputs of all control loops, other than those driving a single AO point that is already being trended
      4) System mode points (e.g. Warm-up, Occupied, etc.)
      5) Global overrides such as demand shed signals
      6) Calculated performance monitoring points, such as chiller efficiency
   d. Submit for review and approval by the Commissioning Provider a table of points to be trended along with trend intervals or change-of-value a minimum of 14 days prior to trend collection period, as Submittal Package 5.
   e. Trends shall be uploaded to the CSS in data format specified in Paragraph 2.12C.3.
   f. Trend logs of all points indicated above shall be collected for a 3 week Trend Period.
   g. At the completion of the Trend Period, data shall be reviewed by the Contractor to ensure that the system is operating properly. If so, data shall be submitted to the College in an electronic format agreed to by the College and Contractor (such as flash drive or via direct access to the CSS via the internet) as Submittal Package 8.
   h. Data will be analyzed by the Commissioning Provider.
   i. The system shall be accepted only if the trend review indicates proper system operation without malfunction, without alarm caused by control action or device failure, and with smooth and stable control of systems and equipment in conformance with these specifications. If any but very minor glitches are indicated in the trends, steps f to h above shall be repeated for the same Trend Period until there is a complete Trend Period of error free operation.
   j. After successfully completing the Post-Construction Trend Tests, the Contractor shall configure all points to trend as indicated in the Continuous Trend column listed in Paragraph 2.12 points list.

F. Remedial Work

1. Repair or replace defective Work, as directed by College's Representative in writing, at no additional cost to the College.

2. Restore or replace damaged Work due to tests as directed by College's Representative in writing, at no additional cost to the College.

3. Restore or replace damaged Work of others, due to tests, as directed by College's Representative in writing, at no additional cost to the College.

4. Remedial Work identified by site reviews, review of submittals, demonstration test, trend reviews, etc. shall be performed to the satisfaction of the College's Representative, at no additional cost to the College.

5. Contractor shall compensate College's Representatives and Commissioning Provider on a time and material basis at standard billing rates for any additional time required to witness additional demonstration tests or to review additional BAS trends beyond the initial tests, at no additional cost to the College.

3.16 TRAINING

A. Coordinate schedule and materials with the College.

B. Interim Training

1. Provide minimal training so the operating staff can respond to occupant needs and other operating requirements during start-up and commissioning phase.

C. Formal Training

1. Training shall be conducted after all commissioning is complete and systems are fully operational.

2. Training materials, including slides, shall be submitted prior to any training in Submittal Package 7.

3. ALC Training
   a. It may be assumed that College building engineers have been previously trained on the existing ALC system.
   b. Include training on ALC system operations only for new features installed at CSS/OWS as a part of this project.

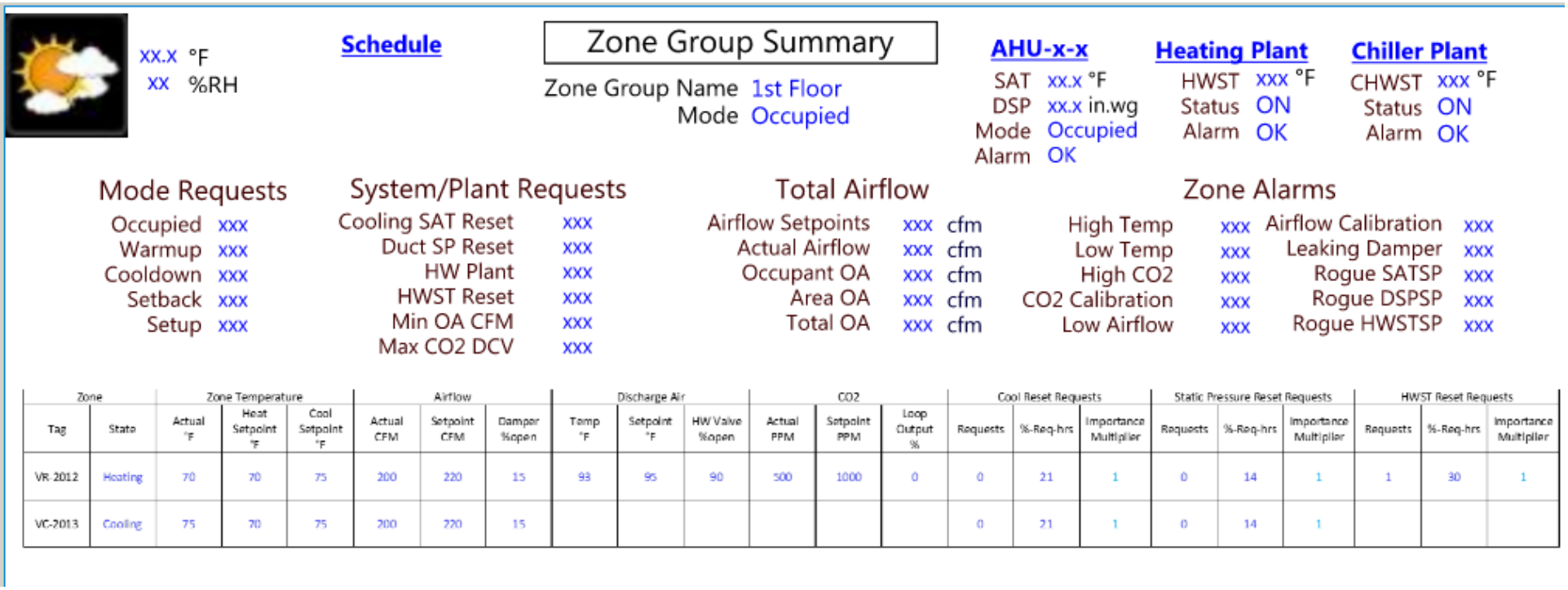
4. Jobsite Training
   a. Include 24 hours total of on-site training to assist personnel in becoming familiar with job-specific issues, systems, control sequences, etc.
   b. College shall be permitted to videotape training sessions.

5. Training may be in non-contiguous days at the request of the College.

6. During the warranty period, provide unlimited telephone support for all trained operators.

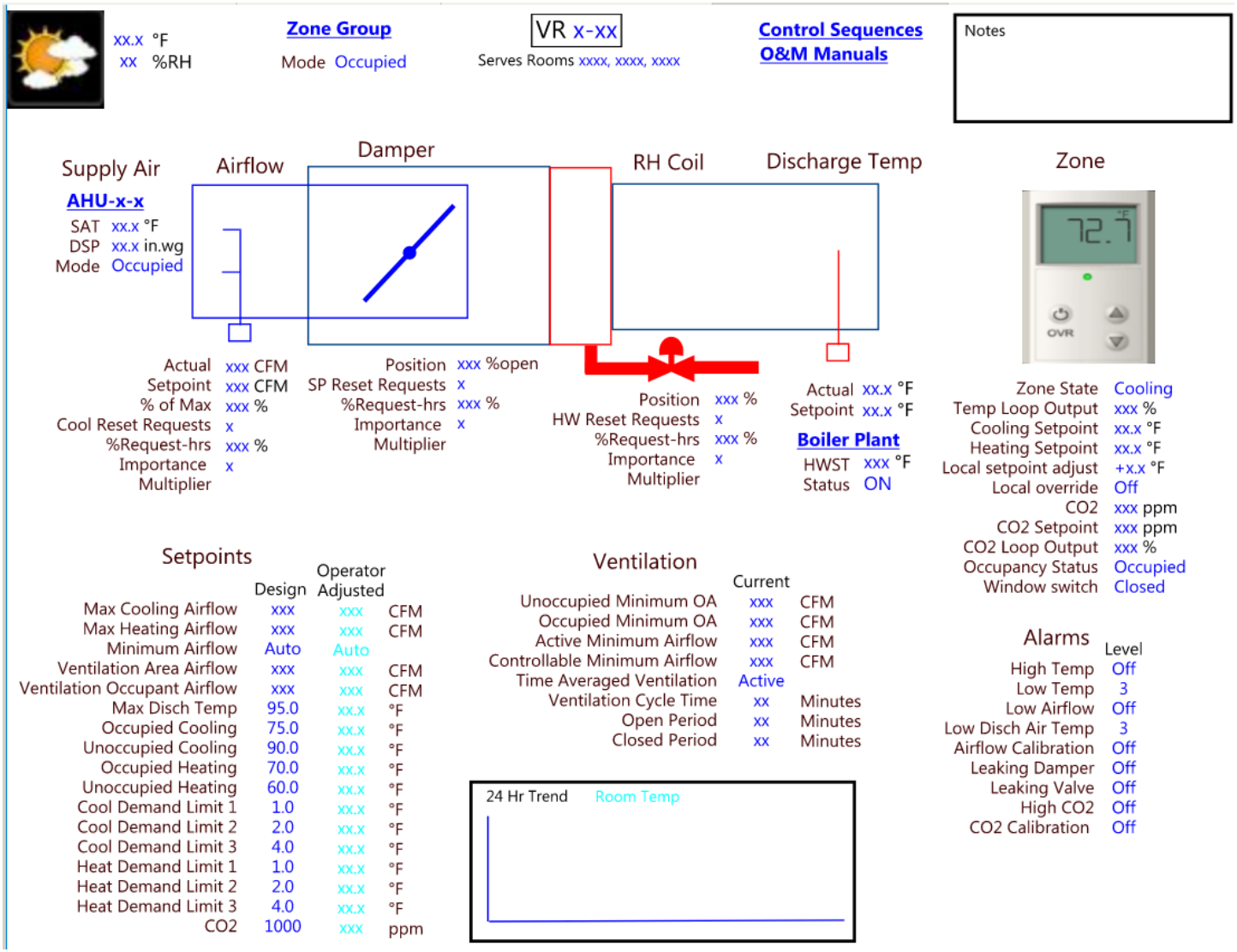
END OF SECTION 250000

ZONE GROUP SUMMARY

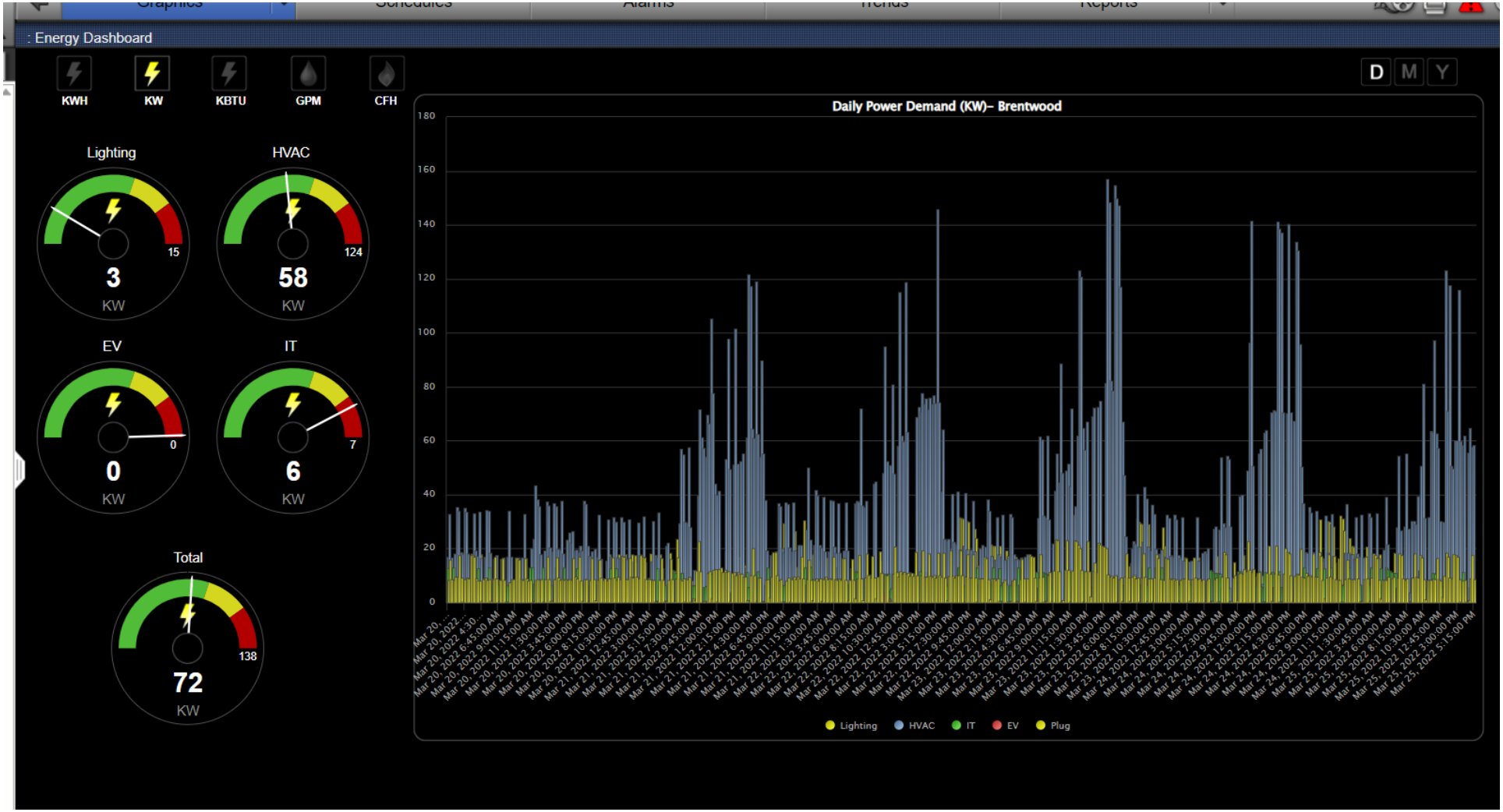


Zone		Zone Temperature			Airflow			Discharge Air			CO2			Cool Reset Requests			Static Pressure Reset Requests			HWST Reset Requests		
Tag	State	Actual °F	Heat Setpoint °F	Cool Setpoint °F	Actual CFM	Setpoint CFM	Damper %open	Temp °F	Setpoint °F	HW Valve %open	Actual PPM	Setpoint PPM	Loop Output %	Requests	%-Req-hrs	Importance Multiplier	Requests	%-Req-hrs	Importance Multiplier	Requests	%-Req-hrs	Importance Multiplier
VR 2012	Heating	70	70	75	200	220	15	93	95	90	500	1000	0	0	21	1	0	14	1	1	30	1
VC-2013	Cooling	75	70	75	200	220	15							0	21	1	0	14	1			

VAV REHEAT ZONE



ENERGY DASHBOARD



SECTION 00300
BID PROPOSAL FORM
ADDENDUM #1

PROJECT NUMBER / NAME: L- 1201 Science Building BAS Upgrade

CAMPUS / LOCATION: Los Medanos College, 2700 E Leland Rd, Pittsburg, CA 94565

DISTRICT: CONTRA COSTA COMMUNITY COLLEGE DISTRICT
500 Court St, Martinez, CA 94553

Herein Referred to as "District"

1. INTRODUCTION

A. The Bidder proposes to perform the Work for the Contract Sum and within the proposed Contract Time, based upon an examination of the site and the Bid and Contract Documents.

B. The Bidder certifies this Bid is submitted in good faith.

C. The Bidder agrees that the Contract Sum and other proposed terms will be considered in evaluating Bids and may be negotiated and adjusted before awarding of Contract.

D. The signed copy of the Certification of the Visit to the Site shall be attached to the Bid Form Submittal.

E. A fully executed Non-Collusion Affidavit signed by an authorized officer of the Bidder submitting Bid shall be attached to the Bid Form.

F. **The District shall award the contract to the lowest responsive and responsible Bidder. The evaluation of the low bid shall be based on the total of Item 2.A Base Bid, 2.B Unit Price, and all listed Additive/Deductive Alternates 3.1 through 3.9.**

G. The District reserves the right to delete any or all Add Alternates, if any, through change orders within **25 calendar days** after the Award of Contract. If deleted by the District, the deleted dollar amount shall be the amount listed for the specific Add Alternate. The Contract Time will remain the same regardless if any Add Alternate is deleted.

2. CONTRACT SUM

A. BASE BID
For labor, materials, bonds, fixtures, equipment, tools, transportation, services, sales taxes, overhead and profit, and other costs necessary to complete the general construction in accordance with the Contract Documents, for a stipulated Contract Sum in the amount of:

_____Dollars ($_____)

B. UNIT PRICES

When estimated quantities as noted below, are exceeded, the Contractor will be compensated per the unit prices listed below. Contractor shall honor the unit price even when the quantities go beyond what is shown below. Should these unit costs not be required a deductive change order will be issued.

Unit prices include labor, materials, bonds, fixtures, equipment, tools, transportation, services, sales taxes, overhead and profit, and other costs necessary to complete the general construction in accordance with the Contract Documents, for a stipulated Contract Sum in the amount of:

1. Unit Price #1: VAV Box Calibration Unit Price (per VAV Box)
(SEE SPECIFICATION SECTION 250000 BUILDING AUTOMATION SYSTEM SUBSECTION 1.2.H.9 FOR FULL DESCRIPTION OF SCOPE FOR UNIT PRICE)

Qty: 3 x $_____

SUBTOTAL $_____

3. ADDITIVE/DEDUCTIVE ALTERNATES

(SEE NEW SPECIFICATION SECTION 250000 BUILDING AUTOMATION SYSTEM ADDENDUM #1 SUBSECTION 1.2.H FOR FULL DESCRIPTION OF SCOPE FOR ADDITIVE/DEDUCTIVE ALTERNATES)

1. **ARCNet for Primary LAN.**

Dollars ($)

2. **Onsite Virtual Server**

Dollars ($)

3. **VFD Integration**

Dollars ($)

4. **Reuse VAV and Lab Zone Reheat Coil Valves**

Dollars ($)

5. **Add DCW Multi-Jet Flow Meters**

Dollars ($)

6. **Add DCW Magnetic Flow Meters**

Dollars ($)

7. **Add Natural Gas Meter**

_____ Dollars ($ _____)

8. **No CAD Files**

_____ Dollars ($ _____)

9. **ACI/ACO-1, 2, 3, 4**

_____ Dollars ($ _____)

4. COMPLETION TIME

A. For establishing the Date of Final Completion, the contract time for the Base Bid shall be as indicated in Section 00600, Construction Agreement. This time may be subject to modification to facilitate the work, as mutually agreed upon at a later date.

B. The Bidder certifies that the Bid is based on the Contract Time for completion as stated in Section 00600, Construction Agreement. Bidder further certifies that the Base Bid amount is sufficient to cover all labor, materials, central office and construction site overhead, profit, and all other costs related to the completion of the Project for the entire Project construction time for both the General Contractor and all Subcontractors, as stated above in paragraphs 2 and 3.

5. ADDENDA

A. The Bidder acknowledges receipt of the following Addenda, and certifies the Bid has provided for all modifications and considerations required therein.

None [ ]

Addendum No.: _____ dated _____

Addendum No.: _____ dated _____

Addendum No.: _____ dated _____

Addendum No.: _____ dated _____

B. List of Additional Addenda Attached: Yes [ ] No. [ ].

6. DESIGNATION OF SUBCONTRACTORS

A. The Bidder has set forth a complete list indicating the type of work, name, and business address of each Subcontractor who will perform work in excess of one-half of one percent of the Contract Sum.

B. Any portion of the work in excess of the specified amount having no designated Subcontractor shall be performed by the Bidder.

C. Substitution of listed Subcontractors will not be permitted unless approved in advance by the District.

D. Prior to signing the Contract, the District reserves the right to reject any listed Subcontractor.

	Type of Work	Subcontractor's Name	Business Address/Phone	CSLB License # and DIR Registration #
1				
2				
3				

E. Complete list of Subcontractors is attached: Yes [ ] No [ ]

F. Continuation list of Subcontractors is attached: Yes [ ] No [ ]

7. ACCEPTANCE AND AWARD

A. The District reserves the right to reject this Bid and to negotiate changes before or after execution of the Contract. This Bid shall remain open and shall not be withdrawn for a period of 90 days after Bid Opening date.

B. If written notice of acceptance of this Bid is mailed or delivered to the Bidder within 90 days after the date set for the receipt of this Bid, or other time before it is withdrawn, the Bidder will execute and deliver to the District a Contract prepared by District with the required Surety Bonds and Certificates of Insurance, within 10 days after personal delivery or deposit in the mail of the notification of acceptance.

C. Notice of acceptance or request for additional information may be addressed to the Bidder at the address provided.

8. BID SECURITY

A. The required 10 percent (10%) Bid Security for this Bid is attached in the form of:

( ) Bid Bond Issued By: _____

( ) Certified or Cashier's Check No._____

Issued by: _____

9. BIDDER'S BUSINESS INFORMATION

A. Individual [ ]:_____

Personal Name: _____

Business Name: _____

Address: _____

_____Zip Code:_____

Telephone: _____

Fax Number: _____

B. Partnership [ ]:_____

Co-partners' Names:_____

Business Name: _____

Address: _____

_____Zip Code:_____

Telephone: _____

Fax Number: _____

C. Corporation [ ]: _____

Firm Name: _____

Address: _____

_____Zip Code:_____

Telephone: _____

Fax Number: _____

State of Incorporation: _____

President: _____

Secretary: _____
Treasurer: _____

Manager: _____

D. Power of Attorney: Name: _____

Title: _____

E. Contractor License No. _____ State of _____

F. Bidder is submitting this proposal on behalf of a Joint Venture. Names, license numbers, and relevant information are given on a separate attachment:
Yes [ ] No [ ].

G. Upon request, furnish appropriate documentation to substantiate and/or support the data given.

10. The undersigned hereby certifies under penalty of perjury under the laws of the State of California that all the information submitted by the Bidder in connection with this Bid and all the representations herein made are true and correct.

Executed this day of _____

_____

CSLB License No. Expiration Date DIR Registration No.

_____

Firm Name

_____

Signature

_____

By (Print or Type Name)

_____

Title

End of Section 00300

MEETING MINUTES 4/14/2022

PROJECT NAME/NO.: L-1201 Science Building BAS Upgrade

PRE-BID MEETING, Mandatory

Date: April 12, 2022
Time: 2:00 PM
Location: Los Medanos College
Science Building, Main Entrance
2700 E Leland Rd., Pittsburg, CA 94565

I. INTRODUCTIONS AND SIGN IN

- Stefan Johnson, Construction Manager

a. Introduction of Project Team Members in Attendance:

~~Carlos Montoya, Ed.D.~~	~~Vice President of Business & Administrative Services~~
Michael Schenone	Buildings and Grounds (B&G) Manager, LMC
Steve Taylor	Taylor Engineering
Stefan Johnson	Construction Manager - Critical Solutions, Inc. (CSI)

b. Sign-in sheet will be circulated and collected by Stefan Johnson; It will be posted to the District's bids webpage.

II. WELCOME AND INTRODUCTORY REMARKS

a. L-1201 Science Building BAS Upgrade Project to convert the Science building from the current Andover controls to ALC controls.
b. An on-site job walk/ field presentation follows this meeting.
c. Review bid documents and submit RFIs by Thursday April 14, so responses can be provided in a timely manner.

III. INTRODUCTION & ADDITIONAL REMARKS

- **Public Safety**
  Currently have COVID-19 pandemic guidelines in place for Contra Costa County.
  District policy requires masks indoors at all times.

IV. BRIEF PROJECT DESCRIPTION

- Steve Taylor with Taylor Engineering to go over project over in detail:
  - Replacing current Andover System with ALC controls
  - Replacing all air valves
  - Base Bid includes IP controllers and Add Alternate is a deduct to use existing Arcnet controllers.

V. PROJECT WORK RESTRICTIONS (see SECTION 00800 Supplementary General Conditions)

a. Project has a very limited timeframe – goal is to issue NTP the last week of May.
b. Contractor may not use the bathroom facilities for the duration of the project and must provide porta-potties and cleaning stations **(TO BE CONFIRMED)**. Location of bathroom facilities to be coordinated with District and approved prior to placement.
c. Staging of material & equipment by contractor to be secured and locked. Staging area or contractor's storage container to be coordinated with District in advance.
d. Interruptions to utility service shall be kept to a minimum and shall be as such times and durations as approved ahead of time by the District.
e. Bidders are encouraged to carefully review Division 0 & 1, specifically Section 00800, referencing Work Restrictions.
f. Additional work restriction information may be added by addendum, including class schedule for summer session.

VI. BID PHASE COMMUNICATIONS & CORRESPONDENCE:

a. All project-related questions/RFIs must be submitted in writing (email is preferable) to:
Ben Cayabyab, Contracts Manager
Contra Costa Community College District
500 Court St., Martinez, CA 94553
Email: bcayabyab@4cd.edu
b. **Deadline for receipt of RFIs is April 14, 2022, prior to 5:00 PM**.

VII. ADDENDA UPDATE:

a. Addendum #1 to be issued with Summer Session class schedule noting unavailable rooms.

VIII. BID PHASE SCHEDULE MILESTONES

- **Last day for RFI:** **April 14, 2022, prior to 5:00 p.m.**
- Last Addendum Issued: April 21, 2022
- **Bid Opening:** **April 28, 2022, 2:00 p.m.**
- Award of Contract: May 12, 2022
- Notice to Proceed May 23, 2022 (approximate)

IX. BID OPENING:

a. **Bids must be received at the Contra Costa Community College District Office at 500 Court St, Martinez, CA by Thursday, April 28, 2022, prior to 2:00 PM.**
b. All bids will be time stamped at the reception counter in the building lobby.
c. Any bid received after the bid opening time will be rejected.

X. BID PACKAGE:

a. Review your bid package carefully before submitting it. Be sure to include all required documentation, or bid will be rejected.
   - Completed Bid Proposal Form (Section 00300), to include bidder's name and signature.
   - An active CLSB license number, as required in the bid documents.
   - Acknowledgement of any addenda issued.
   - Listing of actively-licensed subcontractors, including license numbers.
   - Bid Bond – 10% of bid Amount.
   - Non-Collusion Affidavit, fully executed.
   - Other documents as required by the Contract Documents.

b. Bid bond must accompany bid; company checks can be accepted, but no cash will be accepted.
c. Contact **Ben Cayabyab** if you have additional questions.

XI. CONTRACT DURATION DISCUSSION

a. Review carefully Section 00600, Construction Agreement
b. 124 Calendar Days to Substantial Completion (SC)
c. 60 Calendar Days between SC and Final Completion
d. Award of contract (NOA) scheduled to be issued the day after approval by the District Board.
e. Successful Contractor will be required to submit bonds and insurance expeditiously.

XII. SUBSTITUTION REQUESTS MUST COMPLY WITH CONTRACT DOCUMENTS

a. Reference SECTION 00800, General Conditions, Article 1.4
b. Sample Substitution Request Form is included in bid package.

XIII. SITE JOB WALK/ FIELD PRESENTATION

- Steve Taylor to give overall review of project scope.
- Review project site, classrooms, rooftop units.

XIV. MISCELLANEOUS

Additional bid site review can be scheduled for current bid-walk attendees only.

Contra Costa Community College District
pathways to success

PRE-BID Meeting
Sign-in Sheet

PROJECT TITLE: L-1201 Science Building BAS Upgrade

DATE / TIME: Tuesday, April 12, 2022, 2:00 p.m.

LOCATION: Science Building, Los Medanos College

COMPANY NAME	NAME	TITLE / ROLE IN THIS PROJECT
Sabod Inc.	Lynsie Cates	Administrative Assist
Please provide business card — Office Phone	925-418-4447	
Cell Phone	626-260-2849	
Email Address	TaSghaR@sbcglobal.net	
Taylor Eng	Steve Taylor	Principal
Please provide business card — Office Phone	510 220 7456	
Cell Phone		
Email Address	staylor@taylor-engineering.com	
Sunbelt Controls	Andy Bruch	Project Manager
Please provide business card — Office Phone	925-660-3900	
Cell Phone	925-588-3551	
Email Address	abruch@sunbeltcontrols.com	
J W. Constrctn	Ed Agbemadon	Administrator
Please provide business card — Office Phone	(510) 697-0770	
Cell Phone		
Email Address	edagbe.ea@gmail.com	

Contra Costa Community College District
pathways to success

PRE-BID Meeting
Sign-in Sheet

PROJECT TITLE: L-1201 Science Building BAS Upgrade

DATE / TIME: Tuesday, April 12, 2022, 2:00 p.m.

LOCATION: Science Building, Los Medanos College

COMPANY NAME	NAME	TITLE / ROLE IN THIS PROJECT
Air Systems	Michael Beights	G.F.

Please provide business card

Office Phone
Cell Phone 408-599-4913
Email Address Michael.beights@airsystemsinc.com

Air Systems	Darrel Edinoff	G.F.

Please provide business card

Office Phone
Cell Phone 408-318-8850
Email Address Darrel.Edinoff@AirSystemsinc.com

Please provide business card

Office Phone
Cell Phone
Email Address

Please provide business card

Office Phone
Cell Phone
Email Address

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
June 13	14	15	16	17	18	19
8:00 am - 10:05 am **CHEM 006 0965 MMP 267703 2022SU** *MTWR 0800-1005 02 06/13* LSC2*229	8:00 am - 10:05 am **CHEM 006 0965 MMP 267703 2022SU** *MTWR 0800-1005 02 06/13* LSC2*229	8:00 am - 10:05 am **CHEM 006 0965 MMP 267703 2022SU** *MTWR 0800-1005 02 06/13* LSC2*229	8:00 am - 10:05 am **CHEM 006 0965 MMP 267703 2022SU** *MTWR 0800-1005 02 06/13* LSC2*229			
8:00 am - 12:15 pm **CHEM 025 4338 MMP 267705 2022SU** *MTWR 0800-1215 LAB1 06/13* LSC2*234	8:00 am - 12:15 pm **CHEM 025 4338 MMP 267705 2022SU** *MTWR 0800-1215 LAB1 06/13* LSC2*234	8:00 am - 12:15 pm **CHEM 025 4338 MMP 267705 2022SU** *MTWR 0800-1215 LAB1 06/13* LSC2*234	8:00 am - 12:15 pm **CHEM 025 4338 MMP 267705 2022SU** *MTWR 0800-1215 LAB1 06/13* LSC2*234			
10:15 am - 12:20 pm **CHEM 007 0968 MMP 267704 2022SU** *MTWR 1015-1220 02 06/13* LSC2*229	10:15 am - 12:20 pm **CHEM 007 0968 MMP 267704 2022SU** *MTWR 1015-1220 02 06/13* LSC2*229	10:15 am - 12:20 pm **CHEM 007 0968 MMP 267704 2022SU** *MTWR 1015-1220 02 06/13* LSC2*229	10:15 am - 12:20 pm **CHEM 007 0968 MMP 267704 2022SU** *MTWR 1015-1220 02 06/13* LSC2*229			
10:15 am - 12:20 pm **CHEM 026 0272 MMP 267706 2022SU** *MTWR 1015-1220 02 06/13* LSC2*227	10:15 am - 12:20 pm **CHEM 026 0272 MMP 267706 2022SU** *MTWR 1015-1220 02 06/13* LSC2*227	10:15 am - 12:20 pm **CHEM 026 0272 MMP 267706 2022SU** *MTWR 1015-1220 02 06/13* LSC2*227	10:15 am - 12:20 pm **CHEM 026 0272 MMP 267706 2022SU** *MTWR 1015-1220 02 06/13* LSC2*227			
10:15 am - 1:05 pm **CHEM 006 0965 MMP 267703 2022SU** *MTWR 1015-1305 LAB1 06/13* LSC2*235	10:15 am - 1:05 pm **CHEM 006 0965 MMP 267703 2022SU** *MTWR 1015-1305 LAB1 06/13* LSC2*235	10:15 am - 1:05 pm **CHEM 006 0965 MMP 267703 2022SU** *MTWR 1015-1305 LAB1 06/13* LSC2*235	10:15 am - 1:05 pm **CHEM 006 0965 MMP 267703 2022SU** *MTWR 1015-1305 LAB1 06/13* LSC2*235			
12:30 pm - 2:35 pm **CHEM 025 4338 MMP 267705 2022SU** *MTWR 1230-1435 02 06/13* LSC2*229	12:30 pm - 2:35 pm **CHEM 025 4338 MMP 267705 2022SU** *MTWR 1230-1435 02 06/13* LSC2*229	12:30 pm - 2:35 pm **CHEM 025 4338 MMP 267705 2022SU** *MTWR 1230-1435 02 06/13* LSC2*229	12:30 pm - 2:35 pm **CHEM 025 4338 MMP 267705 2022SU** *MTWR 1230-1435 02 06/13* LSC2*229			
12:30 pm - 4:45 pm **CHEM 026 0272 MMP 267706 2022SU** *MTWR 1230-1645 LAB1 06/13* LSC2*234	12:30 pm - 4:45 pm **CHEM 026 0272 MMP 267706 2022SU** *MTWR 1230-1645 LAB1 06/13* LSC2*234	12:30 pm - 4:45 pm **CHEM 026 0272 MMP 267706 2022SU** *MTWR 1230-1645 LAB1 06/13* LSC2*234	12:30 pm - 4:45 pm **CHEM 026 0272 MMP 267706 2022SU** *MTWR 1230-1645 LAB1 06/13* LSC2*234			
1:30 pm - 4:20 pm **CHEM 007 0968 MMP 267704 2022SU** *MTWR 1330-1620 LAB1 06/13* LSC2*235	1:30 pm - 4:20 pm **CHEM 007 0968 MMP 267704 2022SU** *MTWR 1330-1620 LAB1 06/13* LSC2*235	1:30 pm - 4:20 pm **CHEM 007 0968 MMP 267704 2022SU** *MTWR 1330-1620 LAB1 06/13* LSC2*235	1:30 pm - 4:20 pm **CHEM 007 0968 MMP 267704 2022SU** *MTWR 1330-1620 LAB1 06/13* LSC2*235			

← →

Science Building Summer Schedule

taylor | engineers

Project:	LMC L-1201 Science BAS Upgrade
Submittal No.:	Laboratory Air Valves
Submittal Date:	4/14/2022
Equipment:	Laboratory Air Valves
Reviewer:	Steve Taylor
Review Date:	April 15, 2022

Taylor Engineers has reviewed the following submittal data for compliance with the contract documents. The contractor shall take action appropriate to the review stamp directives and the comments provided in the summary outline given below.

1	NO EXCEPTION TAKEN	4	REVISE AND RESUBMIT
2	REVISE-NO RESUBMISSION REQUIRED	5	REJECTED
3	SUBMIT SPECIFIED ITEM	6	RETURNED WITHOUT ACTION

THIS REVIEW DOES NOT RELIEVE CONTRACTOR FROM FULLY COMPLYING WITH REQUIREMENTS OF THE DRAWINGS AND SPECIFICATIONS.

No.	Description	Review code	Review comments
1	Lab air valves	1	Order with or without flanges at contractor's discretion; draw bands with clamps are also acceptable.

applied equipment LLC
79 Highbridge Court
Danville, CA 94526

SUBMITTAL DATA

April 13, 2022

PROJECT: LMC – SCIENCE

MECHANICAL ENGINEER: TAYLOR ENGINEERS

CONTRACTOR:

ITEM: Laboratory Air Valves

Accutrol AccuValve AVC-6000 series air valves provided with the following:

- Ten (10) – AVC-6400 supply air valve with aluminum construction & factory insulation
- Six (6) – AVC-6400 general exhaust air valve with aluminum construction
- Twenty-eight (28) – AVC-6200 fume hood exhaust air valves with 304SS construction
- One (1) – AVC-6200 cabinet exhaust air valve with 304SS construction
- AVC valves come with built-in valve controller
- Fast acting electronic actuators (Fail Last Position)
- Low pressure drop and low sound levels for all valves
- Vortex air flow measuring probes to provide ACTUAL CFM for each AccuValve
- Twenty-eight (28) model FHM3 fume hood displays (with 25ft cables)
- Twenty-eight (28) model VSS-50 single vertical sash sensors
- Start-up and assisting with TAB on the balancing of the valves

ACCUVALVE® MODEL AVC6000 SUBMITTAL

MODEL CODE

⚠ ***WARNING:*** *NOT FOR USE WITH PERCHLORIC ACID*

AVC6 [ ][ ][ ] - [ ][ ] - [ ][ ][ ][ ][ ]

VALVE HOUSING MATERIAL
2 = 304SS, 20 GAUGE
3 = 316SS, 20 GAUGE
4 = ALUMINUM, 16 GAUGE
6 = HIGH TEMP 304SS, 20 GAUGE

SIZE
06 = 06" DIAMETER
08 = 08" DIAMETER
10 = 10" DIAMETER
12 = 12" DIAMETER
14 = 14" DIAMETER
18 = 12"x18" RECTANGULAR
24 = 12"x24" RECTANGULAR
36 = 12"x36" RECTANGULAR
48 = 12"x48" RECTANGULAR

OPTIONS
BLANK = NO OPTIONS
A = ACCUNET®
F = FLANGES (REF NOTE 4)
I = INSULATION (REF NOTE 3)
S = TIGHT SHUT-OFF (REF NOTE 1)
W = WIRELESS BLUETOOTH

ACTUATOR
03 = FAIL LAST POSITION (FLP), 2 SEC
05 = FAIL OPEN/CLOSED (FSP), 2 SEC
07 = FAIL LAST POSITION (FLP), 21 SEC

MODEL CODE NOTES:
1) Blade seals are standard on all 6" valves, therefore -S option is not available for valve size -06.
2) Actuator Type "5" factory default is set to "fail open".
3) Insulation is not available on High Temperature AccuValve
4) Standard valve flanges do NOT include predrilled holes. Reference Accutrol "Flange Detail Submittal Drawing" for details.

MATERIALS

Materials Exposed to the Airstream				
Model Material Designator	**(2) 304SS**	**(3) 316SS**	**(4) Aluminum**	**(6) High Temp 304SS**
Housing	304 Stainless Steel	316 Stainless Steel	Al. Alloy 5052-H32	304 Stainless Steel
Compression Section	304 Stainless Steel	316 Stainless Steel	Al. Alloy 5052-H32	304 Stainless Steel
Static Regain Section	304 Stainless Steel	316 Stainless Steel	Al. Alloy 5052-H32	304 Stainless Steel
End Plate	304 Stainless Steel	316 Stainless Steel	Galvanized Steel	304 Stainless Steel
Blades	304 Stainless Steel	316 Stainless Steel	Galvanized Steel	304 Stainless Steel
Shafts	316 Stainless Steel	316 Stainless Steel	316 Stainless Steel	316 Stainless Steel
Shaft Bearings	Teflon	Teflon	Teflon	Teflon
Vortex Sensors	Polycarbonate Plastic, UL94-V0	Polycarbonate Plastic, UL94-V0	Polycarbonate Plastic, UL94-VO	303 Stainless Steel
Sensor Tubing	Polyurethane, Ether-based	Polyurethane, Ether-based	Polyurethane, Ether-based	Viton Rubber
Compression Seals	Viton Rubber	Viton Rubber	EPDM Rubber	Viton Rubber
Machine Screws	304 Stainless Steel	316 Stainless Steel	304 Stainless Steel	304 Stainless Steel
Rivets	304SS	316SS	304SS	304 SS
Blade Seals (optional)	Viton Rubber	Viton Rubber	EPDM Rubber	Viton Rubber

OPERATING RANGE

Valve Model	Min. Flow Measured			Full Scale Range		
	CFM	L/S	CMH	CFM	L/S	CMH
AVC6X06-XX	30	14	51	315	149	535
AVC6X08-XX	80	38	136	800	378	1359
AVC6X10-XX	120	57	204	1300	613	2209
AVC6X12-XX	180	85	306	1790	845	3041
AVC6X14-XX	250	118	425	2750	1298	4672
AVC6X18-XX	260	123	442	3200	1510	5437
AVC6X24-XX	350	165	595	4000	1888	6796
AVC6X36-XX	520	245	883	6400	3020	10874
AVC6X48-XX	700	330	1189	8000	3775	13592

SIZE AND WEIGHT

Valve Model	Valve Dimensions (Reference Sheet 2)						Weight					
	"D" or "W"		"L"		"H"		Stainless Steel		Aluminum		Flange Add	
	in.	mm	in.	mm	in.	mm	Lbs.	kg	Lbs.	kg	Lbs.	kg
AVC6X06-XX	**5.88**	149	**22**	559	**10**	254	**13**	5.9	**9**	4.1	**2.0**	0.9
AVC6X08-XX	**7.88**	200	**24**	610	**13**	330	**16**	7.3	**12**	5.4	**2.6**	1.2
AVC6X10-XX	**9.88**	250	**24**	610	**15**	381	**20**	9.1	**14**	6.4	**3.2**	1.5
AVC6X12-XX	**11.88**	300	**27**	686	**17**	432	**26**	11.8	**16**	7.3	**4.5**	2.0
AVC6X14-XX	**13.88**	350	**30**	762	**19**	483	**30**	13.6	**20**	9.1	**5.2**	2.4
AVC6X18-XX	**17.88**	454	**30**	762	**19**	483	**43**	19.5	**26**	11.8	**5.0**	2.3
AVC6X24-XX	**23.88**	607	**30**	762	**19**	483	**49**	22.2	**29**	13.2	**5.5**	2.5
AVC6X36-XX	**35.88**	911	**30**	762	**19**	483	**97**	44	**59**	26.8	**10.0**	4.5
AVC6X48-XX	**47.88**	1216	**30**	762	**19**	483	**109**	49.2	**69**	31.3	**11.0**	5.0

ACCUTROL LLC
21 Commerce Dr
Danbury, CT 06810
Tel: 203-445-9991
accutrolllc.com

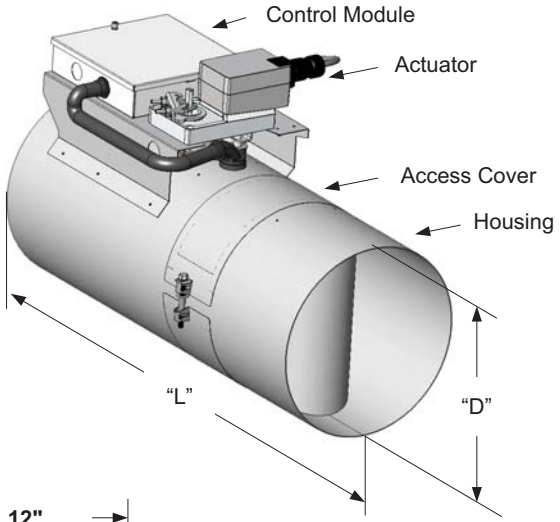
Accutrol Representative:

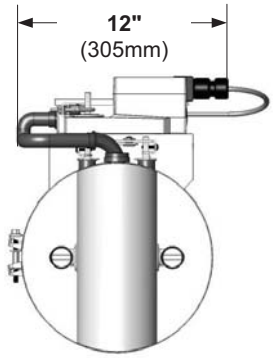
SUBMITTAL DRAWING
AccuValve® Model AVC6000

DWG. NO:	AVC6000 SUBMITTAL DWG		
REVISION:	F	ECN:	2517
REV. DATE:	6-11-19	SHEET: 1 OF: 5	

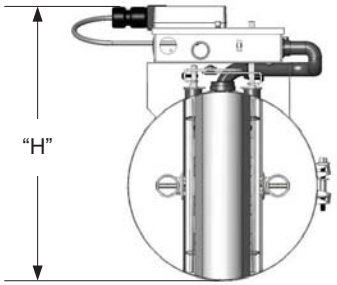
ROUND VALVE

AVC6X06-XX
AVC6X08-XX
AVC6X10-XX
AVC6X12-XX
AVC6X14-XX





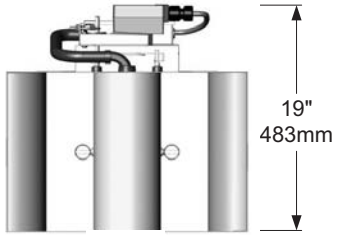
Inlet



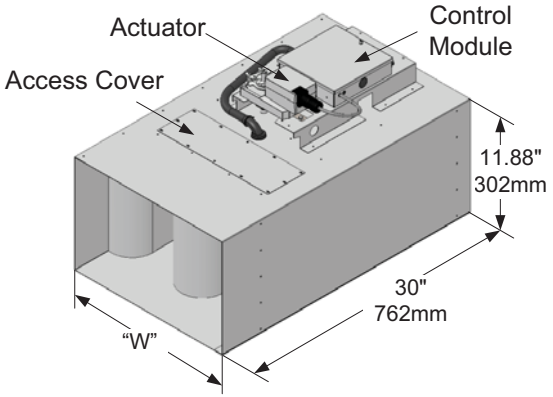
Discharge

RECTANGULAR VALVE

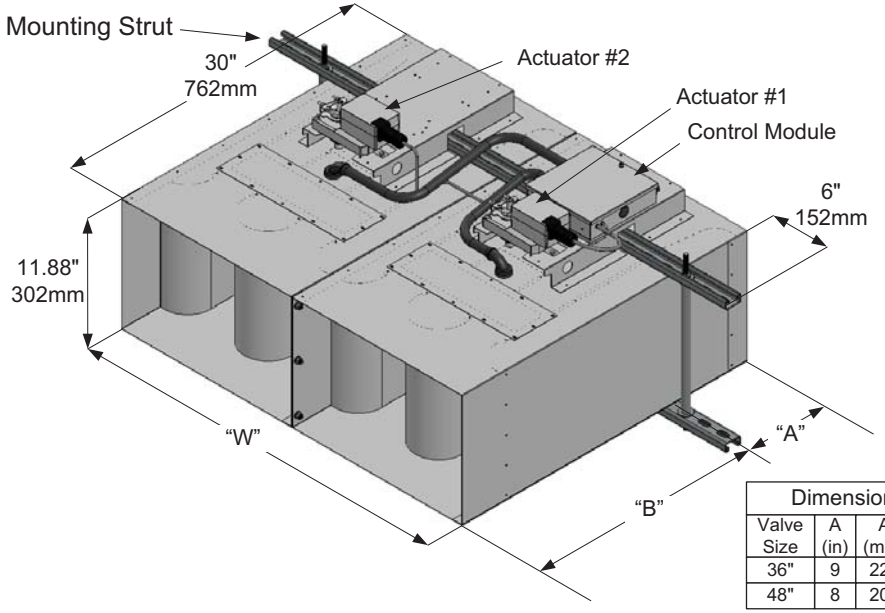
AVC6X18-XX
AVC6X24-XX



Inlet View



AVC6X36-XX
AVC6X48-XX



Dimension to Strut				
Valve Size	A (in)	A (mm)	B (in)	B (mm)
36"	9	229	21	533
48"	8	203	22	559

ACCUTROL LLC
21 Commerce Dr
Danbury, CT 06810
Tel: 203-445-9991
accutrolllc.com

Accutrol Representative:

SUBMITTAL DRAWING

AccuValve® Model AVC6000

DWG. NO:	AVC6000 SUBMITTAL DWG		
REVISION:	F	ECN:	2517
REV. DATE:	6-11-19	SHEET: 2	OF: 5

ROUND VALVE: INSTALLATION INSTRUCTIONS

⚠ ***WARNING:*** *Wear eye protection, protective gloves and clothing suitable for working with sheet metal which may have sharp edges.*

1. Read all instructions prior to beginning installation.

   NOTE: *For detailed installation instructions, refer to the AccuValve® Installation & Operation Manual.*

2. Verify the tag number located on the valve label matches the HVAC schedule.

3. Locate the duct section which the valve is servicing and select a suitable mounting location for the valve.

   NOTES: *The AccuValve® does not require straight inlet duct runs to operate properly, however it's always best to locate the valve away from transitions and bends to minimize impact on system static pressure. Be sure to select a location that will provide a minimum clearance of 14 inches (356 mm) unobstructed access to the control module, actuator and valve access cover. The AccuValve® is not position sensitive. It can be installed in any plane or rotational axis without having impact on the performance.*

4. Provide an opening in the selected duct section sized appropriately for the valve being installed.

   NOTE: *A slip-fit valve will require an opening approximately 2" (50.8 mm) smaller than the valve length, whereas a flanged valve will require an opening the same length as the valve. Reference Sheet 1 for valve dimensions.*

5. Install duct hangers within 12 inches (305 mm) from each end of the valve. Reference Sheet 1 for valve weights.

⚠ ***WARNING:*** *Use duct hangers and hardware designed to support the total load of valve and associated duct sections. Failure to do so may result in serious personal injury or death.*

6. Install the valve into the duct in accordance with the Airflow Direction Label located on the valve. Position the valve for easy access to the controller side then secure to duct per the appropriate Figure below.

   NOTE: *Screws, nuts, fasteners, duct sealant, hangers, and gaskets are not provided by Accutrol LLC.*

Standard Slip-fit Valve Secured Using Tek Screws

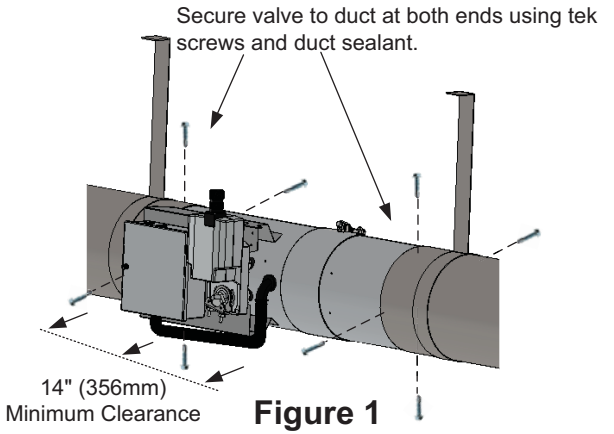


Figure 1

Standard Slip-fit Valve Secured Using Draw Bands

(Draw Bands are Sold Separately)

Reference Accutrol Draw Band Clamp Submittal Drawing for Details

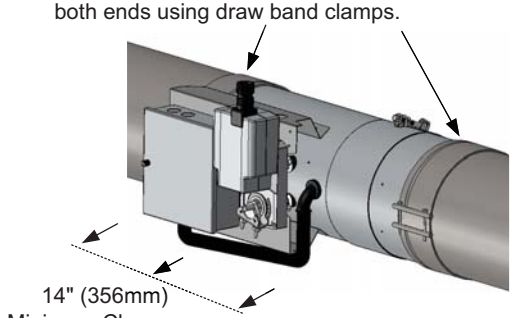


Figure 2

Flanged Valve "Option F" Secured Using Companion Flanges

(Companion Flanges are Sold Separately)

Reference Accutrol Flange Option Submittal Drawing for Details

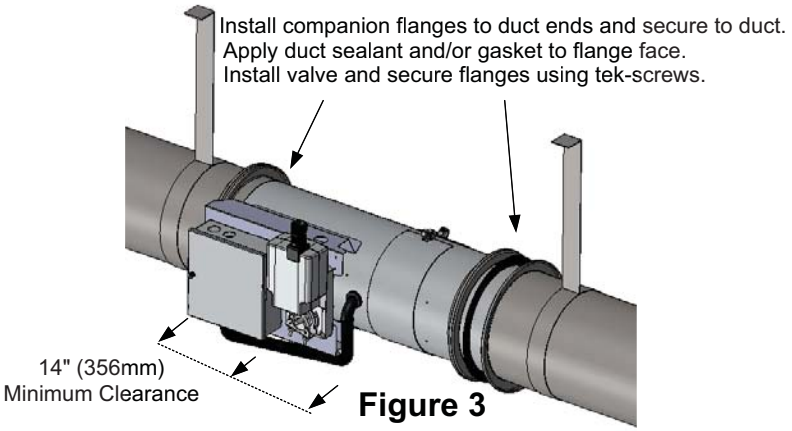


Figure 3

ACCUTROL LLC
21 Commerce Dr
Danbury, CT 06810
Tel: 203-445-9991
accutrolllc.com

Accutrol Representative:

SUBMITTAL DRAWING

AccuValve® Model AVC6000

DWG. NO:	AVC6000 SUBMITTAL DWG		
REVISION:	F	ECN:	2517
REV. DATE:	6-11-19	SHEET: 3	OF: 5

RECTANGULAR VALVE: INSTALLATION INSTRUCTIONS

1. Read all instructions completely before installing the valve.
   ⚠ ***WARNING:*** *Wear eye protection, protective gloves and clothing suitable for working with sheet metal which may have sharp edges.*

2. Verify the tag number located on the valve label matches the HVAC schedule.

3. Select optimum mounting location for the valve.
   NOTE*: The AccuValve® does not require straight inlet duct runs to operate properly, however it's always best to locate any duct device away from transitions and bends to minimize impact on system static pressure.*

4. Allow a minimum clearance of 14 inches (356 mm) unobstructed access to the controller, actuator and valve access cover.
   NOTE: *Rectangular valves are normally installed with the "access side" facing downwards for easy access. However, the AccuValve® is not position sensitive. It can be installed in any plane or rotational axis without having impact on the performance.*

5. To support the weight of the valve, install duct hangers within 12 inches (305 mm) of valve connections. The 12"x36" and 12"x48" valves include an integral mounting strut which shall be used to support the valve in addition to the duct hangers. Reference Sheet 1 for valve weights.
   ⚠ ***WARNING:*** *Use duct hangers and hardware designed to support the total load of the valve and associated duct sections. Failure to do so may result in serious personal injury or death.*

6. After the duct section is properly supported to carry the weight of the valve, install valve into the duct in accordance with the Airflow Direction Label located on the valve. Position valve so the controller, actuator and access cover are easily accessible. For 12x36" and 12x48" valves, attach the integral mounting bracket to threaded rod or duct hangers capable of supporting valve weight.

7. Reference the appropriate diagram to the right for installation details.
   NOTE: *Screws, nuts, fasteners, duct sealant, hangers, companion flanges and gaskets are not provided by Accutrol LLC.*

RECTANGULAR VALVE: INSTALLATION DIAGRAMS

Figure 1
Standard Slip-fit Valve Using Tek Screws

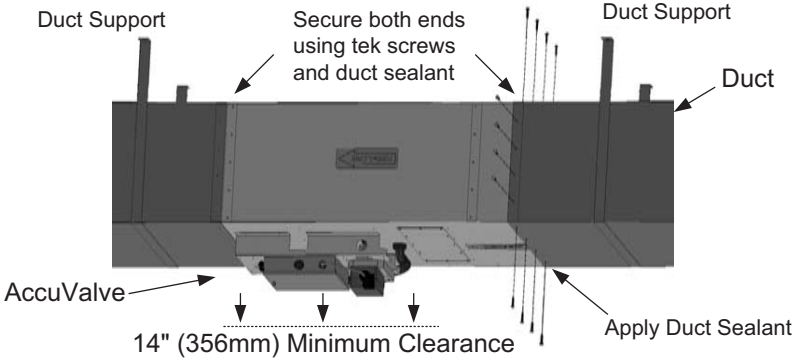


Figure 2
Flanged Valve "Option F" Using Companion Flanges

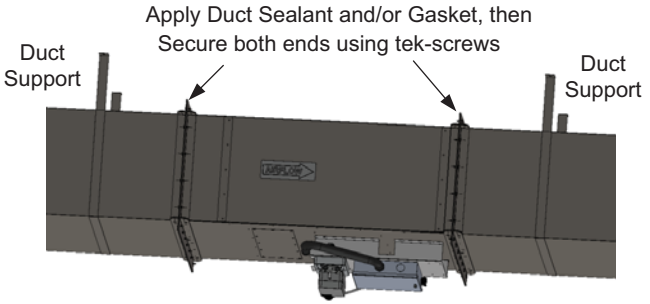
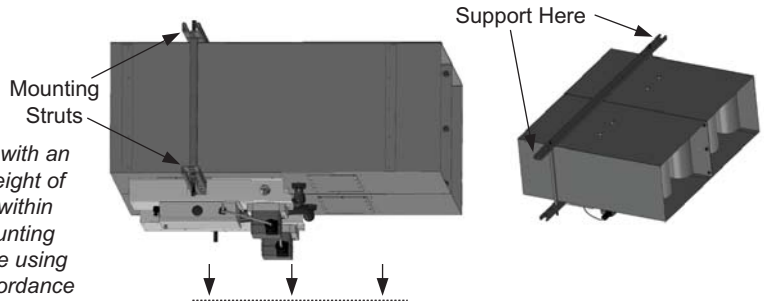


Figure 3
12x36" and 12x48" Valves



⚠ ***WARNING:*** *Dual valves are provided with an integral mounting strut to help support the weight of the valve. In addition to supporting the duct within 12" of the valve, each end of the integral mounting strut shall be secured to the building structure using properly rated hardware and methods in accordance with local building codes. Failure to do so may result in serious personal injury or death.*

ACCUTROL LLC
21 Commerce Dr
Danbury, CT 06810
Tel: 203-445-9991
accutrollllc.com

Accutrol Representative:

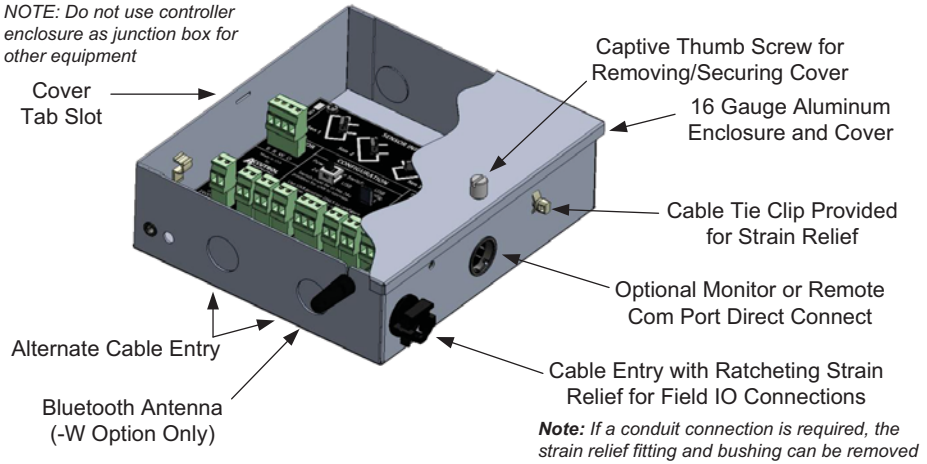
SUBMITTAL DRAWING

AccuValve® Model AVC6000

DWG. NO:	AVC6000 SUBMITTAL DWG		
REVISION:	F	ECN:	2517
REV. DATE:	6-11-19	SHEET:	4 OF 5

CONTROL MODULE

NOTE: Do not use controller enclosure as junction box for other equipment



Note: *If a conduit connection is required, the strain relief fitting and bushing can be removed and replaced with a .875" (22mm) conduit fitting. (Provided by Others)*

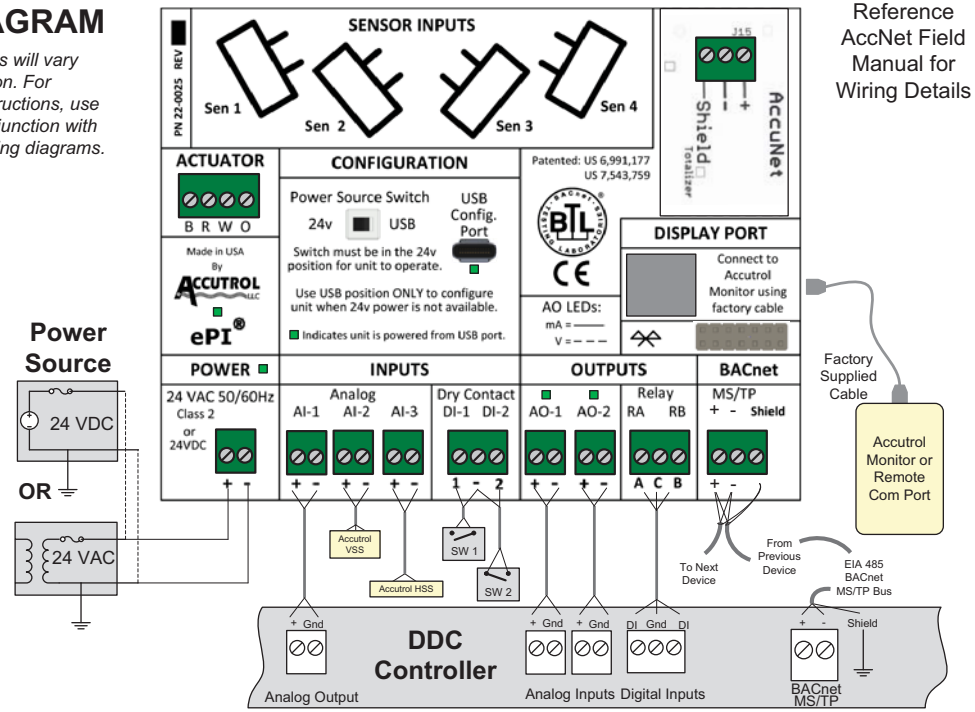
Wiring Instructions

1. Remove cover.
2. Route cables through the strain-relief fitting into the enclosure.
3. Remove terminal block plug(s) and connect wires to the appropriate terminals.
4. Secure terminal screws and reinstall plug(s).
5. Insert the ratcheting strain relief over cable(s) and push down until snug.
6. Reinstall cover and secure thumb screw.

WIRING DIAGRAM

NOTE: Connections will vary based on application. For detailed wiring instructions, use this drawing in conjunction with the job-specific wiring diagrams.

Reference AccNet Field Manual for Wiring Details



CAUTION: Maintain polarity if power source is used to power multiple devices otherwise equipment may be damaged.

ELECTRICAL SPECIFICATIONS

POWER: 24VAC +/-20%, 50/60Hz. (Class 2 Power Source) or 24VDC +/-10%.

Valve sizes 06" through 24"						
Actuator Type	MAX POWER WITH NO MONITOR		MAX POWER WITH FHM1 CONNECTED		MAX POWER WITH FHM3 CONNECTED	
	24 VAC	24 VDC	24 VAC	24 VDC	24 VAC	24 VDC
3	27 VA	14 W	31 VA	16 W	35 VA	18 W
5	28 VA	16 W	32 VA	18 W	36 VA	20 W
7	14 VA	6 W	18 VA	8 W	22 VA	10 W

Valve sizes 36" and 48"						
Actuator Type	MAX POWER WITH NO MONITOR		MAX POWER WITH FHM1 CONNECTED		MAX POWER WITH FHM3 CONNECTED	
	24 VAC	24 VDC	24 VAC	24 VDC	24 VAC	24 VDC
3	49 VA	25 W	53 VA	27 W	57 VA	29 W
5	51 VA	29 W	55 VA	31 W	59 VA	33 W
7	19 VA	9 W	23 VA	11 W	27 VA	13 W

INPUTS:

Analog Inputs: AI-1, AI-2 and AI-3 (Software Selectable)
Voltage: 0-10V Range, Input Impedance = 100K ohms
Current: 0-20mA Range, Input Impedance = 500 ohms
Resistance: 0-20K Range, 500uA Internal Current Source

Digital Inputs: 2 dry-contact inputs

OUTPUTS:

Analog Outputs AO-1, AO-2 (software selectable): 0-20mA, 4-20mA, 0-10V, 2-10V, 0-5V or 1-5V V-out capable of driving 1 K-ohm load @ 10V, I-out capable of driving 1K-ohm load

Alarm Output: DPDT Relay, NC/NO Contacts, 1A @ 30VDC or 0.3A @ 125 VAC

RS-485: EIA 485 BACnet MS/TP 2-wire, Receiver Impedance: ¼ unit load
Note: Network bias and field termination are NOT provided by the AVC Control Module

MONITOR PORT, RJ-45: Connect to Accutrol monitor or remote com port. Connect using factory supplied cable only

CONFIGURATION PORT: USB Type C, Wireless Bluetooth (Optional)

IO TERMINAL PLUGS: 2 & 3 position, vertical pluggable, screw access on top, wire size range 12-30 AWG

ACCUTROL LLC
21 Commerce Dr
Danbury, CT 06810
Tel: 203-445-9991
accutrolllc.com

Accutrol Representative:

SUBMITTAL DRAWING

AccuValve® Model AVC6000

DWG. NO:	AVC6000 SUBMITTAL DWG		
REVISION:	F	ECN:	2517
REV. DATE:	6-11-19	SHEET: 5	OF: 5

Quick Start Guide

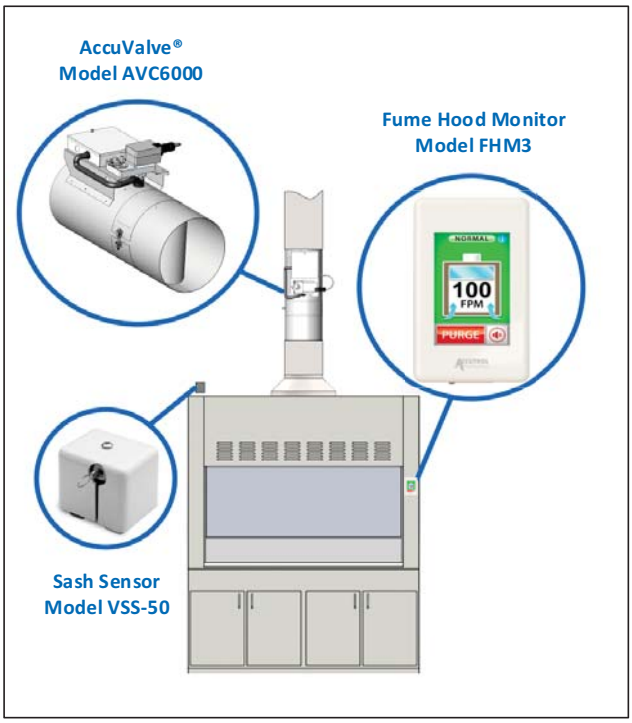
AVC6 Fume Hood Control System

Models: AVC6, FHM3, VSS-50 and HSS1-xx

This Quick Start Guide provides the basic steps required for the installation, wiring and start-up of the AVC6 Fume Hood Control System. For details, refer to the individual product Submittal Drawings, User Manuals and Job-Specific Requirements.

APPLICATION

The AVC6 Fume Hood Control System is comprised of the award-winning AccuValve®, Model AVC6, paired with a dedicated Fume Hood Controller Display Module, Model FHM3. For VAV applications sash sensors are provided for precise measurement of the fume hood face open area. For CAV applications sash switches can be used to change the airflow volume set point to achieve energy savings. The following diagram shows the main components of the AVC6 Fume Hood Control System.



STEP 1: INSTALLATION

CAUTION: Wear eye protection, cut resistant gloves and clothing suitable for working with sheet metal. Failure to do so may result in personal injury.

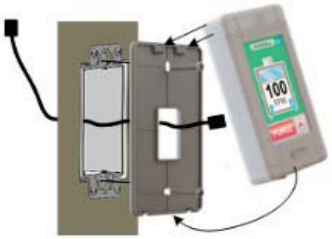
1a. Install AVC6 AccuValve

Select a location in close proximity to the fume hood and install the valve per the AVC6 Submittal Drawing and Manual.

Verify the Airflow Direction Label located on the valve is positioned in agreement with the exhaust airflow direction of the duct and the controller is accessible for wiring.

1b. Install FHM3 Module

Install the FHM3 into a single-gang electrical box located on the front of the fume hood. Be sure to select a location that provides unobstructed access for the user and is clearly visible so the display can be easily viewed.



If the fume hood does not have a preinstalled electrical box available, then one will need to be installed.

1c. Install Sash Sensors

Vertical Sash Sensor (VSS): Select a suitable location to attach the retractable cable to the fume hood sash or counterweight system per the VSS-50 Installation Drawing.

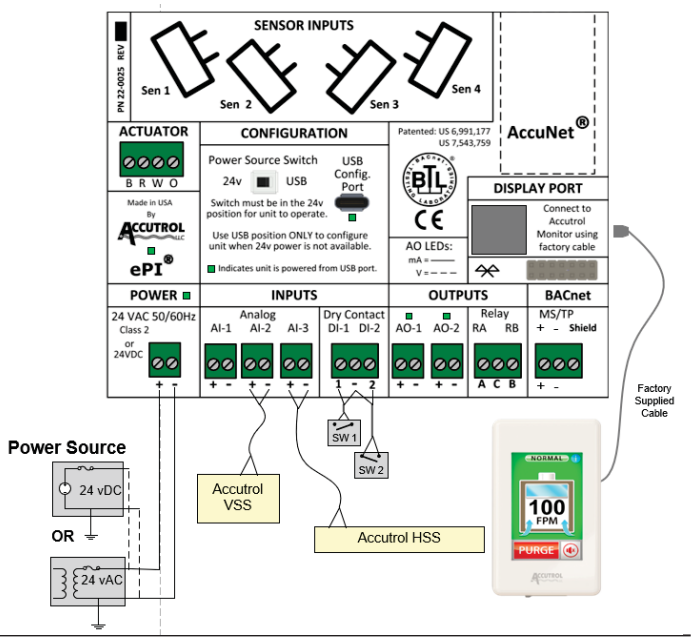
CAUTION: Do not allow the wire rope to "snap back" into the reel or damage to the part or personal injury can result.

After securing the VSS to the fume hood and attaching the retractable cable, verify operation by slowly raising and lowering the sash while observing the VSS and retractable cable to ensure the wire rope extends and retracts straight and without interference.

Horizontal Sash Sensor System: Install the Panel Magnets and HSS onto the fume hood per the instructions provided in the Manual. Use the HSSK Horizontal Sash Kit to manage the cables to prevent them from getting damaged. Due to variations in fume hood construction, custom brackets may be required.

STEP 2: WIRING

Connections to the AVC6 Control Module will vary depending on the application requirements. The below diagram is provided as a general reference only. For detailed wiring requirements, refer to the job specific submittal wiring diagrams and AVC6 Manual.

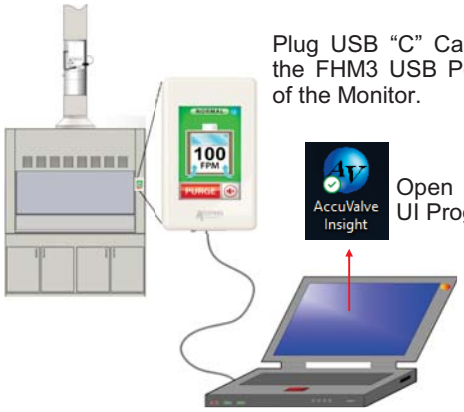


STEP 3: START Up

Before proceeding with start-up, verify the following items have been completed:

- All installation has been completed and verified.
- All wiring has been completed and verified.
- Power is present at the AVC6 and verified to spec.
- Exhaust system is operating with static pressure control.
- The configuration PC has Insight loaded and operational.

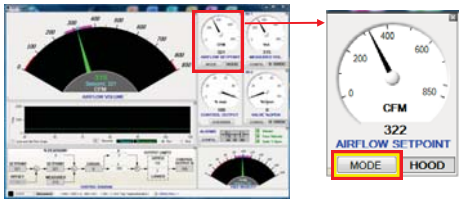
3a. Connect PC to FHM3



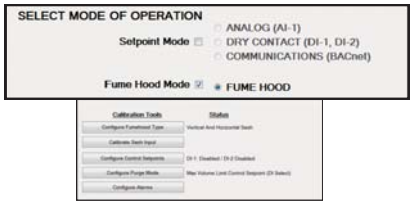
Plug USB "C" Cable from PC into the FHM3 USB Port at the bottom of the Monitor.

Open the AVC Insight UI Program.

3b. On the AIRFLOW SETPOINT Gauge, Select ***MODE***

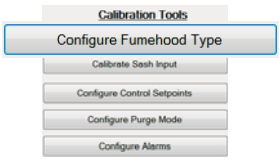


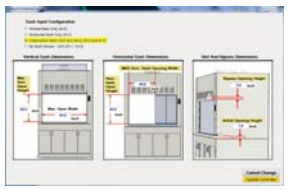
3c. Verify the Mode of Operation is set to ***FUME HOOD MODE***



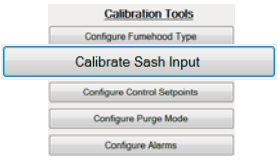
The ***Calibration Tools*** provided for Fume Hood Mode are accessed through a series of buttons that are positioned in the order of which they should be completed during the initial start up.

3d. Select ***Configure Fume Hood Type*** and enter the information required.

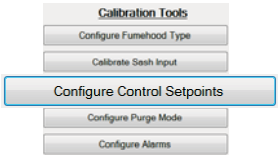


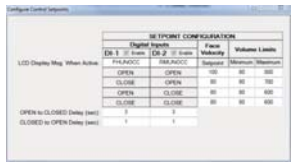


3e. Select ***Calibrate Sash Input*** if sash sensors are employed and perform the sash calibration procedure.

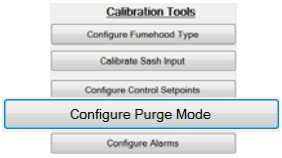


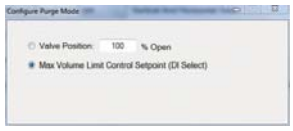
3f. Select ***Configure Control Setpoints*** and enter the setpoint information required for the application.



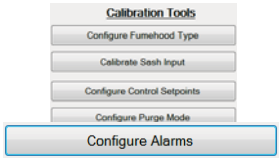


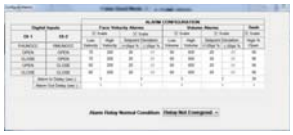
3g. Select ***Configure Purge Mode*** and select the appropriate Purge configuration per the application requirements.





3h. Select ***Configure Alarms*** and enter the alarm setpoint information required for the application.





4. After completing the above steps, verify the displayed face velocity correlates with the measured average face velocity.

Be sure the average face velocity field measurement is obtained using appropriate methods and instrumentation per industry standards and facility requirements.

5. If desired, the displayed face velocity can be correlated to the field measured face velocity by using the Face Velocity Measurement Adjust function, which can be accessed through the utilities Menu under Tools.

This document is a quick-start reference only and is not intended to be used exclusively as a comprehensive guide for the AVC6 Fume Hood Control System. For more details, refer to the AVC6 User Manual, submittal drawings and job specifications to obtain the required operating parameters.

FUME HOOD MONITOR SUBMITTAL (TOUCHSCREEN)

The FHM3 used in conjunction with the AccuValve® Model AVC6 Control Module provides a comprehensive Fume Hood Control System. The FHM3 is provided with 2 mounting screws for securing to a standard single-gang electrical box and a prefabricated factory cable for connecting to the AVC6 Control Module.

FHM 3 - □□□

MODEL
3 – Touchscreen

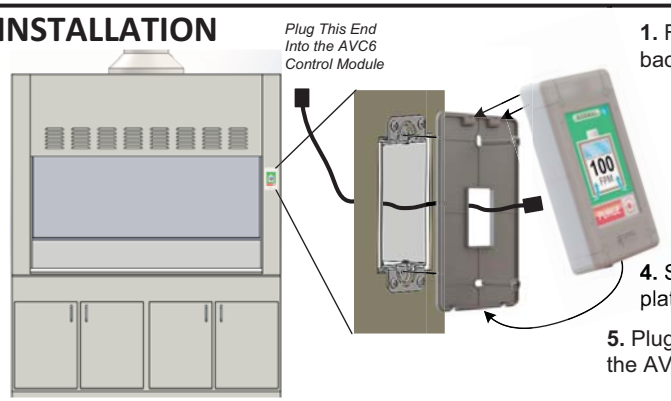
CABLE LENGTH
25' Cable = **025**
50' Cable = **050**
75' Cable = **075**
100' Cable = **100**

NOTE: *If a longer cable is required, please contact factory.*

SPECIFICATIONS

Electrical:
The FHM3 is powered by the AVC6 Control Module using a factory provided cable.
Temperature Range:
Operating: -4°F to +158°F (-20°C to +70°C)
Storage: -22°F to 176°F (-30°C to +80°C)
Physical Construction:
ABS Plastic Enclosure and Mounting Plate, UL94 V-0, RoHS Compliant.
Mounting:
Installs directly into a standard single-gang electrical box, usually provided on the fume hood
Configuration Port:
Easily accessible USB Type C protected by removable rubber plug.

INSTALLATION



1. Feed the display cable into the back of the electrical box.

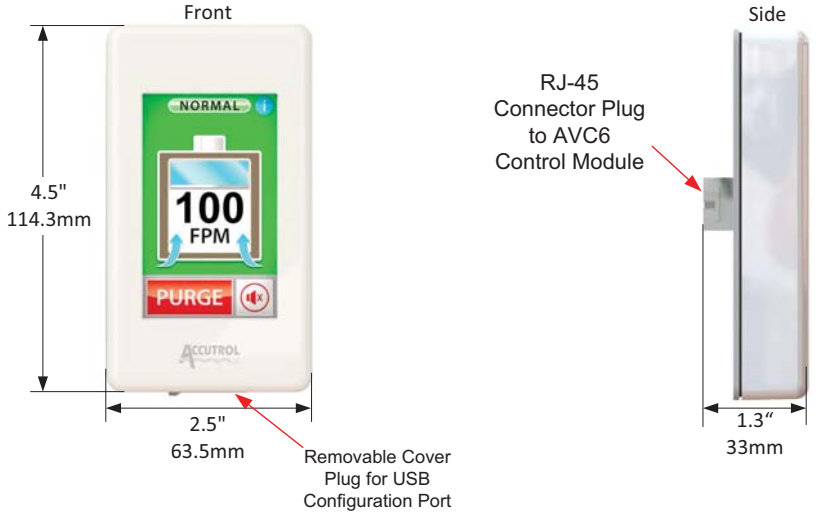
2. Secure the FHM3 back plate to the electrical box using the two screws provided.

3. Plug the display cable into the RJ-45 connector located on the back of the FHM3.

4. Snap the front bezel onto the back plate mounted to the fume hood

5. Plug the other end of the cable into the AVC6 Control Module.

DIMENSIONS & FEATURES: FHM3



Display
3.2 Inch Touchscreen – Resistive. Resolution: 400 x 240 Pixel, 64K Colors
Indicates face velocity or airflow volume on screen
Provides alarm and setback messages on screen
Alarm
Visual Alarm Indicator: on screen
Display Alarm Indicator: Provides message identifying alarm type on screen
Audible Alarm Indicator: Horn, 90dB @ 4KHz
Mute button provided for silencing horn on screen
Purge
Button provided to activate and deactivate local purge on screen
Visual Purge Indicator: on screen
Configuration Port
USB Type C protected by removable rubber plug
Connect to PC with the AccuValve Insight software
All configuration settings for the FHM3 are programmed through the AccuValve Insight software

ACCUTROL LLC
21 Commerce Dr
Danbury, CT 06810
Tel: 203-445-9991
accutrollc.com

Accutrol Representative:

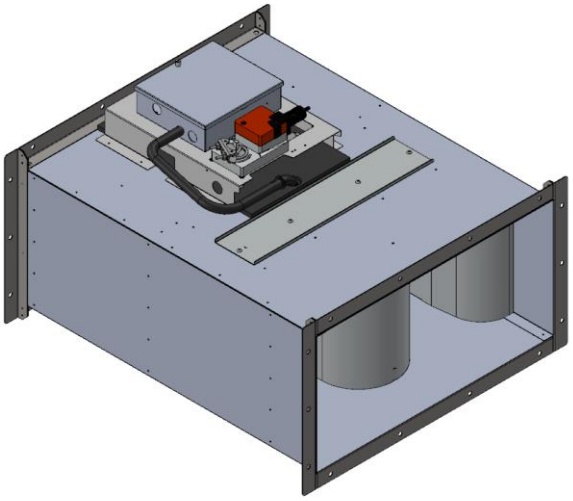
SUBMITTAL DRAWING
FHM3

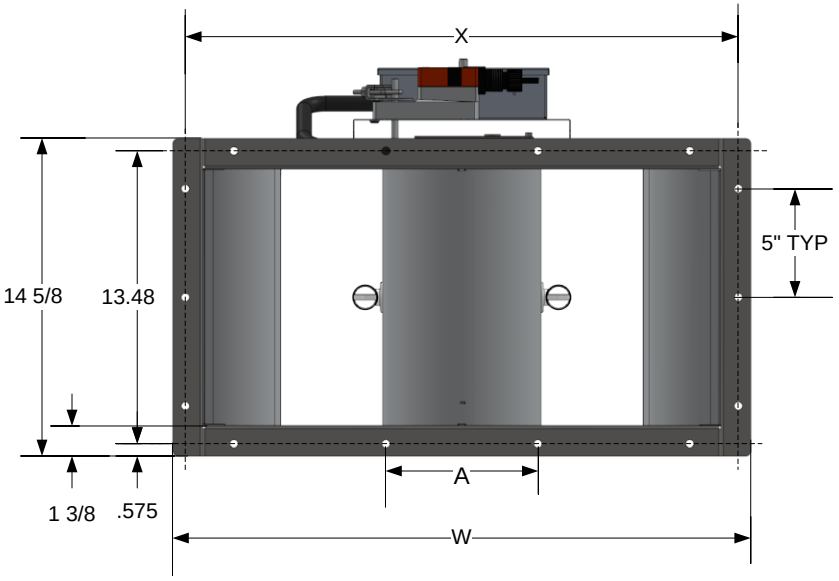
DWG. NO:	FHM3 SUBMITTAL DWG		
REVISION:	A	ECN:	2500
REV. DATE:	4-23-19	SHEET: 1	OF: 1

Flanges for Rectangular AccuValves®

The AccuValve® can be ordered from the factory with optional flanges by adding a "-F" suffix to the model code. This data sheet identifies the flange specifications for rectangular AccuValves® and is intended to be used in conjunction with the standard AccuValve® submittal documentation.

DIMENSIONS





Valve Size	"W"	"A"	"X"	Hole Dia	Hole Qty per Side
12x18	20 5/8"	5"	19.48"	3/8"	14
12x24	26 5/8"	7"	25.48"	3/8"	14
12x36	38 5/8"	5"	37.48"	3/8"	22
12x48	50 5/8"	7"	49.48"	3/8"	22

FLANGE MATERIAL & CONSTRUCTION

Flanges are constructed from 16 gauge steel. Aluminum valve housings use flanges that are constructed from galvanized steel and stainless steel valve housings use flanges that are constructed from the same type of stainless steel as the valve housing. Companion flanges, gaskets and hardware for field installation are not provided with the AccuValve®.

ACCUTROL LLC

21 COMMERCE DRIVE
DANBURY CT, 06810
Tel: 203-445-9991

SUBMITTAL DRAWING

Flange Detail (Predrilled) for Rectangular AccuValve®

Sold By:

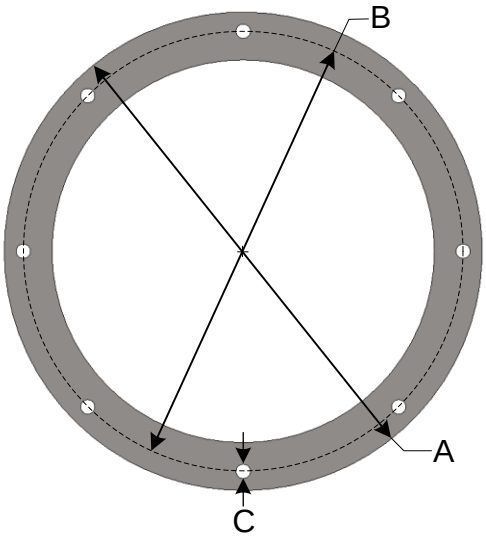
SIZE	ECN NO	DWG NO	REV
A	2533	FLANGE DETAIL (PREDRILLED) – RECTANGULAR AV	F

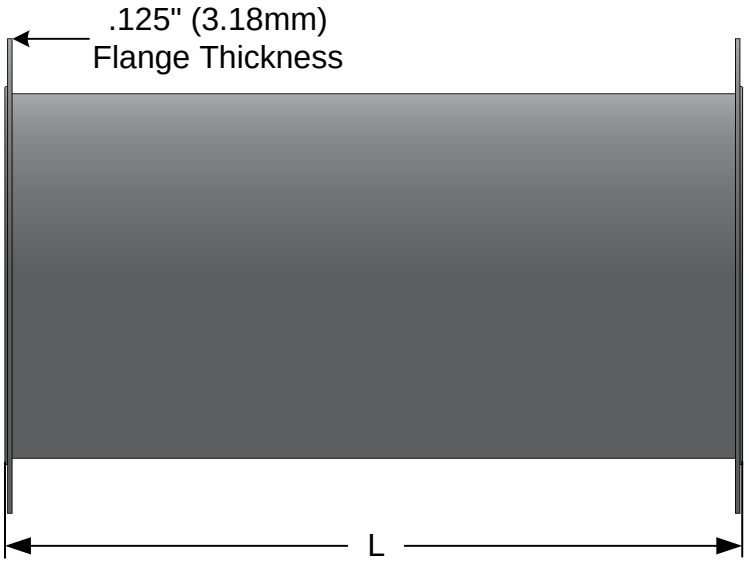
SCALE	REV. DATE: 8-1-19	SHEET
NTS		1 OF 1

VANSTONE FLANGES FOR ROUND HOUSINGS

The AccuValve® and AccuStation can be ordered from the factory with optional Vanstone flanges by adding a "-F" suffix to the model code. This data sheet identifies the flange specifications used on round housings and is intended to be used in conjunction with the standard submittal documentation.

DIMENSIONS





HOUSING SIZE	LENGTH "L"		FLANGE O.D. "A"		BOLT HOLE PATTERN Ø "B"		BOLT HOLE Ø "C"		BOLT HOLE QUANTITY
	in	mm	**in**	mm	**in**	mm	**in**	mm	
06	**21.5**	546	**8.50**	216	**7.50**	191	**0.375**	9.53	6
08	**23.5**	597	**10.50**	266.7	**9.50**	241	**0.375**	9.53	8
10	**23.5**	597	**12.50**	317.5	**11.50**	292.1	**0.375**	9.53	8
12	**26.5**	673	**15.00**	381.0	**13.81**	350.8	**0.438**	11.1	12
14	**29.5**	749	**17.00**	431.8	**15.81**	401.6	**0.438**	11.1	12

FLANGE MATERIAL

HOUSING MATERIAL	VANSTONE FLANGE MATERIAL
304SS	304SS
316SS	316SS
ALUMINUM	GALVANIZED STEEL

ACCUTROL LLC

21 COMMERCE DRIVE
DANBURY CT, 06810
Tel: 203-445-9991

SUBMITTAL DRAWING
Vanstone Flange Detail for Round Housings

Sold By:

SIZE	ECN NO	DWG NO	REV
B	2453	FLANGE DETAIL – VANSTONE	B

SCALE	REV. DATE: 3-6-19	SHEET
NTS		1 OF 2

VANSTONE FLANGES FOR ROUND HOUSINGS

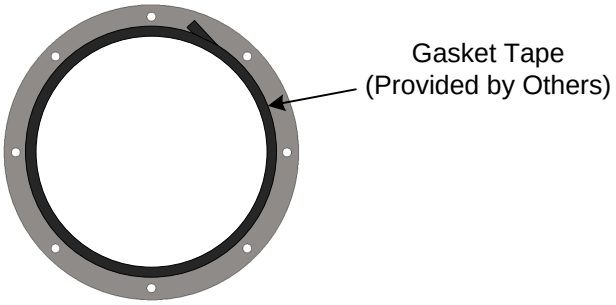
INSTALLATION INSTRUCTIONS

Hardware Required (provided by others)

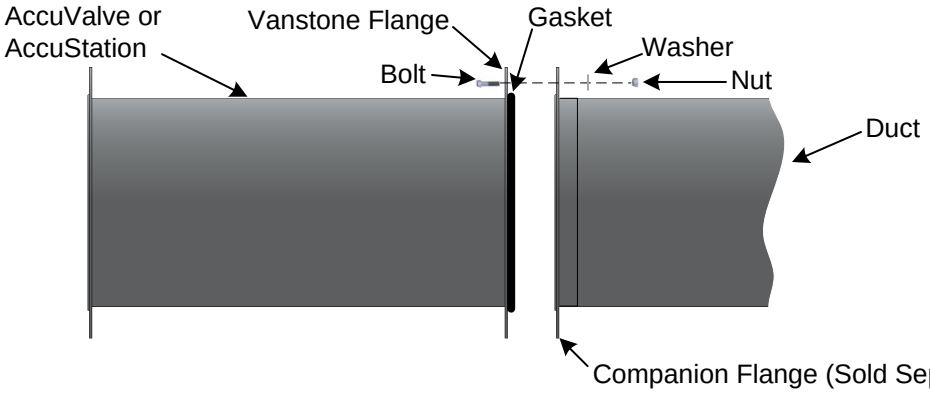
Valve Size	Connecting Hardware Required per Valve (Bolts, Nuts, and Washers)							Gasket Tape 1/2" Wide	
	Qty	Bolt Size		Nut		Washer ID			
06	12	5/16 x 1"	M8 x 25mm	5/16"	M8	5/16"	M8	44"	112cm
08	16	5/16 x 1"	M8 x 25mm	5/16"	M8	5/16"	M8	56"	142cm
10	16	5/16 x 1"	M8 x 25mm	5/16"	M8	5/16"	M8	68"	173cm
12	24	3/8 x 1"	M10 x 25mm	3/8"	M10	3/8"	M10	80"	203cm
14	24	3/8 x 1"	M10 x 25mm	3/8"	M10	3/8"	M10	94"	239cm

Installation

1. Verify the duct mounting location is sized appropriately for the valve being installed
2. Install companion flanges on each duct end using appropriate hardware and sealant.
3. Apply gasket tape to each Vanstone flange just inside the bolt-hole circle as shown below.



4. Position valve into duct opening, rotate Vanstone Flange rings to align with the companion bolt holes, install the bolts, washers, and nuts per figure below.



5. Secure nuts alternating across the bolt circle to provide even torque as you tighten. Torque each nut to approximately 80 ft-lb

ACCUTROL LLC

21 COMMERCE DRIVE
DANBURY CT, 06810
Tel: 203-445-9991

SUBMITTAL DRAWING
Vanstone Flange Detail for Round Housings

Sold By:

SIZE	ECN NO	DWG NO	REV
B	2453	FLANGE DETAIL – VANSTONE	B

SCALE	REV. DATE	SHEET
NTS	3-6-19	2 OF 2

LMC SCIENCE BLDG

FAST ACTING VALVE SCHEDULE

Room Name	Current Room #	Valve Tag	Accutrol Model	Valve Size	CFM RANGE		APD @ MAX CFM	WT LBS	Designated Use	Valve Construction
					MAX	MIN				
Majors Bio Lab	130	SUP 2.8	AVC-6424-03-I	12" x 24"	1680	1515	0.09"	29	Supply	Aluminum
Majors Bio Lab	130	GEX 2.8	AVC-6424-03	12" x 24"	1570	905	0.08"	29	Gen Exhaust	Aluminum
Majors Bio Lab	130	HEX 2.8	AVC-6212-03	12"	800	300	0.09"	26	Fume Hood	304SS
Microbiology	127	SUP 2.9	AVC-6424-03-I	12" x 24"	1770	1550	0.10"	29	Supply	Aluminum
Microbiology	127	GEX 2.9	AVC-6424-03	12" x 24"	1670	950	0.09"	29	Gen Exhaust	Aluminum
Microbiology	127	HEX 2.9	AVC-6212-03	12"	800	300	0.09"	26	Fume Hood	304SS
General Bio Lab	126	SUP 2.11	AVC-6424-03-I	12" x 24"	1670	950	0.09"	29	Supply	Aluminum
General Bio Lab	126	GEX 2.11	AVC-6424-03	12" x 24"	1670	950	0.09"	29	Gen Exhaust	Aluminum
General Bio Lab	126	HEX 2.11	AVC-6212-03	12"	800	300	0.09"	26	Fume Hood	304SS
Biology Prep/Stock	128	SUP 2.12	AVC-6410-03-1	10"	750	540	0.15"	14	Supply	Aluminum
Biology Prep/Stock	128	GEX 2.12	AVC-6408-03	8"	535	80	0.21"	12	Gen Exhaust	Aluminum
Biology Prep/Stock	128	HEX 2.12A	AVC-6212-03	12"	800	300	0.09"	26	Fume Hood	304SS
Biology Prep/Stock	128	HEX 2.12B	AVC-6208-03	8"	80	80	0.01"	16	Cabinet	304 SS
Chem Prep/Stock	237	SUP 2.21	AVC-6424-03-I	12" x 24"	1520	715	0.09"	29	Supply	Aluminum
Chem Prep/Stock	237	GEX 2.21	AVC-6412-03	12"	740	180	0.11"	16	Gen Exhaust	Aluminum
Chem Prep/Stock	237	HEX 2.21A	AVC-6212-03	12"	800	300	0.07"	26	Fume Hood	304 SS
Chem Prep/Stock	237	HEX 2.21B	AVC-6212-03	12"	800	300	0.09"	26	Fume Hood	304 SS
Organic Chem Lab	235	SUP 2.22A	AVC-6424-03-I	12" x 24"	2600	1200	0.20"	29	Supply	Aluminum
Organic Chem Lab	235	SUP 2.22B	AVC-6424-03-I	12" x 24"	2600	1200	0.20"	29	Supply	Aluminum
Organic Chem Lab	235	SUP 2.22C	AVC-6424-03-I	12" x 24"	2600	1200	0.20"	29	Supply	Aluminum
Organic Chem Lab	235	SUP 2.22D	AVC-6424-03-I	12" x 24"	2600	1200	0.20"	29	Supply	Aluminum
Organic Chem Lab	235	HEX 2.22A	AVC-6212-03	12"	800	300	0.09"	26	Fume Hood	304 SS
Organic Chem Lab	235	HEX 2.22B	AVC-6212-03	12"	800	300	0.09"	26	Fume Hood	304 SS
Organic Chem Lab	235	HEX 2.22C	AVC-6212-03	12"	800	300	0.09"	26	Fume Hood	304 SS
Organic Chem Lab	235	HEX 2.22D	AVC-6212-03	12"	800	300	0.09"	26	Fume Hood	304 SS
Organic Chem Lab	235	HEX 2.22E	AVC-6212-03	12"	800	300	0.09"	26	Fume Hood	304 SS
Organic Chem Lab	235	HEX 2.22F	AVC-6212-03	12"	800	300	0.09"	26	Fume Hood	304 SS
Organic Chem Lab	235	HEX 2.22G	AVC-6212-03	12"	800	300	0.09"	26	Fume Hood	304 SS
Organic Chem Lab	235	HEX 2.22H	AVC-6212-03	12"	800	300	0.09"	26	Fume Hood	304 SS
Organic Chem Lab	235	HEX 2.22J	AVC-6212-03	12"	800	300	0.09"	26	Fume Hood	304 SS
Organic Chem Lab	235	HEX 2.22K	AVC-6212-03	12"	800	300	0.09"	26	Fume Hood	304 SS
Organic Chem Lab	235	HEX 2.22L	AVC-6212-03	12"	800	300	0.09"	26	Fume Hood	304 SS
Organic Chem Lab	235	HEX 2.22M	AVC-6212-03	12"	800	300	0.09"	26	Fume Hood	304 SS
Organic Chem Lab	235	HEX 2.22N	AVC-6212-03	12"	800	300	0.09"	26	Fume Hood	304 SS
Organic Chem Lab	235	HEX 2.22P	AVC-6212-03	12"	800	300	0.09"	26	Fume Hood	304 SS
Organic Chem Lab	235	HEX 2.22Q	AVC-6212-03	12"	800	300	0.09"	26	Fume Hood	304 SS
Organic Chem Lab	235	HEX 2.22R	AVC-6208-03	8"	500	200	0.18"	16	Fume Hood	304 SS
Organic Chem Lab	235	HEX 2.22T	AVC-6208-03	8"	500	200	0.18"	16	Fume Hood	304 SS

LMC SCIENCE BLDG

FAST ACTING VALVE SCHEDULE

Room Name	Current Room #	Valve Tag	Accutrol Model	Valve Size	CFM RANGE		APD @ MAX CFM	WT LBS	Designated Use	Valve Construction
					MAX	MIN				
General Chem Lab	234	SUP 2.27	AVC-6436-03-I	12" x 36"	3640	1625	0.16"	59	Supply	Aluminum
General Chem Lab	234	GEX 2.27	AVC-6408-03	8"	525	80	0.20"	12	Gen Exhaust	Aluminum
General Chem Lab	234	HEX 2.27A	AVC-6212-03	12"	800	300	0.09"	26	Fume Hood	304 SS
General Chem Lab	234	HEX 2.27B	AVC-6212-03	12"	800	300	0.09"	26	Fume Hood	304 SS
General Chem Lab	234	HEX 2.27C	AVC-6212-03	12"	800	300	0.09"	26	Fume Hood	304 SS
General Chem Lab	234	HEX 2.27D	AVC-6212-03	12"	800	300	0.09"	26	Fume Hood	304 SS
General Chem Lab	234	HEX 2.27E	AVC-6212-03	12"	800	300	0.09"	26	Fume Hood	304 SS

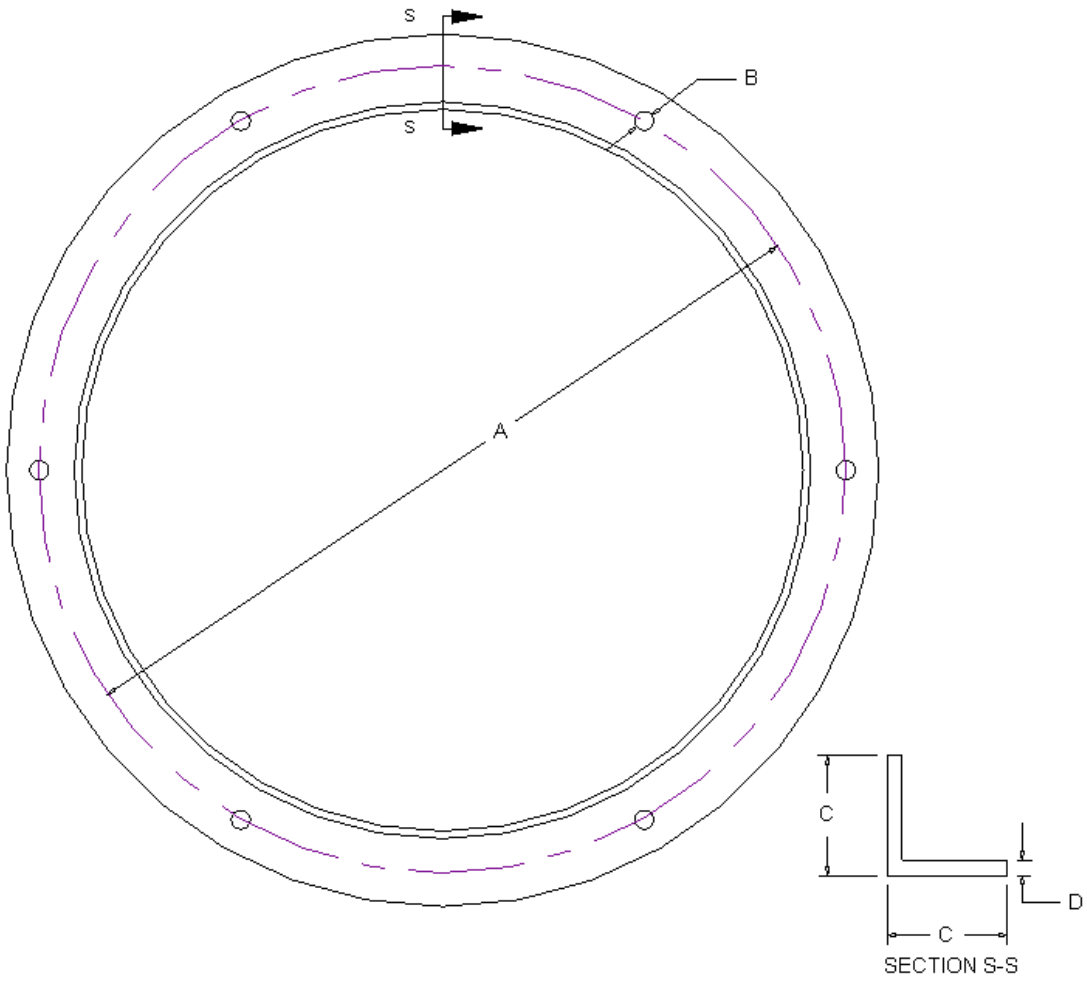
All valves will be provided with construction as noted with fast acting Belimo actuators and are native BACnet

All Supply valves will be provided with factory insulation

Innovative Airflow Solutions for Critical Environments

Venturi Valve Flange

Data Sheet



Flanges	8”	10”	12”	14”
A	9.38	11.37	13.38	15.44
B	0.313	0.313	0.313	0.313
C	1	1.5	1.5	1.5
D	0.125	0.125	0.125	0.125

Flanges may be added to Triatek’s Venturi valves to reduce installation and removal times. Construction material options are aluminum or stainless steel.

MODEL VSS-50

The Vertical Sash Sensor (VSS) is a Cable Extension Position Transducer that produces an electrical output signal proportional to cable extension. The VSS is installed onto the fume hood with it's extension cable attached to the vertical rising fume hood sash or counterweight cable. As the sash moves up and down, the cable extends and retracts, providing an electrical signal that accurately depicts the sash position.

INSTALLATION

The following instructions are provided as a guideline for installing the VSS-50 onto a fume hood. Because fume hood construction varies greatly, additional hardware not provided by Accutrol may be required for some applications.

Regardless of which installation method is used, the VSS shall be installed and secured to the fume hood using the mounting screws provided. The retractable cable end can be attached to the counterweight, the counterweight cable or the vertical sash frame. The basic steps required for each type of installation are similar, however the hardware required may vary due to the specific application.

⚠ **WARNING:** Do not allow the wire rope to "snap back" into the VSS otherwise damage to the part and personal injury can result.

1. Select a suitable location to attach the retracting cable on either the sash frame, counterweight or counterweight cable system. Following are some guidelines to follow for determining a suitable location.

- If you plan on attaching the extension cable end to a counterweight cable, verify there is enough distance between pulleys to account for the full sash travel. The sensor cable should not travel over counterweight pulleys or sprockets.

- Verify the cable will not rub or chafe against any surface during sash movement.

- As the sash is moved in one direction, the extension cable shall only move in one direction in relation to the VSS.

For example, if the VSS is installed on top of the hood and the extension cable is secured to the sash frame, the extension cable shall NOT pass by the VSS during sash movement.

Figure 1A shows an acceptable location for securing the extension cable in relation to the VSS-50. As the sash is raised and lowered, the extension cable end never passes by the VSS.

Figure 1B shows an unacceptable location for securing the extension cable in relation to the VSS-50. As the sash is raised, the extension cable retracts until it passes by the VSS-50 where it changes direction and begins to extend while the sash continues to be raised.

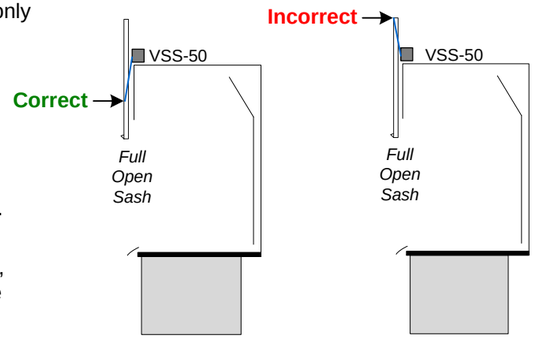
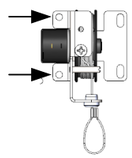


Figure 1A **Figure 1B**

2. Install the VSS to a stationary surface located on the top of the fume hood.

Secure with 2 Screws (Use any 2 of the 4 Holes Provided)

Cover of VSS can be removed to access 2 additional mounting holes

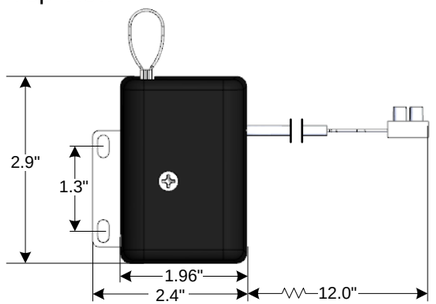


3. Attach the retracting cable to the location selected in Step 1.

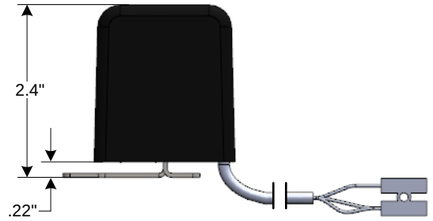
4. Slowly raise and lower the sash while observing the VSS and retractable cable to ensure the wire rope extends and retracts straight and without interference to other objects.

DIMENSIONS

Top View



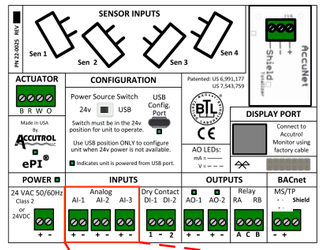
Side View

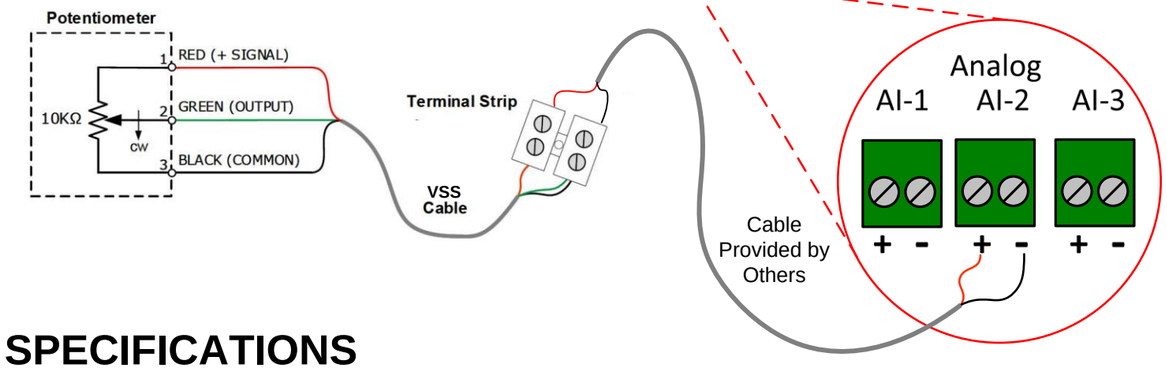


WIRING

WIRING TABLE	
VSS-50	**Control Module**
Red (+ Signal)	AI-2 (+)
Black (Common)	AI-2 (Gnd)

AVC6000 CONTROL MODULE





SPECIFICATIONS

Measurement Range: 50" (1270mm) max
Resistance Range: 0 to 10,000 ohms, Resolution: Essentially Infinite
Measurement cable fully retracted: 10,000 ohms
Measurement cable fully extended: 0 ohms
Operating Temperature Range: -13°F to +221°F (-25°C to +105°C)
Measuring Cable: Stainless Steel, Nylon Coated, .034" (.086mm) dia.
Electrical Cable: 3-cond., 24 AWG, 12" (305mm) Long
Construction: Mounting Frame: Stainless Steel
Cover: ABS Plastic
Life Cycle Rating: 250,000 Full Cycles Minimum
RoHS Compliant

ACCUTROL LLC
21 Commerce Dr,
Danbury, CT 06810
ACCUVALVE.COM

Accutrol Representative:

SUBMITTAL DRAWING

VSS-50

DWG. NO:	VSS-50 SUBMITTAL DWG		
REVISION:	G	ECN:	2561
REV. DATE:	11-8-19	SHEET: 1 OF: 1	

applied equipment LLC
79 Highbridge Court
Danville, CA 94526

April 18, 2022

Contra Costa Community College District
500 N. Court St.
Martinez, CA 94533
Attn: Stefan Johnson

Subject: LMC L-1201 Science Bldg BAS Upgrade

LABORATORY AIR VALVES

AccuValve laboratory air flow control valves with electronic, fast acting, **Fail-Last-Position** actuators and vortex shedding air flow measuring probe. Each valve will be factory calibrated for the specified requirements and do not require any straight duct runs for entering or leaving the valve. It can be installed horizontally, vertically or even at an angle with no accuracy loss.

Included:

- 10 – Accutrol AVC-6400 Supply valves with aluminum construction & factory insulation
- 6 – Accutrol AVC-6400 General exhaust air valves with aluminum construction
- 28 – Accutrol AVC-6200 Fume hood air valves with 304SS construction
- 1 – Accutrol AVC-6200 Cabinet exhaust air valve with 304SS construction
- All AVC valves have a built-in valve controller
- All AVC valves will come with fast acting, Fail-Last Position actuators
- 28 – FHM fume hood displays with 25ft cables
- 28 – VSS-50 single vertical sash sensors
- Start-up and assisting with TAB on the balancing of the valves

Not Included:

- Any room/lab controls, temperature sensors or control power transformers
- Hot water Reheat Coil or RH coil control valve
- Installation or mounting of any of the components quoted above
- **Flanges or draw band clamps**
- Any wiring of these components or connection to the BAS and 24V power wiring
- Duct transitions between the valves and ductwork
- Any tie in to BAS system or its interface

Your price, freight allowed, not including any applicable taxes is: $ 139,500.00

ADD for flanged connections on all valves (not including companion flanges) is: $11,500.00

Sincerely,

Al Alexy

Applied Equipment LLC

● FOB Factory, freight allowed to first destination. ● Prices do not include taxes and are firm for 30 days. ● Applied Equipment LLC standard terms and conditions apply ● Goods may not be returned without written authorization & are subject to restocking charge. ● Orders are subject to acceptance by the factory and manufacturer's standard warranty is applicable.