UNIVERSITY of FLORIDA

BUILDING AUTOMATION SYSTEM GUIDE SPECIFICATION

Sections written in the following format indicate a need for the consultant to edit, modify, or select for specific project conditions ***[Pneumatic/Electric actuation shall be used at all reheat coils]***

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. A complete microprocessor controlled BACnet compatible building automation and control systems tested and ready for operation.
2. Automation and/or monitoring for the various systems such as but limited to:
   a. Air Handlers
   b. Variable Frequency Drives
   c. Variable Air Terminals
   d. Fan Coil Units
   e. Pumps
   f. Heat Exchangers
   g. Air Conditioners
   h. Heaters
   i. Meters

Identify other appropriate major equipment contained in the construction documents and coordinate integration requirements.

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3. In addition to monitor and controlled equipment, this section includes:
   a. Communication and Low voltage cable and pathways.
   b. Power required, but not directly shown on construction documents.
   c. Bridges, routers, drivers, or gateways.
   d. Other miscellaneous items required but not specified for a complete operational system.

B. Products Supplied But Not Installed Under This Section:

1. Control Valves
2. Control Dampers
3. Smoke or Combination Fire/Smoke Dampers
4. Instrument wells
5. Flow Meters

Edit per project requirements and cross reference other related sections. Add installation of wells, control valves, dampers, wells , flow meters, etc in appropriate mechanical section and cross reference.

C. RELATED SECTIONS
1. Section 15005 - Motors
2. Section 15520 - Valves
3. Section 15550 - Vibration Isolation
4. Section 15910 - Control Sequences
5. Section 16130 - Raceway and Fittings
6. Section 16120 - Conductors and Cables

Identify other appropriate specification sections contained in the Project Manual (e.g. electrical raceways, conductors, motor starters, VFD's, etc.)

1.2 REFERENCES

A. ANSI/ASHRAE Standard 135-2004 BACnet

B. FCC Part 15, Subpart J Class A Computing Devices

C. UL 864/UUKL Smoke Control Listing (Ninth Edition)

D. UL 873 Temperature-Indicating and -Regulating Equipment

E. UL 916 Energy Management Systems

Edit references as needed

1.3 DEFINITIONS

A. The following abbreviations, acronyms, and definitions apply to and are used within this Guide Specification:

1.	Actuator	Control device to provide motion of valve or damper in response to control signal.
2.	AHU	Air Handling Unit
3.	AI	Analog Input
4.	AO	Analog Output
5.	Analog	A continuously variable system or value not having discrete levels. Typically exists within a defined range of limiting values
6.	Auto-Tune	Software routine used to adjust tuning parameters based on historical or real-time data
7.	ASC	Application Specific Controller
8.	BACnet	The ASHRAE building automation and control protocol
9.	BAS	Building Automation System
10.	BLC	Building Level Controller – Supervisory control panel and the primary means of communication outside the building. May also act as a global controller, implementing building wide global strategies and energy management routines.
11.	Cx	Commissioning Agent

12. Control Sequence	An BAS pre-programmed arrangement of software algorithms, logical computation, target values and limits as required to attain the defined operational control objectives.
13. DDC	Direct Digital Control
14. DDCP	Direct Digital Control Panel
15. Discrete	A two-state system where an “ON” condition is represented by one discrete signal level and an “OFF” condition is represented by a second discrete signal level each separated by a defined deadband. Digital Inputs and Digital Outputs are examples
16. DI	Discrete Input
17. DO	Discrete Output
18. EEPROM	Electronically Erasable Programmable Read Only Memory
19. EMI	Electromagnetic Interference
20. EMT	Electrical Metallic Tubing
21. E-P	Electric to Pneumatic
22. Fat Client	A network computer with a hard disk drive.
23. FC	Fail Closed position of control device or actuator. Device moves to closed position on loss of control signal or energy source.
24. FO	Fail Open position of control device or actuator. Device moves to open position on loss of control signal or energy source.
25. Furnish	Supply but not install.
26. GUI	Graphical User Interface
27. I/O	Input/Output (typically referring to points monitored by a system).
28. I/P	Current to pneumatic transducer
29. Instrument	Device used for sensing input parameters or used for actuation
30. IP	Internet Protocol
31. HOA	Hand Off Auto
32. Install	To mount, but not furnish.
33. LAN	Local Area Network
34. IT	Information Technology
35. LOT	Local Operator Terminal
36. Modulating	Movement of a control device through an entire range of values proportional to an infinitely variable input value.
37. Motorized	Control device with actuator.
38. NC	Normally Closed position of switch contacts after control signal is removed.
39. NO	Normally Open position of switch contacts after control signal is removed.
40. Node	DDCP, user workstation, or other control device connected to communication's network.
41. Operator	Same as actuator
42. Owner	University of Florida (UF Project Manager)
43. OWS	Operator’s Work Station (Personal Computer with Intranet / Internet capability)

44. PC	IBM-compatible Personal Computer from a recognized major manufacturer. PC “clones” assembled by a third-party subcontractor are not acceptable
45. PDA	Personal Digital Assistant
46. Peer-to-Peer	Mode of communication between controllers in which each device connected to network has equal status and each shares its database values with all other devices connected to network.
47. P	Proportional control, control mode with continuous linear relationship between observed input signal and final controlled output element.
48. PI	Proportional - Integral control, control mode with continuous proportional output plus additional change in output based on both amount and duration of change in controlled variable (Reset control).
49. PID	Proportional - Integral - Derivative control, control mode with continuous correction of final controlled output element versus input signal based on proportional error, its time history (reset), and rate at which it is changing (derivative).
50. PM	Project Manager capable of making project and personnel decisions.
51. PPD	Physical Plant Department (University of Florida)
52. Point	Analog or discrete instrument with addressable database value
53. Protocol	A set of rules and standards governing the on-line exchange of data between control systems of the same or different manufacturers.
54. Provide	To “furnish” and “install”
55. RF	Radio Frequency
56. RFI	Radio Frequency Interference
57. Router	Device for implementation of Network Layer Protocol (BACnet/IP)
58. Self-Tune	Same as Auto-Tune
59. Solenoid	Electric two position actuator.
60. Software	Includes all of programmed digital processor software, preprogrammed firmware and project specific digital process programming and database entries and definitions as generally understood in the control industry for real-time, on-line, integrated control system configurations.
61. Thin Client	A network computer without a hard disk drive.
62. Tier 1	LAN and/or WAN communication network. Building to building communication or high speed Ethernet communication level running within a specific building.
63. Tier 2	Building level communication or low speed tier running under a building level supervisory controller.
64. VAV	Variable Air Volume
65. VFD	Variable Frequency Drive
66. WAN	Wide Area Network

1.4 SYSTEMS DESCRIPTION

A. ACCEPTABLE CONTROL SYSTEM MANUFACTURER

1. [Johnson Controls, Inc.]

2. [Siemens Building Technologies]

3. [Automated Logic Corporation]

Consultant should edit list for each project. Coordinate list with University of Florida Project Manager. Some renovation projects may require sole-source selection, meaning the renovation project control system is intended to be an extension of an existing system. NOTE: IF THE PROJECT TEAM ELECTS TO PURSUE A SOLE SOURCE SOLUTION FOR THE BAS, THE CONSULTANT MUST USE THE UF SOLE SOURCE OPEN BOOK BID FORM AND PRICING AGREEMENT.

B. Scope includes labor and materials including but not limited to:
   1. Tools and other equipment
   2. Software, licenses, configurations and database entries,
   3. Interfaces, wiring, tubing, labeling,
   4. Engineering and calculations
   5. Calibration, testing, verifications, training and other services
   6. Documentation, samples, submittals,
   7. Permits, professional licenses, etc.
   8. Other Administrative fees such as parking, shipping, handling, etc.

C. Provide a complete system and be accessible via manufacturer's specific server system using a web browser interface implemented over the Owner's intranet as well as over the Internet.

D. The BAS network includes but is not limited to the following:
   1. Operator PCs – fixed or portable
   2. Connection to existing network servers.
   3. Routers, bridges, switches, hubs, modems and like communications equipment.
   4. Intelligent and addressable elements and end devices.
   5. Third-party equipment interfaces.
   6. Other components required for a complete and working BAS.

Consultant should edit list for each project. Coordinate list (specifically laptop requirements) with University of Florida Project Manager.

E. The BAS Network shall utilize an open architecture capable of all of the following:
   1. Utilizing standard Ethernet communications and operating at a minimum speed of 10/100 Mb/sec.
   2. Connecting via BACnet/IP at the Tier 1 level in accordance with ANSI/ASHRAE Standard 135-2004. All points shall be made available for monitoring via BACnet/IP.
   3. The BAS network shall support both copper and optical fiber communication media at the Tier 1 level.

F. The BAS Network shall integrate to the following systems:
   1. Lighting
   2. Power metering
   3. Fire Alarm
   4. Security
   5. Other BAS

6. Chilled Water and Steam metering

Consultant should carefully consider all levels of integration. It is the intent of UF PPD that the BAS system be integrated to all building systems/equipment. Coordinate integration requirements into other specifications to insure cooperation from each trade.

G. The system architecture allows complete access to the BAS system via a web browser. The thin-client web browser or GUI will support the latest version of Microsoft and Netscape Navigator browsers and Windows as well as non-Windows operating systems. No special software, (active-x components or fat java clients) shall be required to be installed on the thin client PC's / PDA's used to access the BAS via a web browser.

Verify the requirement to add a local operator station. Performance specifications for the operator workstation is provided in PART 2.

H. The BAS shall be fully expandable with addition of hardware and/or software. Expansion shall not require removal of existing DDCP, sensors, actuators, or communication networks.

I. Include all necessary network hardware

J. System must be of modular design to ensure reliability and system performance.

K. Provide all required system software to support a server/client architecture, designed around the open standards of web services.

L. All electrical work required as an integral part of this section is work of this section.

M. Provide final power connections including conduit, wire, and/or control panel disconnect switches to all control devices from appropriate electrical j-box.

Edit per project requirements and cross reference interrelated sections. Be sure to coordinate power requirements with electrical engineer and to cross-reference responsibilities with other system designers (e.g. HVAC, Electrical, Fire Protection, Plumbing, etc…). Coordinate power requirements for BAS system and show on electrical drawings. The goal of the University is to insure 120 VAC power is provided within a common area (e.g. mechanical room) adjacent to control devices. The control contractor would then be responsible for all final power (120 VAC and >) and low voltage (24VAC and <) to all control components within the common area. Located BAS panels on the mechanical room floor plan drawings.

N. Include the following integrated features, functions and services:
   1. Operator information, alarm management and control functions at any operator's console without the need to purchase special software from the contractor or BAS manufacturer for those consoles.
   2. Enterprise-level information and control functions
   3. Information management including monitoring, transmission, archiving, retrieval, and reporting functions
   4. Diagnostic monitoring and reporting of BAS functions

5. Offsite monitoring and management
6. Energy management
7. Wireless Device capability

1.5 QUALITY ASSURANCE

A. Provide components not specifically indicated or specified, but necessary to make system function within the intent of contract documents.

B. All electrical products to be listed and labeled by UL and comply with NEMA Standards.

C. Control wiring shall be in accordance with National Electric Code.

D. The Contractor shall have support services within a 10 mile radius of Project Site and comply with the service requirement of a two hour on-site response time.

E. As evidence and assurance of the contractor's ability to support the Owner's system with service and parts, the contractor must have been in the BAS business for at least the last five (5) years and have successfully completed total projects of at least 5 times, the value of this contract, in each of the preceding five years.

F. Provide a competent and experienced Project Manager

G. Engineering services shall be performed by factory-trained engineers.

H. System shall be installed by factory trained mechanical and electrical installers either in direct employ of this Contractor or by subcontractors who are under direct supervision of this Contractor.

I. Use only manufacturer trained technicians who are skilled, experienced, trained, and familiar with the specific equipment, software and configurations to be provided under this section.

J. Coordinate with the Owner to ensure that the BAS will perform in the Owner's IT environment without disruption to any of the other activities taking place on that LAN or WAN

K. Coordinate timely delivery of materials and supervise activities of other trade contractors to install inline devices such as immersion wells, pressure tappings, any associated shut-off valves, flow switches, level switches, flow meters, air flow stations, and other such items furnished under this section but installed by other trades.

L. Select sensors and transducers to most closely match the expected sensing or control range.

M. Mark and detail exact location of inline devices, wells, and taps to be installed by Mechanical Contractor on coordination drawings.

N. Instrumentation with factory J-boxes shall not be used for junction boxes.

O. Install control equipment, wiring and air piping in neat and workmanlike manner to satisfaction of A/E, and in accordance with manufacturer's recommendations. Maintain clearances, straight length distances, etc. required for proper operation of each device.

P. Install control devices in accessible location. Coordinate all control device locations with other trade contractors.

Q. All safety devices shall function when VFD is in auto, hand or bypass mode.

1. Wire VFD's so that all safeties and interlocks remain operational (inclusive of isolation dampers, isolation valves, end switches, interlocks, safeties etc) when drive is placed in Auto, Hand or Bypass mode.
2. Safeties and interlocks shall be wired on motor side of the VFD and Bypass.

Include if VFD with by-pass is used. Remove bypass reference if VFD's are specified without Bypass.

R. Provide weather protection cover or weatherproof control devices where required for control devices located outdoors.
   1. All control devices located outdoors shall be rated for the anticipated environment.
   2. Include provisions for supplemental ventilation when control devices must be located within these outdoor control panels.

S. All digital equipment furnished under this contract shall have been tested and made to comply with limits for Class A computing device pursuant to Subpart J of Part 15 of FCC Rules.

T. Performance Standards: The system shall conform to the following:
   1. Text Display: The system shall display a text page with a maximum of 20 dynamic points with all current data within 10 seconds.
   2. Object Command: The time between the command override of a binary object by the operator and the reaction by the device shall be less than 2 seconds and the subsequent update at the terminal shall be no more than 20 seconds (refresh rate).
   3. Object Scan: All changes of state and change of analog values shall be transmitted over the high-speed network such that any data used or displayed at a controller or workstation will have been current within the previous 60 seconds.
   4. Alarm Response Time: The time from which an object goes into alarm to when it is annunciated at the web page shall not exceed 15 seconds.
   5. Program Execution Frequency: Custom and standard applications shall be capable of running as often as once per second. The Contractor shall be responsible for selecting execution times consistent with the mechanical process under control.
   6. Performance: Programmable controllers shall be able to execute PI or 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 rate.
   7. Multiple Alarm Annunciation: All thin client and fat client PC's currently connected through the server shall receive alarms within 5 seconds of each other.
   8. Reporting Accuracy: The system shall report all values with an end-to-end accuracy equal to or better than those listed below:

	Measured Variable	Reported Accuracy
a.	Space Temperature	+/- 0.1 Deg F
b.	Ducted Air (Single Probe)	+/- 0.1 Deg F
c.	Ducted Air (Averaging)	+/- 0.5 DegF
d.	Outside Air	+/- 1.0 Deg F
e.	Dew Point	+/- 1.0 Deg F
f.	Water Temp	+/- 0.1 Deg F
g.	Delta T	+/- 0.1 Deg F
h.	Relative Humidity (duct and space)	+/- 2% RH

i.	Water Flow	+/- 5% (GPM) of full Scale
j.	Air Flow (Terminal unit)	+/- 5% (CFM) of full Scale (see note 1)
k.	Air Flow (Measuring Station)	+/- 5% (CFM) of full scale
l.	Air Pressure (ducts)	+/- 0.05 in WC
m.	Air Pressure (space)	+/- 0.01 in WC
n.	Water Pressure	+/- 2% (psig/psid) of full scale (see note 2)
o.	Electrical (A, V, W, PF)	5% of reading (see note 3)
p.	Carbon Monoxide (CO)	+/- 5% of reading
q.	Carbon Dioxide (CO2)	5% of full scale

Reporting accuracy is a direct function of the actual sensors that are used. Consultant may want to relax or increase the accuracy requirements based on application..

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9. Stability of Control: Control loops shall maintain measured variable at setpoint within the tolerances listed below:

	Controlled Variable	Control Accuracy	Range of Medium
a.	Air Pressure (ducts)	+/- 0.1 in WC	-6 to +6 in WC
b.	Air Pressure (space)	+/- 0.010 in WC	-0.100 to +0.100 in WC
c.	Air flow	+/- 100 CFM or 1% of setpoint (whichever is less)	
d.	Temperature	+/- 0.5 Deg F	
e.	Humidity	+/- 2% RH	
f.	Fluid Pressure	+/- 0.50 psi/psid	1 to 150 psi/psid
g.	Carbon Dioxide (CO_2)	+/- 50 ppm	100 to 2000 ppm

U. Provide all points required to implement control sequences specified, whether or not they are listed in schedules.

V. All outputs, whether sequenced or not, shall have separate programmable hardware outputs. For air handling units, minimum outside air, maximum (economizer) outside air, return, relief air, smoke dampers, heating valves, cooling valves, etc., shall each have separate output.

W. Point and Alarming expectations: The system includes points and alarms as the following:

1. Unless otherwise noted, provide the following Air Handling System I/O and adjustable points listed below:

	Point	Alarm Notification
a.	Occupied Mode	No
b.	Fan Command	No
c.	Fan Status	Yes
d.	Static Pressure	Yes
e.	Static Setpoint	No
f.	Fan Speed Command	Yes
g.	Low Static Alarm Status	Yes
h.	High Static Alarm Status	Yes
i.	Low Limit Alarm Status	Yes

j.	Filter Status	Yes
k.	Mixed Air Temperature	Yes
l.	Mixed Air Setpoint	No
m.	Cooling Coil Valve Output	Yes
n.	Cooling Coil Differential Pressure	Yes
o.	Cooling Coil Temperature	Yes
p.	Cooling Coil Setpoint	No
q.	Heating Coil Valve Output	Yes
r.	Heating Coil Differential Pressure	Yes
s.	Heating Coil Temperature	Yes
t.	Heating Coil Setpoint	
u.	UV Light Status	Yes
v.	UV Lights Runtime	Yes
w.	Fan Fire Shutdown Relay	Yes
x.	Supply Air Temperature	Yes
y.	Isolation Damper Output	No
z.	Isolation Damper Status	Yes
aa.	Fan Duct Smoke Detector Status	Yes
bb.	Return Humidity	Yes
cc.	Return Water Temperature	Yes
dd.	Outside Airflow	Yes
ee.	Return Air Temperature	Yes
ff.	Relief Air Damper Output	No
gg.	Economizer Damper Output	No
hh.	Minimum Outside Air Damper Output	No
ii.	Minimum Outside Air Fan Damper Status	Yes
jj.	VFD Bypass	Yes
kk.	Outside Air Temperature	No
ll.	Outside Air Humidity	No
mm.	Runtime	Yes
nn.	General Exhaust Fan Start	No
oo.	General Exhaust Fan Status	Yes
pp.	General Exhaust Runtime	Yes

Ideally points should be in drawings. Points are for a typical system Adjust points and add alarm for specific AHU application.

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2. Unless otherwise noted, provide the following Air Terminal Unit System I/O and adjustable points listed below:

	Point	Alarm Notification
a.	Damper Output	Yes

b.	Air Flow	Yes
c.	Airflow Setpoint	No
d.	Reheat Coil Valve Output	Yes
e.	Reheat Temperature	Yes
f.	Filter Status	Yes
g.	Zone Temperature	Yes
h.	Heating Setpoint (+ Or - 3.0 Deg F)	No
i.	Cooling Setpoint (+ Or - 3.0 Deg F)	No
j.	Starved Box Alarm	Yes
k.	Design Differential Airflow (Non Adj.)	No
l.	Actual Differential Air Flow	Yes

Ideally points should be in drawings. Points are for a typical system Adjust points and add alarm for specific ATU application.

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3. Unless otherwise noted, provide the following Fan Coil Unit System I/O and adjustable points listed below:

	Point	Alarm Notification
a.	Duct Smoke Detector	Yes
b.	Filter Status	Yes
c.	Fire Shutdown Relay	Yes
d.	Fan Status	Yes
e.	Cooling Coil Valve	Yes
f.	Drain Pan Float Switch	Yes
g.	Heating Coil Valve	Yes
h.	Discharge Temperature	Yes
i.	Space Temperature	Yes
j.	Heating Setpoint (+ Or - 3.0 Deg F)	No
k.	Cooling Setpoint (+ Or - 3.0 Deg F)	No

Ideally points should be in drawings. Points are for a typical system Adjust points and add alarm for specific FCU application.

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4. Unless otherwise noted, provide the following Chilled Water System I/O and adjustable points listed below:

	Point	Alarm Notification
a.	Chilled Water Flow	Yes
b.	Plant Chilled Water Supply Temperature	Yes
c.	Plant Chilled Water Supply Pressure	Yes
d.	Plant Chilled Water Return Temperature	Yes
e.	Plant Chilled Water Return Pressure	Yes

f.	Building Chilled Water Supply Temperature	Yes
g.	Building Differential Pressure	Yes
h.	Building Chilled Water Return Temperature	Yes
i.	Pump Command	No
j.	Pump Status	Yes
k.	Pump Speed Command	Yes
l.	Pump Speed Feedback	Yes
m.	Pump Vibration Transmitter	Yes
n.	Pump VFD Alarm	Yes
o.	Plant Differential Pressure	Yes
p.	Loop Control Valve Output	Yes
q.	System Start Up	No
r.	Lead Pump	No
s.	Redundant Pump	No
t.	Pump Rotation	No
u.	Differential Pressure Setpoint	Yes
v.	Pump Runtime	Yes

Ideally points should be in drawings. Points are for a typical system Adjust points and add alarm for specific CHW application.

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5. Unless otherwise noted, provide the following Hot Water System I/O and adjustable points listed below:

	Point	Alarm Notification
a.	Steam Pressure	Yes
b.	Steam Flow	Yes
c.	1/3 Steam Valve	Yes
d.	2/3 Steam Valve	Yes
e.	Heating Hot Water Supply Temperature	Yes
f.	Heating Hot Water Supply Setpoint	Yes
g.	Pump Command	No
h.	Pump Status	Yes
i.	Pump Speed Command	Yes
j.	Pump Speed Feedback	Yes
k.	Pump Vibration Transmitter	Yes
l.	Pump VFD Alarm	Yes
m.	Heating Hot Water Flow	Yes
n.	Differential Pressure	Yes
o.	Heating Hot Water Return Temperature	Yes
p.	Condensate Flow	Yes
q.	Condensate Pump Alarm	Yes

r.	System Start Up	Yes
s.	Lead Pump	Yes
t.	Redundant Pump	Yes
u.	Rotation	Yes
v.	Differential Pressure Setpoint	Yes
w.	Pump Runtime	Yes

Ideally points should be in drawings. Points are for a typical system Adjust points and add alarm for specific HHW application.

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6. Unless otherwise noted, provide the following Electrical I/O and adjustable points listed below:

	Point	Alarm Notification
a.	Building Total Elec. Consumption	Yes
b.	Building Instantaneous Elec.	Yes
c.	Building Phase A Voltage	Yes
d.	Building Phase A Current	Yes
e.	Building Phase B Voltage	Yes
f.	Building Phase B Current	Yes
g.	Building Phase C Voltage	Yes
h.	Building Phase C Current	Yes

7. Unless otherwise noted, provide the following Exhaust System I/O and adjustable points listed below:

	Point	Alarm Notification
a.	System Start Up	No
b.	Lead Fan	No
c.	Redundant Fan	No
d.	Rotation	No
e.	Static Pressure	Yes
f.	Static Pressure Setpoint	No
g.	Exhaust Fan Damper Output	Yes
h.	Exhaust Air Damper Status	Yes
i.	Exhaust Fan Command	Yes
j.	Exhaust Fan VFD Speed Command	Yes
k.	Exhaust Fan VFD Speed Feedback	Yes
l.	Exhaust Fan VFD Alarm	Yes
m.	Fan Minimum On Time	Yes
n.	Fan Runtime	Yes

Ideally points should be in drawings. Points are for a typical system Adjust points and add alarm for specific Exhaust application.

1.6 COMMISSIONING

A. Assist Testing Adjust Balance Contractor in verifying system operation for all modes of operation.

B. Demonstrate the sequence of operation for each system and/or sub-system to [**Commissioning Agent (Cx) and/or Engineer**]. Perform all other requirements and perform all services as required in specification Section [**(#####) Commissioning Requirements**].

Edit per project requirements and cross reference other related sections. All references to commissioning activities shall be coordinated with commissioning specification.

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1. Use either vendor specific forms or commissioning agent documentation to document the operation and performance of all control systems.
2. Demonstrate functional tests for on each point, control strategy, and control loop.
3. Provide trends, schedules, printouts, etc to Cx as requested to document system performance.

Consultant shall confirm with University of Florida Project Manager whether this project will utilize a Commissioning Agent. The control contractor shall provide appropriate commissioning documents as described above, regardless of Cx participation. Edit above as appropriate.

1.7 SUBMITTALS

A. Organized submittals based on specification numbers with major tabs to separate major sections and a master index indicating all elements of submittal.

B. Identify specific parts and accessories proposed for project. Order submittals based on the specification section.

C. Include the following:
1. BAS network architecture diagrams including all nodes and interconnections.
2. Schematics, sequences and flow diagrams
3. Points schedule for each real point in the BAS, including: Tag, Point Type, System Name and Display Units. Device Type, Address, Cable Destination, Module Type, Terminal ID, Panel, Slot Number, Reference Drawing, and Cable Number. Cable destination, terminal ID, slot number, etc… may also be identified in panel detail drawings.
4. Samples of Graphic Display screen types and associated menu penetrations to show hierarchy and functional interrelationships for systems specified.
5. Detailed Bill of Material list for each system, identifying quantity, part number, description, and optional features selected.
6. Control Dampers
   a. Schedule including a separate line for each damper and a column for each of the damper attributes, including: Code Number, Fail Position, Damper Type, Blade Type, Bearing Type, Seals, Duct Size, Damper Size, Mounting, and Actuator Type.
   b. Leakage and flow characteristics data for all control dampers. Leakage ratings to be based on AMCA Standard 500 and dampers to bear AMCA leakage certification seal.
7. Control Valve

a. Schedules including a separate line for each valve and a column for each of the valve attributes: Code Number, Configuration, Fail Position, Pipe Size, Valve Size, Body Configuration, Close off Pressure, Capacity, Valve CV, Calculated CV, Design Pressure drop, Actual Pressure drop, and Actuator Type.

b. Engineering calculations for sizing modulating control dampers including outside, return, and relief air dampers of air handling and exhaust systems.

8. Room Schedule including a separate line for each terminal unit indicating terminal identification, minimum/maximum cfm, box area, thermostat/sensor location, Htg/Clg Setpoints and bias setting. The schedule shall include typical calibration factors to be filled in by TAB contractor during startup and verification.

9. FCC compliance.

Insert appropriate requirements for project as designed.

D. Training Plan

1. Schedule
2. Agenda
3. Classes
4. Participants

E. Integration Plan

1. Coordination of vendor protocol and pointlist submission.
2. Workflow processes to integrate systems.
3. Include communication hardware, software, and protocols to implement full systems integration.
4. Identify proposed enhancements or deviations from project documents. Include specific drawings or specifications impacted.
5. Provide coordination efforts to accommodate complete integration of systems including:
   a. Vendor protocol requirements.
   b. Vendor pointlist.

Edit integration requirements and cross reference integration requirements with other sections.

F. Operating and Maintenance Manuals:

Edit per project requirements and cross reference other related sections.

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1. Operating and maintenance
   a. Include descriptions of maintenance for all components supplied under this section, including (but not limited to) sensors, actuators and controllers.
   b. Include inspection requirements, periodic preventative maintenance recommendations, fault diagnosis, instructions for repair or replacement of defective components, calibration instructions, parts lists, name, address, and phone number of manufacturer's representative.

2. Provide product operational and maintenance data in electronic PDF format (Acrobat latest version- 6.0 or greater) on vendor specific server, and provide means to access this data using intuitive operator interaction (quick links from main system graphics).
   a. Include name and 800 number of a 7 day a week 24 hour a day service line for needed service during the first year of operation

G. Software Manual:
1. As part of operating and maintenance manuals, submit one software manual to UF PPD plus one extra copy for archive use. Divide software manuals into separate parts with tabs for each part. CD versions of this information may be provided as the archive copy
2. Include the following:
   a. Complete description of operating system including all commands, configuration programs, printouts, logs, database functions and passwords.
   b. Describe general operating procedures, starting with system overview and proceeding to detailed description of each software command feature with sample printed displays and system function description for each option. Include instructions on verifying errors, status, changing passwords and initiating or disabling control programs.
   c. Complete description of programming language including all commands, configuration programs, control loop functions and testing.
   d. Describe general programming procedures, starting with system overview and proceeding to detailed description of each software command feature. Include instructions on creating or modifying any control algorithm or parameter, debugging, etc. Include all control functions, algorithms, mathematic equations, variables, setpoints, time periods, messages, and other information necessary to load, alter, test and execute custom or pre-written programs.
   e. Factory standard technical manuals may be provided in lieu of copied subsections.
   f. Software Backup: Upon successful completion of acceptance testing, submit to Owner 2 archive copies of all accepted versions of source code and compiled code for all application programs and data file on compact disc media. All control software must be readily accessible by Owner using BAS server hardware and software.

H. Record Drawings:
1. Submit as-built shop drawings indicating all changes made during project.
   a. Install all as-built control drawings (and associated sequence of operation) in electronic format on specific server, and provide means to access this data using intuitive interaction by end users.
   b. Each system web page shall allow for an automatic link to the associated control diagram. Provide operator a way to access product and as-built control information from the associated system web page (e.g. AHU system, chilled water system, hot water system, VAV system, etc…)
2. Mount system control diagrams (including sequence of operations), laminated and mounted under 11X17 plexi-glass frame within associated mechanical space.
3. Mount (within control panel or in separate enclosure) control panel wiring diagrams (also laminated) indicating all field points connected.
   a. The control panel wiring diagrams shall utilize the same field device tag names used within the associated control diagram.
   b. Not required for room level controllers.

Coordinate all submittal requirements with Division 1.

1.8 WARRANTY

A. Submit warranty documentation upon substantial completion of project or phase (if applicable) and acceptance by Engineer and Owner.

B. Repair or replace systems or parts found defective at no cost to Owner.

C. Include parts, labor, and necessary travel during warranty.

D. Provide vendor specific warranty and registration information.

E. Provide services incidental to proper performance.

F. Provide a minimum two year warranty for all parts provided under this section. Warranty includes all services, materials and equipment necessary to cover defective hardware replacement, software modifications and debugging of the entire system for a period of one year after final acceptance by the A/E and the Owner.

1. First year of warranty includes parts and labor for entire system (including 3rd party equipment). Adjust, repair, or replace, at no additional cost to the owner, Control system failures during the 1st year.
2. Second year of warranty includes parts only.

G. Warranty response time shall be within two hours or less of being notified. The designated UF PPD representatives representing the operations and service departments shall be the authorized callers and will determine the required response level.

1. Emergency service - must respond within two hours of being notified.
2. Warranty service - must respond within 4 hours of being notified.
3. Scheduled service – must respond within 48 hours of being notified.

H. Include, Operator workstation software, project-specific software, graphic software, database software, and firmware updates which resolve known software deficiencies at no additional charge, during the 2 year warranty period.

1.9 OWNER INSTRUCTION

A. Provide minimum of **XX** hours of on-site training to University's representatives.

B. Conduct training sessions during normal business hours.

C. Scheduling of training session(s) will be established by University of Florida Project Manager.

D. The training shall consist of the following:

1. HVAC System Controls **XX** hrs (**X** sessions)
2. Central Utility Plant Controls **XX** hrs (**X** sessions)
3. Special System Controls **XX** hrs (**X** sessions)
4. BAS operating system **XX** hrs (**X** sessions)

E. Complete site/field training prior to final completion.

Coordinate training hours with University of Florida-PPD.

F. Provide classroom training for **XX** Owner's representatives. Include all cost (lodging, tuition, and lab materials) required for factory training at the manufacturer's training site for one UF-PPD employee for every 100,000 square feet of gross facility space that is partially or fully controlled by contractor's product.
   1. Site or field training does not replace factory training.
   2. Factory training does not substitute for site/field training.

Coordinate all training requirements with University of Florida-PPD.

PART 2 - PRODUCTS

2.1 SOFTWARE

A. Data Storage and Archiving:
   1. Trend data shall be stored at the stand alone BLC/AAC panels, and upload automatically to server hard disk storage when archival is desired or when local trend storage capacity drops below 20%.

B. Control Software Description for BLC/AAC include:
   1. The ability to perform the following pre-tested stand alone control algorithms:
      a. Two-position control
      b. Proportional control
      c. Proportional plus integral control
      d. Proportional, integral, plus derivative control
      e. Automatic tuning of control loops with enable disable capabilities
      f. Equipment Cycling Protection: Include a provision for limiting the number of times each piece of equipment may be cycled within any one-hour period.
      g. Heavy Equipment Delays: Provide protection against excessive demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads (user selectable).
      h. Power Fail-Motor Restart: Upon the resumption of normal power, the BLC/AAC panel shall analyze the status of all controlled equipment, compare it with normal occupancy scheduling, and turn equipment on or off as necessary to resume normal operation.
   2. The ability to perform all of the following energy management routines:
      a. Time-of-day scheduling
      b. Calendar-based scheduling
      c. Holiday scheduling
      d. Temporary schedule overrides
      e. Start-Stop Time Optimization
      f. Automatic Daylight Savings Time Switch-over
      g. Night setup and setback control
      h. Enthalpy switch-over (economizer)
      i. Peak demand limiting
      j. Temperature-compensated duty cycling

3. Read and display the value of any property, including all required properties, supported optional properties, and proprietary extensions of every object located within each networked device.
4. The ability to execute custom, job-specific processes to automatically perform calculations and special control routines.
   a. Incorporate measured or calculated data from l other DDC controllers on the network.
   b. Issue commands to points in other DDC controllers on the network.
   c. Support 30 characters, English language point names, structured for searching and logs.
   d. Directly send a text message to a specified device or cause the execution of an alarm message at any connected thin client PC, dial-up connection to a remote device or cause the execution of a remote connection to a remote device such as a printer, pager, PDA or cell phone.
   e. Include a HELP function key.
   f. Incorporate comment lines for program clarity.

C. Alarm management
   1. Monitor and direct alarm information to operator devices.
   2. Generate custom written operator alarm message (to be developed by the Vendor / Installer in conjunction with the owner) and advisories to operator I/O devices.
   3. Perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic and prevent alarms from being lost.
      a. At no time shall the ability of the BLC/AAC to report alarms be affected by either a remote PC, local I/O device or communications with other panels on the network.
      b. All alarm or point change reports shall include the point's English language description and the time and date of occurrence.
   4. Users shall have the ability to manually inhibit alarm reporting for each point.
   5. Alarm suppression
      a. Prevent abnormal alarms from occurring when associated system has been deactivated, such as:
         1) AHU shut down shall suppress low static alarm.
         2) Boiler shut down shall suppress low temperature alarm.
      b. Minimize alarms at sub-systems resulting from central equipment malfunction. For example:
         1) Chilled water high alarm shall suppress AHU High temperature alarm.
         2) AHU low static alarm shall suppress VAV box low flow alarm.
   6. Alarm destinations shall be included so that alarms are indicated and printed at a pre-defined University of Florida reporting device, personnel, or transaction log.
      a. Alarm reports and messages will be directed to a user-defined list of operator devices or PCs based on time (after hour's destinations) and/or based on priority.
      b. Alarms shall directly send an alarm message to specified client PC destination or cause the execution of a dial-up connection to a remote device (owner to designate) and cause the execution of a communications connection to a remote wireless device (pager, hand held, email or Pocket PC device).
      c. Alarm messages, and point graphic assignments alarms shall have accurate descriptions and response instructions, so that alarms may be quickly associated with appropriate graphic display.
   7. Alarm reports to multiple WEB connected PC's, cell phones or PDA's and shall send alarm reports without dependence upon a central or intermediate processing device.

Consultant to review requirements and edit as appropriate. Actual point alarming requirements should be identified in point list. All alarm or point change reports shall include the point's English language description and the time and date of occurrence.

D. A variety of historical data collection utilities shall be provided to manually or automatically sample, store, and display system data for points as specified in the I/O summary.
   1. Any point, physical or calculated, may be designated for trending.
   2. Any point, regardless of physical location on the network, may be collected and stored in each BLC/AAC point group.
   3. Two methods of collection shall be allowed: either by a pre-defined schedule or upon a pre-defined change of value. Sample intervals of 1 minute to 7 days shall be provided.
   4. Each BLC/AAC shall have a dedicated RAM-based buffer for trend data and shall be capable of storing a minimum of 10,000 data samples. All trend data shall be available for use in 3rd party data manager applications (i.e. SQL, Microsoft Excel, Lotus 123).
   5. BLC/AAC units shall provide high resolution sampling capability for verification of control loop performance.
   6. Operator-initiated automatic and manual loop tuning algorithms shall be provided for operator-selected PID control loops as identified in the point I/O summary.

E. BLC/AAC units shall be capable of automatically accumulating and storing run time hours for digital input and output points and automatically sample, calculate and store consumption totals for analog and digital pulse input type points, as specified in the point I/O schedule.

F. The building level network shall allow the BLC/AAC units to access any data from or send control commands and alarm reports directly to any other BLC/AAC or combination of controllers on the network without dependence upon a central or intermediate processing device.

G. The building level network shall also allow any BLC/AAC to access, edit, modify. add, delete, back up , and restore all system point database and all programs.

H. Failsafe hardware shall be provided such that BAS failures result in immediate return to local control. If the controller uses database values from other controllers, and the communication network fails or malfunctions, control loop outputs shall continue to function using last value received from BAS.

I. The BLC/AAC shall automatically call for a new database download from the server upon loss or corruption of a database. An operator with sufficient access privileges may in addition, activate a database download manually from the server.

2.2 CONTROL WIRING AND PATHWAYS

A. All cables (< 50 VAC/VDC) used within control system shall contain an overall jacket (plenum rated)

The intent of this paragraph is to hold the control contractor responsible for power wiring associated with the various field devices (actuators, meters, intermediate power supplies, etc… In most cases the control contractor can utilize the 120 VAC line voltage power serving the DDC panel for all field device power requirements. It is up to the consultant to coordinate (with the electrical engineer) power points that will be needed for the DDC system. Power must be provided for both main equipment control panels and terminal unit controllers.

Locating an BAS power junction box (w/circuit dedicated for DDC power) within a mechanical room is the preferred method. This gives the control contractor the flexibility to run power from this j-box to wherever its needed.

B. Jacket Color-Coding:
   1. I/O low voltage signal wire: Gray
   2. Field Device Low Voltage (< 50 VAC/DC) Power Wiring: Orange
   3. Communication Cable: White

C. Refer to Section 16120 for conductors, except as noted.

D. Refer to Section 16130 for pathways except as noted.

If no electrical specification is included in contract documents and paragraph 1.1 RELATED WORK included herein is not applicable, Consultant should include appropriate specifications for electrical work in place of the above paragraph.

E. Instrumentation I/O Conductors (<50 Volts and Under):
   1. No wire smaller than #18 AWG shall be used, except for manufacturer supplied instrument specific wire, or unless otherwise specified
   2. Provide isolated instrument grounding system per manufacturer's recommendations and project requirements.
   3. Conductors shall have UL listed plenum rated teflon insulation.

F. Communication Cable:
   1. Minimum 24 AWG twisted pair cable, Category 5E, or fiber optics for communications between control devices. Provide additional shielding and grounding per applicable manufacturer's recommendations and/or job site conditions. Conductors shall have UL listed plenum rated teflon insulation.

2.3 AIR PIPING

A. Copper Tubing:
   1. Type L, hard or soft seamless, ASTM B88, wrought copper soldered fittings, ANSI B16.22 except at connections to apparatus, where brass compression-type fittings shall be used.
   2. Solder joints shall be made with ASTM B32, 95-5 tin-antimony solder-joint, Bridgit or Silvabrite.

B. Plastic Tubing:
   1. Fire resistant virgin polyethylene, meeting stress-crack test ASTM D1693-60T.
   2. Individual tube polyethylene or multi-tube instrument tubing bundle shall be classified as flame retardant under UL 94 and polyethylene material shall be rated as self-extinguishing when tested in accordance with ASTM D 635.

C. Isolation valves for air piping to be threaded or soldered, two piece, bronze ball valves. Valves shall be suitable for intended service and pressure.

2.4 AIR SUPPLY SYSTEM

A. Central Supply Source
1. Control air will be supplied from the existing central campus main air pneumatic system at approximately 80 psig (when available)

Consultant should edit above as required

B. Air Compressor Assembly:
1. Manufacturers: Quincy, Ingersol Rand.
2. Assembly shall be duplex type complete with air storage tank, automatic tank drain trap, belt guards, gauges, low resistance sub-micron type intake air filter and silencer, safety valve and all necessary accessories including automatic start-stop pressure switches. Furnish necessary reducing valves to reduce pressure to that required for automatic control purposes with integral relief valve. Mount compressors on single air storage tank or base mounted compressors with separate tank as required.
3. Air storage tank to be ASME constructed and stamped for pressure 50 percent greater than operating pressure but not less than 150 psig.
4. Air intake silencer to have minimum 35 dB attenuation capability at 2000 HZ frequency.
5. Provide vibration isolation per UF Design and Construction Standards.
6. Each compressor and storage tank shall provide sufficient supply air to entire control system while operating no more than 1/3 of time with maximum of 3 starts per compressor per hour and maximum of 6 total compressor starts per hour for entire compressor system.
7. Motors shall be **[XXX]** volt, 3 phase, or **[XXX]** volt, single phase provided with magnetic starter, fusible disconnect and proper overload protection. Provide automatic alternator, which shall switch lead compressor after each running cycle. Alternator shall be capable of bringing on both compressors if one cannot handle load, and either shall continue to function on failure of the other.

Consultant should edit above as required

C. Refrigerated Air Dryer Assembly:
1. Manufacturers: Hankison Model 8010, 8015 or 8025, Ingersol Rand.
2. Refrigerated air dryer assembly shall be complete with pressure regulator (single or dual), filter station, 3-way bypass valve, automatic drain, power-on status light, high temperature alarm light, and safety pressure relief. Air capacity shall be 120% of compressor system capacity. Dryer shall have hot gas bypass control to maintain continuous operation and constant dew-point control. Outlet dew-point shall be not higher than 38℉ at 20 psig main pressure.
3. Filter assembly shall be housed in clear plastic and be replaceable element type. Filter rating shall remove 99% of total oil present, 100% of solid particles .6 micron or larger, 98% of solid particles .4 micron or larger.

Consultant should coordinate with electrical designer to provide 120 volt, 1 phase power outlet near dryer.

2.5 LOCAL CONTROL PANELS

A. Local control panels shall be constructed of steel, high strength composite, or extruded aluminum with hinged door and keyed lock, with baked enamel finish of manufacturer's standard color. Construction shall comply with NEMA 1 standards for interior panels, NEMA 4 for exterior panels.

Consultant should adjust per project conditions. NEMA 1 for indoor applications and NEMA 4x for outdoor conditions.

B. Panel mounted controlling instruments, temperature indicators, relays, switches and gauges shall be factory installed and permanently labeled. Devices shall be located inside or flush mounted on face of panel.

2.6 NETWORK ROUTERS & BRIDGES

A. BACnet Router: The BAS shall use the campus Wide Area Network (WAN) for communication to the campus vendor specific server.

B. The communication between the central server and the buildings DDC controllers shall be BACnet/IP.

C. This router or a separate broadcast manager shall limit BACnet data traffic to within the building level network until a remote request for information is requested or when a message must be transmitted outside the building level network.

2.7 BUILDING LEVEL CONTROLLER

A. BLC units shall be a general purpose multiple application direct digital controller (DDC) used to manage global programs, complex system control, local data storage, building level communications, and remote server interface.
   1. Controllers shall have a minimum 32-bit microprocessor. Controllers shall be capable of operating in a stand-alone capacity or within a networked Ethernet environment.
   2. Controller hardware, firmware and software shall support true, non-volatile flash memory, input/output, 12 bit A to D conversion, hardware clock/calendar and voltage transient and lightning protection devices.
   3. Units shall be equipped with full multi-tasking, multi-user real-time digital control processors consisting of modular hardware with plug-in enclosed processors, communication controllers and power supplies.
   4. Controller size shall be sufficient to fully meet the requirements of this specification.

B. The BLC shall perform the function of monitoring all system variables, including but not limited to:
   1. Hardware points, software points and controller parameters such as setpoints.
   2. Software/hardware required to interface at the campus intranet and peer to peer level (Tier 1) using the ANSI/ASHRAE Standard 135-2001 BACnet/IP protocol.
   3. The BLC shall manage and direct all information traffic on the Tier 1 network, between the Tier 1 and Tier2 networks, and to servers.
   4. Each BLC shall be able to extend its performance and capacity through the use of remote Application Specific Controllers (ASC's) and Advanced Application Controllers (AAC).
   5. BLC shall provide an RS-232C serial data communication port or Ethernet RJ45 connection for operation of local operator I/O devices independent of the LAN used for primary access, such as industry standard printers, operator terminals, modems and portable laptop

operators/terminals. BLC shall allow temporary use of portable devices without interrupting the normal operation of permanently connected Ethernet, modems, printers or terminals.

6. Each BLC shall have sufficient memory to support its own operating system and databases, Including:
   a. Control processes
   b. Energy management applications
   c. Alarm management applications including custom alarm messages for each level of alarm for each point in the system
   d. Historical / trend data for points specified
   e. Maintenance support applications
   f. Custom processes
   g. Operator I/O
   h. Ethernet/Dial-up communications
   i. Manual override monitoring
7. Configuration and Download: The BLC shall have the capability of receiving configuration and program loading by means of the following: 1) locally, via a direct connect portable laptop service tool, 2) over the network, from the portable laptop service tool, and; 3) from the server or associated thin client PC, via the communication networks.
8. Configuration and Upload: The BLC shall have capabilities of uploading configurations program to be archived on local operator terminal and/or remote server.
9. Each BLC shall contain both software and firmware to perform global control strategies.
10. Each BLC shall continuously perform self-diagnostics, including communication diagnosis of all panel components. The BLC shall provide both local and remote annunciation of any detected component failures, low battery condition or repeated failure to establish communication.
11. Isolation shall be provided at all peer-to-peer network termination's, as well as all field point termination's to suppress voltage transients consistent with IEEE Standards 587-1980
12. In the event of the loss of normal power, there shall be an orderly shutdown of all BLC's to prevent the loss of database or operating system software. Nonvolatile flash type memory shall be incorporated for all critical controller configurations and battery backup shall be provided to support the real-time clock and volatile memory for a minimum of 72 hours.
    a. Upon restoration of normal power, the BLC shall automatically resume full operation without manual intervention. Provide for the orderly and predefined scheduling of controlled return to normal, automatically time scheduled, operation of controlled equipment as a result of the auto restart processes.
    b. Should BLC memory be lost for any reason, the user shall have the capability of reloading the BLC via the local RS-232C port or from an Internet client or server PC.
    c. All BLC units shall include an internal or external UPS power supply unit to insure reliability of network communications through any power outage event. UPS shall be sized for 50% spare capacity. The UPS shall be complete with batteries, external bypass and line conditioning.

The consultant shall consider UPS power backup for BLC's when a controlled shutdown/startup of equipment is required after standby power transfer. Power for BLC controllers, AAC controllers and ASC controllers shall be served from emergency power when controlling emergency powered equipment. Note: All supervisory controllers located upstream of any controller powered from the emergency system in the network should be tied to emergency power to ensure communication is maintained throughout the BAS architecture.

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13. The BLC shall be capable of direct connection to multiple field busses. Communication Speed (Building Level Network): Local controllers shall communicate at a minimum of 115 Kbps.

2.8 ADVANCED APPLICATION CONTROLLERS - HARDWARE (AAC)

A. AAC units shall be a general purpose multiple application direct digital controller (DDC) used to manage complex system control, local data storage, and building level communications.

B. At minimum, Include the following:
   1. 32-bit microprocessors. AAC shall be capable of operating in a stand-alone capacity, or within a Tier 1 or Tier 2environment.
   2. Support non-volatile flash memory, input/output, 12 bit A to D conversion, hardware clock/calendar and voltage transient and lightning protection devices.
   3. Include full multi-tasking, multi-user real-time digital control processors consisting of modular hardware with plug-in enclosed processors, communication controllers, power supplies and input/output point modules.
   4. Include firmware revisions to the module shall be made from the central server remotely over the Intranet.
   5. Each AAC shall accommodate multiple I/O expansion via a designated expansion I/O bus port.

C. Each AAC shall be able to extend its performance and capacity through the use of remote Application Specific Controllers (ASCs).

D. Each AAC shall provide an RS-232C serial data communication port for operation of local operator I/O devices independent of the LAN used for primary access, such as industry standard printers, operator terminals, modems and portable laptop operators/terminals.
   1. Allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers or terminals.
   2. As indicated in the point I/O schedule, the operator shall have the ability to manually override DO automatic or centrally executed commands at the AAC via local terminal or controller DO manual H/O/A point for digital control type points.
      a. Switches shall be mounted either within the controller's key-accessed enclosure, or externally mounted with each switch keyed to prevent unauthorized overrides.
      b. Monitor the status of all overrides and inform the operator that automatic control has been inhibited. The AAC shall also collect override activity information for reports.

Consultant should edit above as required. DO manual override is not necessary when starters are used and incorporate hand-off-auto controls or when VFD's are used with manual override. Manual override requirements shall be identified in point lists. Terminal level controllers (VAV air terminal, FCU, FTU, reheat etc…) do not require DO manual override.

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   3. As indicated in the point I/O schedule, the operator shall have the ability to manually override AO automatic or centrally executed commands at the AAC via local terminal or controller AO manual Hand/Auto point for analog control type points.
      a. Switches shall be mounted either within the AAC'S key-accessed enclosure, or externally mounted with each switch keyed to prevent unauthorized overrides.
      b. The AAC shall monitor the status of all overrides and inform the operator that automatic control has been inhibited. The AAC shall also collect override activity information for reports.

Consultant should edit above as required. AO manual override is required at major equipment only (AHU'S chillers, boilers, exhaust systems, etc…). Manual override requirements shall be identified in point lists. Terminal level controllers (VAV air terminal, FCU, FTU, reheat etc…) do not require AO manual override.

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4. Each AAC shall have sufficient memory to support its own operating system and databases, Including:
   a. Control processes
   b. Energy management applications
   c. Alarm management applications including custom alarm messages for each level of alarm for each point in the system
   d. Historical / trend data for points specified
   e. Maintenance support applications
   f. Custom processes
   g. Operator I/O
   h. Manual override monitoring
5. Configuration and Download: The AAC shall have the capability of receiving configuration and program loading by means of the following: 1) locally, via a direct connect portable laptop service tool, 2) over the network, from the portable laptop service tool, and; 3) from the server or associated thin client PC, via the communication networks.
6. Configuration and Upload: The AAC shall have capabilities of uploading configurations program to be archived on local operator terminal and remote server.
7. Each AAC shall contain both software and firmware to perform full DDC Proportional, Integral, Derivative (PID) control loops and programs.
8. Each AAC shall continuously perform self-diagnostics, including communication diagnosis of all panel components. The AAC shall provide both local and remote annunciation of any detected component failures, low battery condition or repeated failure to establish communication.
9. Isolation shall be provided at all peer-to-peer network termination's, as well as all field point termination's to suppress voltage transients consistent with IEEE Standards 587-1980.
10. In the event of a loss of normal power, there shall be an orderly shutdown of all AAC'S to prevent the loss of database or operating system software. Nonvolatile flash type memory shall be incorporated for all critical controller configurations and battery backup shall be provided to support the real-time clock and volatile memory for a minimum of 72 hours.
    a. Upon restoration of normal power, the AAC shall automatically resume full operation without manual intervention. Vendor / Installer shall add custom programming to sequentially start all controlled equipment with a time delay between each command.
    b. Should AAC memory be lost for any reason, the user shall have the capability of reloading the controller via the local RS-232C port or from an Internet client or server PC.
    c. All AAC units shall include an internal or external UPS power supply unit to insure reliability of network communications through any power outage event. UPS shall be sized for 50% spare capacity. The UPS shall be complete with batteries, external bypass and line conditioning

The consultant shal consider UPS power backup for critical applications. Edit as appropriate.

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11. All AAC units shall be expandable and shall act as one control unit. In addition to the specified I/O point requirements and capacity requirements the Contractor shall provide two spare DI's, DO's, AI's, and AO's per panel.
12. Communication Speed (Building Level Network): Local controllers shall communicate at a minimum of 115 Kbps.

2.9 APPLICATION SPECIFIC CONTROLLERS (ASC'S)

A. Performance and capacity of AAC/BLC units shall be extended through the use of stand-alone remote ASC'S for VAV terminals, fan coil units, unit ventilators, heat pumps, small single zone air handlers etc.
   1. Controllers shall be capable of field configuration and program uploads and downloads.
   2. Controllers shall operate as a stand-alone controller capable of performing its specified control responsibilities independently of other controllers in the network.
   3. Controllers shall be a microprocessor-based, multi-tasking, real-time digital control processor.

B. Alarm Management: Each ASC shall perform its own limit and status monitoring and analysis to maximize network performance by reducing unnecessary communications.

C. ASC'S shall include all point inputs and outputs necessary to perform the specified control sequences. Analog outputs shall be industry standard signals such as 24V floating control, 4-20ma proportional signals, 0-5 Vdc or 0-10 Vdc proportional signals allowing for interface to a variety of modulating actuators.

D. VAV Terminal Controllers
   1. The unit controller used for VAV applications shall support the air terminal unit used as the basis of design for this project, including the air terminal unit damper actuator and multi-point, center averaging velocity sensor. The controller shall be capable of controlling the air terminal unit in all control strategies as described in contrct documents.
   2. Setpoints, flow limits, and occupancy schedules shall be maintained indefinitely in each controller's non-volatile memory. No batteries shall be required.
   3. It shall be possible to monitor flow in CFM and to adjust flow limits, temperature setpoints, and schedules, without direct access to the terminal unit, by plugging in a standard laptop computer or PDA device at the room temperature sensor.
   4. Each controller shall control by modulating the terminal unit electrically actuated device(s) using a proportional/integral (PI) algorithm with programmable PI coefficients.
   5. If required by the sequence of operation, ASC's used as a VAV terminal unit controller shall be able to accept a relay input from an occupancy sensor. This input shall toggle the air terminal unit between occupied and unoccupied modes and override occupied/unoccupied scheduling information the air terminal unit receives from the BLC or AAC.

Consultant shall coordinate inter-discipline requirements for occupancy sensors.

2.10 ELECTRICAL POWER METER

A. Manufacture Veris Industries or Approved Equal

B. Insulation Class 600VAC†

C. Sample Rate 1280Hz.

D. Internal Isolation 2500VAC

E. Operating Temp. Range 0 to 50℃ (<95%RH, non-con densing)

F. Storage Temp. Range -40℃ to 70℃

G. Systems Accuracy ±1% of reading from 2% to 100% of the rated current of the CTs. accomplished by matching the CTs with a meter and calibrating them as a system

H. Power Consumption 50VA

I. Electrical Services:

J. Any service where the phase A-N voltage is ≤300VAC and the phase-to-phase voltage is≤480VAC nominal with neutral

K. Frequency 50/60Hz.

L. Protection Class NEMA 1

M. BACnet communication card

Approved equal must include a communication card to integrate to BAS

2.11 SERVERS

A. Servers are existing.

2.12 LAPTOP PC - SERVICE TOOL

A. Provide, a commercially available laptop PC with Windows operating system, standard control system engineering tool set, all required interface cables, and at least 256 MB of RAM. LCD backlit display and a full-featured keyboard. The laptop shall plug directly into all controllers and unitary controllers and include one standard Ethernet connection. Provide a user-friendly, English language-prompted interface for quick access to system information, not codes requiring look-up charts.

1. Functionality of the portable operator's terminal connected at any general controller:
   a. Backup and /or restore controller databases for all system panels, not just the controller to which it is connected.
   b. Display all point logs.
   c. Add, modify and/or delete any existing or new system point.
   d. Command; change set point, enable/disable any system point.
   e. Program and load custom control sequences as well as standard energy management programs.
2. Connection of a laptop to any controller shall not interrupt nor interfere with normal network operation in any way, prevent alarms from being transmitted to server or preclude centrally initiated commands and system modification.

Consultant shall coordinate laptop requirements with PPD. Not all projects will require supplemental laptop PC.. For special applications, consider upgrading requirements for on board RAM to 512 MB.

2.13 CONTROL VALVES

A. General:
1. Use 2 port (normally open or closed based on sequence of operation) or 3 port globe type control valves with equal percentage contoured throttling plugs for steam and AHU water applications, unless otherwise noted.
2. Use 2 port (normally open or closed based on sequence of operation) or 3 port ball type valves for terminal reheat control unless otherwise noted.

Consultant should insure control diagrams and/or valve schedules clearly indicate normally open and normally closed requirements. UF standard is to have cooling devices fail open and heating devices fail closed.

3. Butterfly valves may be used for water system control valves 2-1/2" and larger provided that valves meet pressure and temperature requirements.
   a. High performance butterfly valves shall be used for modulating applications.
   b. General-purpose butterfly valves may be used for two-position control.

B. Globe Valves:
1. Valves shall be bronze or brass body, threaded, 150 psi rating for 2" and smaller, iron body bronze mounted, flanged, 125 psi rating for 2-1/2" and larger.
2. Valves shall have stainless steel stems, spring-loaded teflon packing, replaceable seats and discs.

C. Ball Valves
1. Valves shall be bronze or brass body, 150 psi rating. Ball valves larger than 2” are not permitted.
2. Valves shall have stainless steel ball and stem, valve stem seals with dual EPDM O-Rings, rangeability must be greater than 150:1, and shall have equal percentage flow characteristics.

D. Solenoid Valves:
1. Brass or bronze body. Valves shall be selected to match required temperatures and pressure, and shall have materials which are compatible with intended working fluid.
2. All line voltage actuators shall be Class "H" (high temperature) and listed by UL or CSA.

2.14 CONTROL DAMPERS

A. General:
1. If control damper sizes are not shown or scheduled, refer to Part 1 of this Section for sizing criteria.
2. Unless otherwise indicated, modulating control dampers shall be opposed blade or parallel blade type and two position (open/close) dampers shall be parallel blade type.
3. All blade linkage hardware shall have corrosion-resistant finish and be readily accessible for maintenance.

B. Standard Modulating and Two-Position Dampers:
1. Manufacturers and acceptable model numbers:
   a. Johnson Controls D-1200/D-1300 (Double Piece)
   b. Honeywell D642/D643
   c. Ruskin CD50/CD60

2. Damper frames shall be minimum of 16 ga galvanized steel or 14 ga extruded aluminum. Blades shall be minimum of 16 ga galvanized steel or 14 ga aluminum. Blades shall have maximum blade width of 8" with steel unions mounted in bronze sleeve, nylon or ball bearings.
3. Furnish dampers with blade seals and stainless steel side seals. Dampers and seals shall be suitable for maximum system temperature, pressure differential and approach velocity, but not less than temperature range of -40 to 200°F, pressu re differential of 6" WG, and approach velocity of 4000 fpm.
4. Dampers, when closed, shall be guaranteed by manufacturer not to leak air in excess of 8 cfm per sq ft at 4" WG differential static pressure

C. Exhaust System Outside Air Bypass Dampers:
1. Manufacturers: Ruskin Model CD80AF2 or American Warming and Ventilating Model VC-423.
2. Galvanized steel construction, suitable for maximum temperature 250°F, approach velocity 6000 fpm and differential pressure of 13.5" WG.
3. Air foil blade design, 16 gauge minimum and 12" maximum width.
4. Furnish with flexible jamb seals, EPDM, silicone or neoprene blade seals and pneumatic damper actuators with pilot positioners.

Note to engineer to carefully size these modulating dampers per good engineering practice.

D. Smoke Dampers:
1. Dampers to be leakage rated at no higher than Leakage Class I (4 cfm/ft^2 at 1" WG and 8 cfm/ft^2 at 4" WG) under UL 555S at temperature category 250°F. Furnish dampers with factory-mounted, caulked sleeve and pneumatic or electric operator. Damper shall have 16-gauge frame with air foil-shaped blades, rated to minimum 4" WG in closed position and to 2000 fpm in open position.

Note the 2000 fpm limitation. If 4000 fpm is required, flat spec Ruskin SD60.

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2. Actuator assemblies shall be installed outside airstream, linked to damper for fail (normally) [**open/closed]** operation. Actuator shall be capable of closing damper at pressures encountered in system.
3. Size smoke dampers as close as possible to duct size, but in no case is damper size to be less than duct size.
4. Dampers shall fully open in 15 seconds or less and fully close in not more than 15 seconds and not less than 7 seconds when activated.
5. For pneumatic applications, provide 120 VAC E-P switches to interface with Fire Protection System.

Verify voltage requirement of the Fire Protection System for proper E-P switch voltage.

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6. Electric actuators shall be non-stall type.

2.15 DAMPER AND VALVE ACTUATORS

A. Damper and valve actuators for major equipment **[Central Utility Plant, AHU's, Lab Exhaust Fan Systems, etc]** located in mechanical rooms shall be pneumatic type. Actuators for all remote

devices **[VAV Terminal Units, Reheat Coils, FCU's, Heat Pumps, etc…]** located in spaces outside of mechanical rooms shall be electric type.

Consultant should confirm pneumatic requirements with University of Florida Project Manager and UF-PPD. In many cases, an existing pneumatic system may be extended to accommodate new work. The consultant should verify the availability of campus air within existing or proposed new building site.

B. Each actuator shall be full-proportioning or two-position type as required or specified, and shall be provided with spring-return for fail open or fail closed position for fire, freeze, occupant safety, equipment protection, moisture, heating or cooling protection on power interruption as indicated and/or as required. Smoke dampers and steam valves serving pressure rated heat exchangers or convertors shall fail closed.

C. Pneumatic Diaphragm with Spring Return: Actuators shall be same manufacturer as valve body and shall be selected to match maximum diaphragm air pressure, fail position, stroke, shutoff pressure, temperature, torque, etc., required for intended service. Unless otherwise scheduled, diaphragm air pressure shall be enough to provide 100% valve shutoff at least equal to pump shutoff head or 125% of rated flow head for water systems, or full rated pressure for steam systems. Select spring ranges to match intended service. If valves or dampers are sequenced, spring ranges shall not overlap.

Standard.

D. Pneumatic Piston Actuator: Provide dual action piston actuators for large torque applications. Actuators shall be sliding piston type with appropriate linkage and mounting hardware. Provide units suitable for 60 to 100 psig compressed air operation, self-draining body, position indicator, and spring return if fail position required. Body shall be aluminum or fiberglass with aluminum piston, BUNA-N or PTFE piston seals, and open/close travel stops.

Standard with large butterfly valve.

E. Pilot Positioners (Pneumatic Actuators Only):
   1. Provide pilot positioners with mechanical feedback of actual actuator position. Pilot positioners may use 3-15 psi pneumatic input signal with a full range 3-15 psi pneumatic output. Input ranges and gain factors shall be field adjustable.

F. Analog Electronic:
   1. Actuators shall be electric motor/gear drives which respond proportionally to analog voltage or current input. Stroke time for major equipment shall be 90 seconds or less for 90° rotation. Stroke time for terminal equipment shall be compatible with its associated local controller, but no more than 6 minutes.
   2. Provide spring return feature for fail open or closed positions as required by control sequence and for critical applications such as outside, return, or exhaust dampers, heating and cooling coils on major air handling units, humidifiers, heat exchangers, and flow control for major equipment items such as chillers, cooling towers, boilers, etc.
   3. Reheat terminal units - Utilize factory assembled ball valve with horizontal mount; non-spring return proportional actuator (0-10 Vdc, 0-5Vdc, or 4-20ma). Electric actuator installed on ball valves shall have a separate and distinct operating handle used to position the valve into any

desired position once power is removed or a valve failure occurs. Similar to Belimo B2 CCV Series valve/actuators

4. Actuators for terminal heating/cooling equipment do not require spring return feature.
5. Provide standard cable from actuator to controller unit.

G. Discrete Two-Position Electric:

1. Actuators shall be hydraulic or electric motor/gear drives for two-position control. Stroke time shall be 90 seconds or less for 90° rotation.
2. Provide spring return feature for fail open or closed positions as required by control sequence.
3. Provide adjustable end switches as required by control sequence.

2.16 GENERAL INSTRUMENTATION

Consultant shall edit Instrumentation list per project specific requirements.

A. Pressure Gauges:

Standard for projects with pneumatic actuators.

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1. Air pressure indicating gauges to be at least 1-1/2" diameter. Gauge faces to be marked with range of unit being controlled.
2. Pressure gauges used for panel-mounted indicators shall be marked in appropriate units and with appropriate range of values. Panel mounted indicators shall be minimum 4-1/2" in diameter and have accuracy of 1% of scale range.

B. Analog Electronic Instrument Indicators:

1. Electronic indicators, used for displaying sensor and/or output values as measured by current or voltage, shall be panel mount type and at least 2" square. Output may be analog needle type or digital with 1/2" high LED or backlit LCD displays.
2. Electronic indicators shall be marked in appropriate units (Degrees, psi, %RH, gpm, cfm, etc.) and with appropriate range of values. Panel mounted indicators shall have minimum accuracy of 1% of scale range. Digital units shall be scaled to show 3 digits plus 1 decimal point.

2.17 DISCRETE ELECTRIC INSTRUMENTATION

A. General:

1. Electrical devices, switches, and relays shall be UL listed and of type meeting current and voltage characteristics of the project.
2. Outdoor unit enclosures shall be NEMA 4 with concealed adjustment.
3. Ratings of normally open and closed contacts shall be adequate for applied load (Minimum 5 amps at 240 volts).
4. Accuracy of devices shall be ± 1% of scale with adjustable offset unless otherwise specified.

B. Temperature Switches (Electric Thermostats):

1. Line voltage or low voltage type suitable for application with adjustable setpoint and setpoint indication.
2. Low voltage type to have heat anticipation.

3. Thermostats with remote sensing bulb shall have liquid filled sensing element and exposed setpoint adjustment.
4. Wall mounted space thermostat enclosure shall have concealed sensing element and exposed setpoint adjustment.
5. Unless otherwise stated, space thermostat covers shall be factory standard cover.

Consultant should coordinate with Architect regarding special cover material or finish color requirement. Some executive offices may require special covers.

C. Temperature Low Limit Switches:
   1. Electric 2-position type with temperature sensing element and manual reset. Controls shall be capable of opening circuit if any one-foot length of sensing element is subject to temperature below setting.
   2. Sensing element shall not be less than one lineal foot per square foot of coil surface area. Unless otherwise indicated, calibrate temperature switch setpoint to 38℉.
   3. Low Limit switches shall be hardwired into safety circuit of motor control device.

D. Relays:
   1. Equal to IDEC type RH2B-U, miniature 8 blade pilot relay with DPDT silver cadmium oxide contacts rated at 15A, 30 VDC, or 120 VAC or RIB series with H-O-A switch option. Coil shall match control circuit characteristics. Rectangular base socket mount with blade type plug-in terminals and polycarbonate dust cover.
   2. Control relays with self contained HOA circuit shall satisfy DO HOA requirement for major equipment start/stop control points.
   3. Provide DIN rail mountable (Snap type) mounting sockets equal to IDEC SH2B-05.

E. Pressure Switches:
   1. Adjustable set point, differential pressure type. Select switches for accuracy, ranges (20 to 80% of operating range) and dead-band to match process conditions, electrical requirements and to implement intended functions.
   2. Pressure differential switches for air systems shall have pressure rating of at least 10" WG.
   3. Pressure indicating differential switches for air systems shall be equal to Dwyer Series 3000 photohelic gauge.
   4. Pressure differential switches for water systems shall be rated for 150 psig unless otherwise noted. Chilled water pressure differential switches shall be provided with totally sealed vapor tight switch enclosure on 300 psi body. Differential pressure switches to have 3-valve manifold for servicing.
      a. Maximum Temperature Rating: 300℉
      b. Repeatability: ± 1%

F. Target Type (Paddle) Flow Switches:
   1. Adjustable set point, paddle type. Select switches for accuracy and ranges to match process conditions, electrical requirements, and to implement intended functions.
   2. Air sensing switches shall be for duct mounting, top, side, or bottom. Mounting in vertical duct with downward flow is not allowed.
   3. Water-sensing switches shall include NPT fittings suitable for mounting on piping. Switches shall be rated for 150 psi. Chilled water switches shall be rated for 300 psi.
      a. Maximum Temperature: 200℉

b.	Repeatability:	±1%
c.	Pressure Rating:	300 psi for chilled water
		150 psi for other applications

Do not use target type flow switches at pump discharges.

G. Gas Detection Systems:
   1. Manufacturers: Toxalert, General Analysis Corporation, MDA Scientific, MSA.
   2. Provide gas detection systems as listed below. Each system shall be complete package with remote or local space sensors, detection instruments, alarm contacts, local indication of current measured value for each sensor, and status indicator lights for power and status of each sensor. Devices not requiring remote mounting shall be housed in metal control panel. All status indicators shall be mounted on panel faceplate.
   3. Units shall have adjustable setpoints and self-test diagnostics.

Add column for each system.

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a.	Tag number	**XXX**
b.	Panel Location	**XXX**
c.	Gas to be Detected	**XXX**
d.	Alarm Setpoint:	**XXX**
e.	Range:	0-2 times Alarm Setpoint
f.	Remote Sensor Locations:	**XXX**

For refrigeration machine rooms, refer to ASHRAE Standard 15-1992, Section 11.13. For group A1 refrigerants (R-11, 12, 22, 134a, 500 and 502) use oxygen sensor set at 19.5%. Others (including R-123) use specific refrigerant with a setpoint at the TLV per Table 1.

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   4. Provide panel mounted alarm horn with silence switch.

H. E-P Switches (Solenoid Valves):
   1. Manufacturers: Asco, Johnson Controls, Siemens Building Technologies, Invensys,
   2. E-P switches shall provide control air for operation of fan isolation dampers, smoke or smoke/fire dampers, or other On/Off dampers. Line voltage actuators shall be Class "H" (high temperature) and listed by UL or CSA.

a.	Valve Body:	Brass or bronze
b.	Valve Type:	2-way or 3-way
c.	Operating Voltage:	24 VDC, 24 VAC, 120 VAC or as specified
d.	Operating Temperature:	32 to 104℉
e.	Operating Pressure:	Greater than maximum supply pressure
f.	Pipe Size:	1/4" NPT
g.	Enclosure Rating:	NEMA 4
h.	Conduit Connection:	1/2"

I. Position Switches (End Switches):

1. Rotary switches shall consist of an encapsulated mercury switch mounted on a ½" damper crank arm (Similar to Kele & Associates TS-470).
2. Door position switches shall be magnetic proximity type.

J. Current Switches:
1. Induction type sensor clamped over a single phase of AC electrical power conductor shall be solid-state sensor with adjustable threshold and normally open contacts. Each current switch shall be selected for proper operating range of current.
2. VFD and NON-VFD Applications (Similar to Hawkeye Model 904,934)
   a. The sensor shall be capable of detecting motor belt or coupling loss when mounted on the load side of variable frequency drives
   b. The current sensor shall be factory programmed to detect motor undercurrent situations (belt or coupling loss) on variable or constant volume loads, no calibration required
   c. The current sensor shall store the motor current operating parameters in non-volatile memory.
   d. The current sensor shall have a push button reset to clear the memory if the operating parameters change or the sensor is moved to a different load.

e.	Transition current:	75 mA at 1 A setpoint
		2.5 A at 10 A setpoint
f.	Hysteresis:	0.015 A at 1 A setpoint
		0.20 A at 10 A setpoint
g.	Response Time:	less than 0.5 seconds

2.18 ANALOG ELECTRONIC INSTRUMENTATION

A. Steam Metering and Totalization:
1. Manufacturers: Yokogawa, Foxboro or EMCO PhD Series.
2. Vortex shedding Piezoelectric type with bluff body. All wetted parts shall be 316 stainless steel.
3. The meter shall be FM approved explosion proof for Class 1, Div.1, Groups, Groups B, C and D.
4. Flow computer for mass flow and totalize calculations including temperature and pressure compensation.
5. Temperature and Pressure elements and transmitters
6. Minimum requirements include:

a.	Temperature Range:	0-400℉
b.	Accuracy:	± .8% of reading
c.	Span	< 2 times design flow
d.	Power Supply:	14 - 30 VDC unregulated
e.	Output:	4 - 20 mA DC current (for BAS lb/hr reading)
f.	Connection:	ANSI Class 150 SS Raised Face Flange.
g.	Turndown	15 to 1
h.	Enclosure	NEMA 4
i.	Display	Remote LCD with operator interface

7. Provide remote mounted indicator/transmitter. Indicator shall be 1/2" LCD or back lit LED. The remote mounted indicator transmitter shall display lb/hr.
8. Where BAS is not available non-resettable totalizing register shall display lb and shall be non-resettable. Register shall read in "kilo-pounds" of steam (Klbs).

B. Water Metering and Totalization
   1. Manufacturers: Yokogawa, Foxboro or EMCO.
   2. Electromagnetic induction type with linear response proportional to flow rate. Selected span shall not be greater than twice the design flow range. Select units for 10:1 turndown.
   3. Unit shall be complete with 150 lb. raised face flanged flowtube, PTFE, neoprene or PFA liner, magnetic coils, self-cleaning 316 stainless steel or Hastelloy C4 electrode, and 4-20 mA transmitter/power supply housed in NEMA 4 enclosure. Transmitter shall be fully field configurable microprocessor based unit.
      a. Minimum Accuracy: ± 0.5% of Span including hysteresis
      b. Repeatability: ± 0.1% of reading
      c. Operating Temperature: 0-125℉
      d. Output: 4 - 20 mA DC current (for BAS gpm reading)
      e. Power Requirements: 120 VAC / 60 Hz
   4. Transmitter shall be integrally mounted on flow meter.
   5. Provide remote mounted indicator. Indicator to be 1/2" LCD or back lit LED. The remote mounted indicator shall display gpm.
   6. Flow meter shall read in GPM with accuracy of ±1.0%.

Where BAS is not available, consultant shall coordinate requirements for flow and energy totalization with UF-PPD and UF Project Manager. Retrofit building may allow insertion type meters. Coordinate with PPD.

C. Industrial Grade Pressure/Differential Pressure Transmitter:
   1. Manufacturers: Foxboro, Fisher Rosemount, or Yokogawa.
   2. Pressure sensor and integral 4-20 mA VDC transmitter. Select instrument for intended usage (differential pressure, gauge pressure, level, etc.), range, maximum pressure/temperature. Sensor shall be capacitance or strain gauge type. Enclosure to be NEMA 4.
   3. Differential pressure transmitters shall have 3-valve manifold for servicing.
   4. Diaphragm Material: Stainless Steel or Hastelloy
   5. Process Connection: 1/2" NPT Stainless Steel
   6. Power Supply Voltage: 13 - 35 VDC unregulated
   7. Over Pressure: 1000 psig or 2 times maximum operating pressure which ever is greater.
   8. Accuracy: ± 0.25% of calibrated span, including effects of linearity
   9. Drift: ± 0.1% of upper limit for 6 months.
   10. Power Supply Effect: Less than 0.01% of output span per volt.
   11. Static Pressure Effect: Zero Error: ± 0.1% of upper range limit per 1000 psi.
   12. Span Error: ± 0.075% of reading per 1000 psi.
   13. Temperature Effect: ± (0.025% upper range limit plus 0.125% span) per 50℉.
   14. Zero control shall be continuously adjustable between ± 50% of upper range limit. Total calibrated span and zero adjustment cannot exceed upper range limit. Zero span shall be independently field-adjustable with no interaction.

D. Wall Mounted Space Sensors:
   1. Sensors shall be platinum or nickel RTD type, with the following minimum performance:
      a. Temperature Coefficient of Resistivity (TCR): .00385 ohm/ohm/℃
      b. Accuracy: ± 0.1% at 32℉ (Class B)

c.	Conformance:	DIN-IEC 751
d.	Operating Range:	-50 to 500℉
		0 to 99% RH

Change accuracy to ± 0.06% at 32℉ (Class A) if pro ject requires higher accuracy. .

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2. Thermistors will be acceptable in lieu of platinum or nickel RTD provided thermistor carries 5 year guarantee that device will maintain its accuracy within tolerance of ± 0.36℉ between 32℉ and 150℉, and 0.5℉ between -20℉ and 212℉.

Thermistors are used by some commercial control vendors as part of their standard solution.. Specify these as project requires.

3. Unless otherwise stated, space sensor covers shall be factory standard cover

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E. Room Thermostats

1. Setpoint shall be resettable only from remote BAS or from any server/client PC. Temperature sensors shall be compatible with the associated controlled devices (e.g. DDC air terminal controller). Mounting box shall be recessed type unless otherwise indicated, or required by the building construction materials.
2. Room Temperature Sensors shall incorporate a thermistor/RTD element and a portable operator terminal plug-in port under the cover.
3. Temporary override push-button/timers shall be installed at locations indicated on plans. When an override controls more than one zone, an 8 ½ x 11 inch framed and laminated map shall be located adjacent to the override device indicating control zone served. The intent of this requirement is to ensure the occupants understand the zoning where it is not obvious what the override device controls or what zones it serves.
4. Where local setpoint is required, provide warmer/cooler setpoint adjustment. Minimum and maximum adjustable range shall be set through the BAS only.
5. Unless otherwise stated, Room Thermostat covers shall be factory standard cover

Note: Standard UF policy is to have no remote set-point. There are some instances when local set-point is needed. In these cases consultant shall get UF PPD approval for all proposed locations.

F. Duct Mounted probe or Insertion Temperature Sensors:

1. Nickel or platinum RTD type, with the following minimum performance:

a.	Temperature Coefficient:	.00385 ohm/ohm/℃
b.	Accuracy:	+/- 0.1% at 32℉ (Class B)
c.	Conformance:	DIN-IEC 751
d.	Operating Range:	-50 to 170℉
		0 to 99% RH

2. Thermistors or nickel RTD will be acceptable in lieu of platinum RTD provided thermistor carries 5 year guarantee that the device will maintain its accuracy within a tolerance of ± 0.36℉ between 32℉ and 150℉, and 0.5℉ between -20℉ and 212℉.
3. Furnish sensors and wells as shown on drawings or required for proper operation.
4. Coordinate and the installation of sensor wells.

a. Wells mounted in pipe 3" and larger may be installed in horizontal or vertical lines provided element is always in flow (for condensate and other gravity return lines, install in bottom of pipe).
b. Wells mounted in pipe 2-1/2" and smaller shall be installed at a 90° pipe junction consisting of tee fitting (2" minimum size) and appropriate reducing fittings.
c. Install sensor well pointed upstream in tee.

Thermistors are used by some commercial control vendors as their standard.. Specify this as project requires.

G. Duct Mounted Averaging Temperature Sensors:
1. Nickel or platinum RTD type, with the following minimum performance
a. Temperature Coefficient: .00385 ohm/ohm/℃
b. Accuracy: ± 1.0% at 32℉ (Class B)
c. Conformance: DIN-IEC 751
d. Operating Range: -50 to 170℉
0 to 99% RH

H. Dew Point Temperature Transmitter:
1. Manufacturers: General Eastern, Hy-Cal.
2. Chilled mirror type primary dew point temperature measurement using platinum RTD, 4 wire, 100 ohm temperature sensing element with 4-20 mA transmitter.
a. Accuracy: ± 1℉
b. Repeatability: ± 0.1℉
c. Hysteresis: None
d. Sensor Range: -10℉ to +140℉ dew point
32℉ to 140℉ ambient
3. Unit shall be selected for proper application (wall or duct mounted).

These are expensive instruments. Use only if application requires it.

I. Space Humidity Sensors/Transmitters:
1. Manufacturers: General Eastern, TCS, Hy-Cal, Rotonic or Vaisala.
2. Space humidity sensors shall be wall mount type with brushed aluminum or brushed nickel cover to match room thermostats and/or temperature sensors.
3. Sensing element shall be resistive bulk polymer, or thin film capacitive type. Sensor/transmitter shall have the following minimum performance.
a. Accuracy: ± 2% RH at 25℃ over 20-95% RH inclu ding hysteresis, linearity and repeatability.
b. Temperature Effect: Less than 0.06% per ℉.
c. Sensitivity: 0.1% RH.
d. Repeatability: 0.5% RH.
e. Hysteresis: Less than 1%.
f. Long Term Stability: Less than 1% RH drift per year.
g. Adjustment: ± 20% RH zero, non-interactive.
h. ± 10% RH span, non-interactive.

i. Operating Range: 0-99% RH, non-condensing, sensor.
j. 0-95% RH, non-condensing, electronics.
k. Output: 4-20 mA, 0-10Vdc, 0-100% linear, proportional
l. Power: 12-36 VDC.

4. Space humidity sensor covers shall be factory standard cover unless otherwise stated.

J. Duct Mounted Humidity Sensors/Transmitters:
1. Manufacturers: General Eastern, TCS, Hy-Cal, Rotonic or Vaisala.
2. Probe type, temperature compensated, resistive bulk polymer or thin film capacitive type. Sensor/transmitter shall have the following minimum performance.
a. Accuracy: ± 2% RH at 25℃ over 20-95% RH inclu ding hysteresis, linearity and repeatability.
b. Temperature Effect: Less than 0.06% per ℉.
c. Sensitivity: 0.1% RH.
d. Repeatability: 0.5% RH.
e. Hysteresis: Less than 1%.
f. Long Term Stability: Less than 1% drift per year.
g. Adjustment: ± 20% RH zero, non-interactive.
± 10% RH span, non-interactive.
h. Operating Range: 0-99% RH, non-condensing, sensor.
0-95% RH, non-condensing, electronics.
i. Output: 4-20 mA, 0-10Vdc, 0-100% linear, proportional
j. Power: 12-36 VDC.

K. Vortex Shedding Air Flow Sensors/Transmitters:
1. Manufacturers: Similar to Tek-Air.
2. Velocity measured by each sensor shall be linearized, summed, averaged, and converted to 4-20 mA output signal proportional to air flow rate (CFM) by transmitter electronics. Measured value converted to airflow (CFM) shall have accuracy within 2% rate ± 0.1% full scale throughout velocity range and temperature and humidity change of 40 to 130℉, and 10-95% RH (non-condensing). Transmitter shall be provided as part of air flow sensor, and shall include integral diagnostics with on-line zeroing and sensor operation verification.
3. Manufacturer shall provide all cabling required to connect probe assemblies and transmitter electronics. Transmitter and/or systems, which require periodic calibration to maintain accuracy specified shall not be acceptable.

Note: Vortex Shedding technology requires a minimum velocity. Consultant should verify application and use this technology where operating ranges fall within acceptable velocity limits.

L. P-E Transducers (Pressure Transmitters):
1. Manufacturers: Ashcroft, Mamac, Setra, Kele or Modus.
2. Units shall have the following characteristics:
a. Input: Pressure 0-15 psig, minimum
b. Output Signal: 4-20 mA, 0-5 VDC, 1-5 VDC, 1-10 VDC
c. Accuracy: 1% of span
d. Operating Temperature 32 to 125℉
e. Power Requirements: 24 VDC (10-30 VDC)

M. Ducted Air System Static Pressure and Differential Pressure (Velocity) Transmitters:
   1. Manufacturers: Modus, Setra, Ashcroft XLDP.
   2. Provide transducers/transmitters to convert velocity pressure differential or static duct pressure relative to sensor location into electronic signal.
   3. Unit shall be capable of transmitting linear 4 to 20 mA DC output signal proportional to the differential (total minus static or static minus ambient) pressure input signals with the following minimum performance and application criteria:
      a. Span: Not greater than twice duct static or velocity pressure at maximum flow rate, nor more than 16 times velocity pressure at minimum flow rate.
      b. Accuracy: ± 1.0% of span or 1.0% of full scale
      c. Dead Band: Less than 0.5% of output
      d. Hysteresis: Within 0.5% of span or within 0.5% of full scale
      e. Linearity: Within 1.0% of span or within 0.5% of full scale
      f. Repeatability: Within 0.5% of output
      g. Response: Less than 1 second for full span input
   4. Return and exhaust air system static pressure transducers/transmitters shall be furnished with protective integral air filters on pressure sensing lines from the static pressure sensing stations, and static air probes to prevent migration of moisture or particulate matter into transducers. Supply air system sensors do not require integral air filters.

N. Building and Space Pressure Differential Transmitter:
   1. Air velocity transmitter shall be equal to Omega FMA-900 Series with the following characteristics:
      a. Accuracy: ± 1.5% full scale, ± 0.5% reading
      b. Repeatability: ± 0.2% of full scale
      c. Probe Temperature Range: -40℃ to 121℃ (-40℉ to 250℉)
      d. Pressure Range: 150 psig, max
      e. Response Time: 400 msec. to within 63% of final value
      f. Output Signal: 4-20 mA
      g. Accessories: Compression Fitting - Omega 5SLK with Teflon Ferrules.

O. Electric to Pressure Transducers:
   1. Manufacturers: Similar to MAMAC EP311,313,
   2. Provide pressure transducers integral to DDC panels or separate components to convert digital analog signal to variable pneumatic air pressure signal. Units to have following characteristics:
      a. Input 4-20 mA or 0-5 VDC
      b. Linearity 1% of span
      c. Hysteresis 0.75% of span
      d. Maximum air consumption 0.008 scfm @ 20 psi
      e. Incorporate a manual override switch and, in the manual mode, the pressure shall be increased or decreased.

P. Carbon Dioxide Sensor:
   1. Provide non-Dispersive Infra Red (NDIR) carbon dioxide sensor suitable for room mounting. 4-20 ma output signal corresponding to input CO2 concentration.

2. Manufacturer: Valtronics Model 2089, Veris CXD, or approved equal
3. Input 4-20 mA
4. Range 0-2000 PPM
5. Accuracy +/- 3% of full scale
6. Repeatability .1% of full scale
7. Calibration frequency No less than every 3 years

PART 3 - EXECUTION

3.1 SOFTWARE

A. Coordinate graphics and points for consistency with existing campus system.

B. Continuously archive all data in standard database platform Microsoft Data Engine or Microsoft SQL. Including but not limited to:
   1. I/O points
   2. Software points such as
      a. Alarm limits
      b. Setpoints
      c. Parameters
   3. Schedules
   4. Alarm messages
   5. Reports
   6. Trends/History

C. Provide BAS Reports including:
   1. Alarm Summary
   2. Schedules
   3. Control Loop Performance
   4. Equipment energy performance (such as Heat Wheels, AHU's, Buildings, etc.)

Define custom reports required for this project here. Examples: tenant billing, chiller efficiency reports, alarm reports, run time summaries, etc….

D. Graphic Displays
   1. Provide a color graphic system flow diagram display for each system with all points as indicated on the point list.
   2. Provide graphics for using floor plans of the building as a minimum. Coordinate with the Architect/Engineer (A/E). Size graphics to allow the operator to read room numbers and descriptions. Incorporate the capability to navigate section to section as required to view entire floor and to navigate floor to floor.
   3. Color shall be used to indicate normal and alarm conditions within all spaces. Color or common border lines shall be used to link HVAC equipment with zone(s) served.
   4. User shall be able to access the various system schematics and floor plans via a graphical penetration scheme and/or menu selection.

a. User shall be able to penetrate from floor plan to associated HVAC system text based display.

5. Create enhanced alarm programs for all system points. These points shall be programmed for appropriate seasonal high or low alarm limits.

Verify with UF project manager the level of graphics needed on a specific project. Floor plan graphics are minimum requirements. Additional system graphics (AHU's VAV's FCU's) shall be specified for each project as required by UF PPD and UF Project Manager.

3.2 CONTROL WIRING AND PATHWAYS

A. Provide all electrical wiring required for a complete and functional control system, including power circuit to control panels and field devices in accordance with all applicable local codes and the latest version of National Electric Code and NFPA when applicable.

B. Sizing of cable, conduit, and raceways to accommodate system with 25% spare copacity.

C. Labeled wiring with unique tag to match I/O device identifier tag (e.g. sensor TE-1 wire shall be labeled at panel and device as "TE-1"). Communication cable shall be labeled with Loop/Trunk #, previous and destination device (e.g. L1VAV101/VAV102 would be used to label the loop 1 communication bus between VAV101 and VAV102)

D. Low voltage wiring concealed above accessible ceilings does not require raceway, however, cables run above accessible ceilings shall be run within a j-hook pathway system spaced no more than 4 ft apart. Cables run in concealed areas or within un-accessible spaces shall be installed in EMT. Run pathways and cables parallel and perpendicular to building structure.

Verify with pathway requirements with Owner.

E. Flexible Metal Conduit shall be used for vibration isolation and shall be limited to 3 feet in length when terminating to vibrating equipment. Flexible Metal Conduit shall be UL listed.

F. Run direct current instrument conductors separately from alternating current conductors. Where allowed by NEC wiring classification, AC-DC route crossings shall be at 90 degrees. Install special sensor to converter cables in accordance with drawings or in compliance with manufacturer's instructions. Extra precautions shall be taken when pulling and shortening these "vendor furnished" cables. Any extra length on these cables shall be neatly coiled into minimum 3" diameter coils and installed into junction box.

G. BAS Network Communication Cable:

1. Run communication cable in separate raceways or in j-hooks with proper clearances.
2. Install special cable connectors in accordance with manufacturer's recommendations.
3. BAS network communication cable shall not be spliced.

H. All control wiring located in mechanical or exposed spaces shall be run in EMT.

I. Refer to Division 16 for additional requiements, except as noted.

If no electrical specification is included in contract documents and paragraph 1.1 RELATED WORK included herein is not applicable, Consultant should include appropriate specifications for electrical work in place of the above paragraph.

J. Control panels and operator's terminals serving equipment fed by emergency power shall also be served by emergency power. Locate LOT and its UPS where shown on plans.

Consultant should coordinate with electrical designer for power source for for DDC controller.

K. Power wiring to control compressors and dryers shall be as indicated on electrical power plans. Provide field mounted starters to Electrical Contractor for installation and supervise installation.

Consultant should coordinate with electrical designer for power source for both compressors and dryer.

L. Raceway Identification. All the covers to junction and pull boxes of the BAS raceway system shall be painted white.

If no electrical specification is included in contract documents and paragraph 1.1 RELATED WORK included herein is not applicable, Consultant should include appropriate specifications for electrical work in place of the above paragraph.

3.3 AIR PIPING

A. Conceal all piping, except for piping in mechanical rooms and other areas where mechanical system piping is exposed.

B. Install exposed piping and conduit parallel to or at right angles to building structure and support adequately at uniform intervals. Use only tool-made bends.

C. Polyethylene tubing not exceeding 18" may be used for final connection to instrument or actuator.

D. Install polyethylene tubing with no concealed splices and number code all tubing.

E. Make tests on sectional piping during progress of installation to ensure no leakage.

Consultant should consider testing system as a whole and having contractor provide runtime testing documentation for an operational system.

F. Provide cartridge type desiccant dryers for air lines passing through outside air stream or through unheated spaces where space temperatures can be below 30℉.

G. Piping type shall be as follows:

1. Inside Panels:
   a. Use polyethylene tubing.
2. Piping Serving Smoke Dampers and Combination Fire-Smoke Dampers:
   a. Use hard copper for mains and exposed piping and hard or soft copper for branches and concealed piping.

Specify entire air piping to be hard copper if engineered smoke control system is designed for the project. For additions to existing engineered smoke control systems, verify with Owner if entire system needs to be hard copper.

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3. Exposed Spaces:
   a. Use hard copper tubing or,.
   b. Polyethylene tubing may be used if run in fully enclosed EMT raceway where environment is within temperature limits of polyethylene tubing.
   c. Use PVC coated copper tubing for wet environments.
4. Concealed:
   a. Use hard copper, soft copper or polyethylene tubing.

Standard choice.

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5. Concrete Buried:
   a. Use hard copper, soft copper or polyethylene tubing in metal or plastic conduit.

This is intended for areas such as greenhouses where tubing has to run through concrete slab.

3.4 AIR SUPPLY SYSTEM

A. Provide an appropriate air pressure reducing station connected to the existing piping system and providing a new refrigerated air dryer assembly for the piping extension, all having the required system capacity to serve the devices included in the Vendor / Installer's work.

Consultant should confirm pneumatic requirements with University of Florida Project Manager and UF-PPD. In many cases, the existing campus pneumatic air system can be extended to accommodate new work. In the event pneumatic air is not available via the central plant system, the consultant shall include the appropriate compressor specifications (see below).

B. Install air compressor assembly where indicated on drawings.
   1. Pipe tank drain to nearest floor drain.
   2. Install vibration isolators as recommended by manufacturer.

C. Install air dryer assembly where indicated on drawings or suitable location adjacent to air compressor assembly.
   1. Mount air dryer on wall with suitable supports.
   2. Pipe unit drain to nearest floor drain.

3.5 LOCAL CONTROL PANELS

A. Provide local control panel for each system where more than one control device requires field mounting (air handling units, miscellaneous control system including pump controls, etc.). Single devices may be mounted exposed on piping or ductwork. Install local control panel where indicated on drawings or suitable location adjacent to system served. Do not mount panels on equipment.

B. Mount panel on wall with suitable brackets or on floor with self-supporting stand.
   1. Mount top of panel no higher than 6 feet above floor.
   2. Install panels so front cover door can swing full open without interference and maintain a minimum of 36" clearance.

C. Unless otherwise indicated, mount controllers, adjusting switches, pressure gages, temperature indicators and other indicating or manually operated devices inside panel with permanent labels identifying device and controlled device or function.

D. In-line pneumatic gages shall be hard mounted to back panel and shall include permanent labels identifying end device. Other factory standard labeling methods are acceptable as long as the device name and function is clearly identified and is permanent. Labels shall correspond to control drawing tags and identifiers.

E. Labels shall correspond to control drawing tags and identifiers.

3.6 NETWORK ROUTERS & BRIDGES

A. Provide router as required, to bridge BACnet/IP and the data link used between the controllers (BACnet ARCNET, BACnet MS/TP).

B. Proprietary networks (networking between buildings and central server) and proprietary protocols are not acceptable.

C. Coordinate final location with Owner and other trades.

3.7 BUILDING LEVEL CONTROLLER

A. Provide controllers as required.

Coordinate power requirements with Electrical

B. Coordinate final location with Owner other trades.

3.8 ADVANCED APPLICATION CONTROLLERS - HARDWARE (AAC)

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

B. Size controller to meet the requirements of this specification and the project point I/O schedule +15% additional capacity.

Coordinate power requirements with Electrical

3.9 APPLICATION SPECIFIC CONTROLLERS (ASC'S)

A. Provide the following types of application specific controllers (embedded or as a predefined software application) as a minimum:

Consultant should select appropriate controllers specific for this project.

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1. Variable Air Volume (VAV) boxes
2. Constant Air Volume (CAV) boxes
3. Fan Coil Units
4. Unit Conditioners
5. Heat Pumps
6. Unit Ventilators
7. Small AHU'S
8. Room Pressurization

3.10 ELECTRICAL POWER METER

A. Furnish power meter as shown on drawings and/or as required to perform control sequence specified.

B. Provide communication to the BAS.

C. Coordinate location and power requirements with other trades.

Consultant should coordinate electrical power and location for this project.

3.11 SERVERS

A. Archive all historical data such as trends, alarm and event histories, and transaction logs on existing server.

Consultant should confirm server requiements for this project.

3.12 LAPTOP PC - SERVICE TOOL

A. Provide, a commercially available laptop PC with Windows operating system, standard control system engineering tool set, all required interface cables, and at least 256 MB of RAM. LCD backlit display and a full-featured keyboard. The laptop shall plug directly into all controllers and unitary controllers and include one standard Ethernet connection. Provide a user-friendly, English language-prompted interface for quick access to system information, not codes requiring look-up charts.

3.13 CONTROL VALVES

A. Furnish control valves as shown on drawings and/or as required to perform control sequence specified.

B. Coordinate the installation of control valves.

C. Control valves furnished by this contractor shall be installed by [Division 15XXX Contractor] under coordinating control and supervision of this Contractor.

Use this paragraph only if the Vendor / Installer is to size valves. Valve sizing is a function of many variables, many are not known until coil data is submitted. If Consultant sizes valves, be sure that coil data is fixed, or that sizing is redone after coil submittals have been approved.

D. Sizing:
1. Select control valves to meet their intended service without cavitations. Provide cavitation calculations for modulating globe control valves over 250℉ and all modulating butterfly valves over 60℉.
2. Valve body ratings indicated in Part 2 are minimum required. Valve body, trim and packing selected shall be designed to withstand maximum pressure and temperature encountered in the systems.
3. Submit engineering calculations used for sizing modulating control valves. Control valves serving terminal devices may be sized based on flow ranges for each pump system.
4. Calculations for sizing modulating valves shall be based on actual characteristics of equipment and system being installed.
   a. Valve calculations shall include information such as pump head or available pressure; branch piping circuit losses including all pipe, fittings, valves, and coils; flow rates; and pressure losses of other in-line devices.
   b. Obtaining adequate system information necessary for sizing valves.
5. Design criteria for sizing modulating valves shall be based on two port, fail open or fail closed, as shown on plans, equal percentage valves unless otherwise specified.
6. Heating control valves shall be full port ball valve or globe valve and shall be selected for a minimum of 25% of equipment subcircuit pressure drop, but not more than maximum available pump head allowing minimum 2 psi drop for balance valve.
7. Size three-way mixing or diverting valves not directly associated with pump sub-circuit, for 3-5 psi pressure drop.
8. Terminal reheat control valves shall be ball type and shall be selected for a minimum of 25% of equipment subcircuit pressure drop, but not more than maximum available pump head allowing minimum 2 psi drop for balance valve.
9. Cooling control valves may be full port ball, globe or butterfly type and shall be selected for minimum of 10% of equipment subcircuit pressure drop, but not more than maximum available pump head allowing minimum 2 psi drop for balance valve.
10. Select control valves based on pressure drop calculations using Cv values at 100% stroke.
11. Subcircuit is defined as all branch supply and return piping to terminal device, including all valve, coil, control valves, and balance valve.

Verify all pressure parameters.

E. Steam Valves
1. Modulating steam control valves shall be straight-through globe type with linear characteristics for 90% of closing stroke and equal-percentage for final 10%.
2. For steam inlet pressure less than 15 psig, size valves for pressure drop equal to 75 to 80% of gauge inlet steam pressure.
3. For steam inlet pressure of 15 psig or greater, size valves for pressure drop equal to 50% of absolute inlet pressure.

3.14 CONTROL DAMPERS

A. Furnish control dampers as shown on drawings and/or as required to perform control sequence specified except those furnished with other equipment.

B. Coordinate the installation of control dampers.

C. Control dampers furnished by this Contractor will be installed by [Division 15XXX Contractor] under coordinating control and supervision of this Contractor.

D. Blank-off plates or transitions required to facilitate dampers will be provided by the **[Division 15XXX Contractor]**.

Consultant to edit spec references as appropriate. Coordinate control dampers with AHU specification. If control dampers are to be provided with the AHU then the AHU specification should include this requirement.

3.15 ACTUATORS AND PILOT POSITIONERS

A. Provide actuator for each automatic damper or valve with sufficient capacity to operate damper or valve under all conditions. Select actuators to provide tight shut off against maximum system temperatures and pressure encountered.

B. Provide pilot positioners for pneumatic modulating valves and dampers for major equipment such as air handling unit coils, humidifiers, heat exchangers, converters, major water system temperature controls, etc.

Consultant shall include valve and damper schedule on drawings and indicate specific valves/dampers requiring pilot positioners. Pilot positioners are typically needed on control valves exceeding 2 inches and/or when multiple valves are controlled from one control signal. Pilot positioners could also be needed when large dampers are used as a modulating device..

C. Provide pilot positioners for all sequenced devices, and devices which require adjustable operating speeds.

D. Provide pilot positioners for modulating outside and return air dampers and fan volume control devices such as fan inlet dampers where used.

E. Provide pilot positioners for modulating valve and damper operators when torque required by controlled devices exceeds 50% of torque capacity of operator.

F. Pilot positioners are not required for terminal heating/cooling equipment or booster humidifiers.

G. Valve and damper operating speeds shall be selected or adjusted so operators will remain in step with controller without hunting regardless of load variations.

H. Provide proper linkage and brackets for mounting and attaching actuators to devices. Design mounting and/or support to provide no more than 5% hysteresis in either direction (actual movement of valve stem/damper shaft/ideal movement) due to deflection of actuator mounting.

I. Sizing

University of Florida standard is to require the Consultant to size all dampers using this criteria. Damper sizes should be shown on drawings or scheduled. Consultant should delete the following requirements for the Vendor / Installer to submit calculations if sizes are provided by consultant.

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1. Calculations for sizing dampers shall be based on actual characteristics of ductwork system being installed.
2. Opposed blade dampers shall be sized for minimum of 10% of duct section pressure drop. Parallel blade dampers shall be sized for minimum of 30% of duct section pressure drop. Duct section is defined as ductwork containing flow control damper starting with inlet or branch tee and ending with outlet or branch tee.
3. Calculate actual duct pressure drops for each duct section containing modulating damper using latest version of ASHRAE Handbook of Fundamentals.
4. If control system fixes pressure drop, use those pressure setpoints. Use duct blank-offs to provide additional pressure drop as required to obtain linear damper response.
5. Contractor is responsible for obtaining adequate system information necessary for sizing.
6. Contractor to provide dampers as shown on drawings or as scheduled.

Consultant should delete above only if Vendor / Installer is required to submit engineering calculations.

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7. Two position dampers shall be sized as close as possible to duct size, but in no case is damper size to be less than duct area.

3.16 GENERAL INSTRUMENTATION

A. Pressure Gauges (Pressure Indicators):
1. Install pressure gauges for indication of supply and control pressure in pneumatic systems at output of I/P transducers, electric air solenoid valves and pressure switches, actuators and other points where visible indication of air pressure is required for operating and maintenance purposes (include a pressure gage with 12 inches of controlled device)
2. Furnish pressure gauges with tappings for piping.
3. Provide pressure gages in control panel and at end device (pneumatic actuators). End device pressure gage shall be mounted so that gage can be easily seen from eye level.

B. Water Differential Pressure Sensors
1. Differential pressure transmitters used for flow measurement shall be sized to the flow-sensing device. Transmitter range shall be selected for mid range values while operating under normal operating range.
2. Differential pressure transmitters shall be supplied with tee fittings and shut-off valves in the high and low sensing pick-up lines.
3. Differential pressure transmitter shall include a separate pressure gage scaled to indicate normal operating range of device. This pressure gage shall be installed in parallel with sensing lines.
4. The transmitters shall be installed in an accessible location whenever possible.

3.17 DISCRETE ELECTRIC INSTRUMENTATION

A. General
1. Terminate at terminal blocks inside enclosures unless otherwise specified.
2. Include auxiliary contact for remote status indication of safety devices.

B. Temperature Switches (Electric Thermostats):
1. Provide temperature switches as shown or as required for sequence of operation.

C. Low Limit Temperature Switches (Freeze Stats):

1. Install low limit controls where indicated on drawings or as specified. Unless otherwise indicated, install sensing element at downstream side of heating coils.
2. Distribute sensing element across entire area of medium being sensed. Install controls at accessible location with suitable mounting brackets and element duct collars where required.
3. Serpentine sensing element, starting at the lowest point (6" above coil bottom) of the coil being protected. Operation of low limit trip shall provide protection to associated coils.
4. Low limit trip activation shall cause all water coils to be overridden to full flow.

D. Relays:
1. Provide control relays where indicated on drawings or as required to accomplish sequences.
2. Provide DIN mounted relays in control panels.
3. Provide RIB type relays for field control devices.
4. Mount relay for easy accessibility.
5. Mount relay for easy visual accessibility.

E. Pressure Switches:
1. Provide pressure switches where indicated on drawings or as required to accomplish sequences.
2. Coordinate installation of flow switches for proper location and installation.

Consultant to edit spec references as appropriate. Consultant to coordinate installation of pressure switches with appropriate mechanical piping section if used in large pipe.

F. Target Type (Paddle) Flow Switches:
1. Furnish paddle switches as required.
2. Coordinate installation of flow switches for proper location and installation.

G. Flow Switches:
1. Furnish flow switches as required.
2. Coordinate installation of flow switches for proper location and installation.

Consultant to edit spec references as appropriate. Consultant to coordinate installation of paddle and flow switches with appropriate mechanical piping section..

H. Gas Detection Systems:
1. Provide gas detectors where indicated on drawings or as required to accomplish sequences.

I. E-P Switches (Solenoid Valves):
1. Provide E-P switches where indicated on drawings or as required to accomplish sequences.

J. Position Snitches (End Switch):
1. Provide position switches where indicated on drawings or as required to accomplish sequences.

K. Current Switches:
1. Provide current switches where indicated on drawings or as required to accomplish sequences.

2. Locate in starter or VFD or in an appropriate adjacent enclosure.

L. Transmitters and Indicators:
1. Locate transmitters at sensing device or within 100 ft for remote mounted transmitters. For hot systems (150℉ and higher) mount electronics on side of pipe or remotely mount. For indicating type instruments, locate indicating element within 6 ft of floor with readout easily visible from floor level. Provide remote readouts if necessary.

3.18 ANALOG ELECTRONIC INSTRUMENTATION

A. Steam Metering and Totalization:
1. Furnish steam meter.
2. Coordinate the delivery and installation of meter.
3. Installation in high pressure piping (> 75 PSIG)
4. Mount remote unit at eye level in accessible location.

Consultant to edit spec references as appropriate. Consultant to coordinate installation of meter with appropriate mechanical piping section

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B. Water Metering and Totalization
1. Furnish chilled water meter.
2. Coordinate the delivery and installation of meter.
3. Installation where indicated on drawings.
4. Mount remote unit at eye level in accessible location.

Consultant to edit spec references as appropriate. Consultant to coordinate installation of meter with appropriate mechanical piping section

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C. Industrial Grade Pressure/Differential Pressure Transmitter:
1. Provide differential pressure transmitter for building chilled water differential pressure.
2. Coordinate the location with other trades.

D. Wall Mounted Space Sensors:
1. Install space thermostats/sensors where indicated, as required to perform specified controls, or directed to meet job site conditions.
2. Mount non-adjusting sensors at 5 ft above floor unless otherwise indicated. Mount adjustable sensors 4 ft above floor unless otherwise indicated.
3. Any room sensor mounted on exterior walls shall be mounted on thermally insulated sub-base.
4. Relocate room sensors if required due to draft, interferences with cabinets, chalkboards, etc., or improper sensing.
5. Mount room sensors in corridors, stairways and public toilets 7ft above floor.
6. Room sensors in gymnasium, locker rooms and **[XXX]** shall be protected by heavy-duty cast and die formed guard.
7. Provide a conduit from sensor box to above the ceiling where it shall stub out into an accessible area parallel with the ceiling.

E. Room Thermostats
   1. Install space thermostats where indicated, as required to perform specified controls, or directed to meet job site conditions.
   2. Mount thermostats at 4 ft above floor unless otherwise indicated.
   3. Any room thermostat mounted on exterior walls shall be mounted on thermally insulated sub-base.
   4. Relocate room thermostats if required due to draft, interferences with cabinets, chalkboards, etc., or improper sensing.
   5. Provide thermostats in gymnasium, locker rooms and **[XXX]** heavy-duty cast and die formed guard.
   6. Provide a conduit from thermostat box to above the ceiling where it shall stub out into an accessible area parallel with the ceiling.

F. Duct Mounted probe or Insertion Temperature Sensors:
   1. Provide sensors where shown or drawings or to accomplish sequences.
   2. Install wit sensors in stainless steel probes or wells.
   3. Install outside air sensors in weatherproof, non-corrosive solar shield.

Consultant to edit spec references as appropriate. Consultant to coordinate installation of sensor wells with appropriate mechanical piping section.

G. Duct Mounted Averaging Temperature Sensors:
   1. Use where temperatures are prone to stratification or where ducts are larger than 9 sq. ft. (1 sq. m); length as required.
   2. Serpentine sensor in duct to maximize coverage of measured area.
   3. Duct mount sensors shall mount in an electrical box through a hole in the duct and be positioned so as to be easily accessible for repair or replacement.
   4. Mounted to suitable supports using factory approved element holders.

H. Dew Point Temperature Transmitter:
   1. Provide dew point transmitters where indicated or to accomplish sequences.

I. Space Humidity Sensors/Transmitters:
   1. Install space humidity sensor where indicated, as required to perform specified controls, or directed to meet job site conditions.
   2. Mount sensors at same height as temperature sensors.
   3. Any sensor mounted on exterior walls shall be mounted on thermally insulated sub-base.
   4. Relocate room thermostats if required due to draft, interferences with cabinets, chalkboards, etc., or improper sensing.
   5. Provide sensors in gymnasium, locker rooms and **[XXX]** heavy-duty cast and die formed guard.
   6. Provide a conduit from sensor box to above the ceiling where it shall stub out into an accessible area parallel with the ceiling.

J. Duct Mounted Humidity Sensors/Transmitters:
   1. Provide duct humidity sensor where indicated, as required to perform specified controls, or directed to meet job site conditions.

K. Vortex Shedding Air Flow Sensors/Transmitters:
   1. Provide air flow sensor where indicated, as required to perform specified controls, or directed to meet job site conditions.

L. P-E Transducers (Pressure Transmitters):
   1. Provide transducers as required to perform specified controls, or directed to meet job site conditions.
   2. Mount transducers in control panels.
   3. Provide gauge for all transducers.

M. Ducted Air System Static Pressure and Differential Pressure (Velocity) Transmitters:
   1. Provide transducers/transmitters to convert velocity pressure differential or static duct pressure relative to sensor location into electronic signal.
   2. Mount transducers in control panels.
   3. Terminate transducers directly to the controller that is implementing control loop.

N. Building and Space Pressure Differential Transmitter:
   1. Provide directional mass flow transmitter installed in 2" thin-wall rigid conduit (EMT) or PVC between spaces to measure relative velocity created by the pressure difference.
   2. Extend 2" EMT or PVC pipe between spaces for room pressure control, or between space and outside for building static pressure control.
   3. Provide algorithm in software to convert air velocity to pressure differential ($DP = C(V/4005)^2$). Field determine coefficient C by calibrated measurement.
   4. Construct shroud of aluminum, painted to match building exterior.

O. Electric to Pressure Transducers:
   1. Provide pressure transducers integral to DDC panels or separate components to convert digital analog signal to variable pneumatic air pressure signal.
   2. Provide output gauge for all transducers.
   3. Mount in control panel.

P. Carbon Dioxide Sensor:
   1. Provide carbon dioxide sensor where indicated, as required to perform specified controls, or directed to meet job site conditions.

3.19 SPARE PARTS

A. Contractor shall provide to the Owner the following spare parts:
   1. Two (2) APPLICATION SPECIFIC CONTROLLERS (ASC) as used on the project.
   2. Two (2) each of each analog temperature and pressure sensors used on the project.
   3. Two (2) each of each digital input devices (current sensors, pressure switches, etc.) used on the project.

END OF SECTION