BOND MANAGEMENT OFFICE
COLLEGE OF THE DESERT

ADDENDUM NO. 2R

Date: April 29, 20224
Project Name: Desert Community College District
SCIENCE BUILDING RENOVATION
Bid #43-98P-0500-SBR-REBID

To all Contractors submitting a bid for the above captioned project, this addendum is hereby included in the contract documents to the same extent as though it were originally included therein. The following items modify, add to, delete from, or explain the drawings, specifications and/or contract documents.
The Bid Due date remains unchanged and is Tuesday, May 14, 2024 @ 2:00pm.

General:
Revisions to the specifications are clouded with a Delta #2R
RFI responses are included as an attachment to this document.

Item #1:
A02R.01: REBID RFI 001 Clarify Bid Schedule.
Question: Per Paragraph 6.3, section 6.3.1.1 in the General Conditions please provide the bid schedule.
Answer: The Bid Schedule is as follows;
1st Advertisement 04.09.2024; 2nd Advertisement 04.16.2024; Mandatory Pre-Bid Conference and Job Walk 04.18.2024; Bid Due Date 05.14.2024 @2:00pm, with Bid opening to follow in North Annex 1A.

Item #2:
A02R.02: REBID RFI 002 Clarify Labor.
Question: Are there any prequalification requirements? GC? MEP subcontractors? Does the project include PLA, CWA, PSA, CBA or any other type or form of labor agreements? Are there estimated start and completion dates? What is the anticipated project duration? Is this project subject to Davis Bacon? Is STW (Skilled & trained Workforce) required on this project? (Per Public Contract Code sections 2600-2603)
Answer: Refer to Section 00 11 13 Notice Calling for Bids for all of the references to your questions.
-Pre-qualification is the mandatory Pre-Bid Conference for and walk for the GC., as identified in the bid documents and Notice Calling for Bids.
- There are not any labor agreements as you have identified in your question.
-This is a Prevailing Wage project (Davis-Bacon) with Certified Payroll Reporting to the California Department of Industrial Relations (DIR) with all trade payroll.
-The project is 442 calendar days with an estimated start date of 07.01.2024.
- This does not fall into the categories as outlined in Public Contract Code 2600-2603. Apprenticeships are discussed in General Conditions 00 72 00 Article 4 Section 4.18.4 Apprenticeships. J. Dawson-Garcia, PM 04.15.2024

Item #3:
A02R.03: REBID RFI 003 Confirm roof tie backs are not required.
Question: Please confirm that the roof tie backs will not be required for this project. We believe that the roof height of the building is not high enough to require it and will add unnecessary cost to the project.
Answer: • Roof tie backs (personal fall arrest anchorage connector devices) or guards are not required for the project since there are no Mechanical Equipment, Systems, and Devices within 10 feet of a roof edge per 2019 CBC 1015.6.
• Also, an internal roof access ladder is not required per 2019 CMC Section 304.3.1 since the building is under 15' tall.
Tim Hall/ Gensler 4/18/2024

Item #4:
A02R.04: REBID RFI 004 Clarify Construction Schedule.
Question: Please confirm tht the constructiion schedule for the project will not require to be cost nd resource loaded. In ur experience, it only complicates the monthly updates and gives no value to the owner when providing current scheduing information on the project. This is an unnecessary added cost to the project.
Answer: Please see section 00 72 00, 7.3.8 regarding cost of scheduling and section 7.3.9 for scheduling software and requirements. A cost and Resource loaded baseline schedule is required. J.Dawson-Garcia 04.17.2024.

Item #5:
A02R.05: Clarify Alternate 01 is included.
Question: On Attachment B of the Bid Form, the "1" for the first alternate has a line through it. Please advise if this alternate was eliminated.
Answer: The Alternate No. 1 is included and that appears to be a typo on the document. The AOR will release a corrected document in the Addm. 2R. J. Dawson-Garcia 04.17.2024

Item #6:
A02R.06: REBID RFI 006 Confirm no unit pricing.
Question: There does not appear to be any unit price items listed in the composite unit price proposal worksheet. We see that RFI 3 response dated 02.16.24 states no unit costs unless otherwise noted. Please confirm that no unit pricing is to be included with proposals, and tht the composite unit price proposal worksheet can be exclude from bid proposals.
Answer: Confirming no Unit Pricing. Indicate N/A on the Worksheet and submit with all other Bid Documents as required. J. Dawson-Garcia 04.17.2024

Item #7:
A02R.07
- Revised Specification Section 27 41 16 Integrated AV Systems and Equipment
- Clarify Controls for HVAC

Attachments:

1. REBID RFI 001
2. REBID RFI 002
3. REBID RFI 003
4. REBID RFI 004
5. REBDI RFI 005
6. REBID RFI 006
7. Revised Specification Section 27 41 16 Integrated AV Systems and Equipment

END OF ADDENDUM 2R

Gensler

April 19, 2024

California Community Chancellor's Office
Chay Yang
1102 Q. Street
Sacramento, CA 95811

Subject: College of the Desert – Palm Desert Campus
– Science Building Renovation
Project #220023
Contract #C0001573
Addendum 02R Executive Summary
Project Number: 007.3766.000
File Code: 6A

Dear Ms. Yang,

Please see attached a summary of the items proposed to be included in Addendum 02R for the College of the Desert Science Building Renovation Project at the Palm Desert Campus. The items do not affect the approved budget, program, scope or to the best of our knowledge the cost. Rather they provide clarification or confirmation of items already included in the bid documents.

Please let me know if there are any further clarification or documentation required for this addendum.

Sincerely,

Nick Acevedo
Principal
Gensler
4675 MacArthur Court, Suite 100
Newport Beach, CA 92660

cc: Jennefer Dawson-Garcia / MAAS
Deborah Shepley / Gensler
Eric Mittlestead

Addendum Number 02R

Gensler

Project	College of the Desert – Palm Desert Campus – Science Building Renovation	**Date**	4/19/2024
Project Location	43-500 Monterey Avenue Palm Desert, CA	**Architect's Project Number**	007.3766.00
Owner / Client	College of the Desert	**File** 6A	**This is page** 1 of 1
To	California Community Chancellor's Office	**Attention**	Chay Yang
Address	1102 Q. Street		
City	Sacramento	**State** CA	**Zip Code** 95811

Delivered via:

☐ **Messenger**	☐ **Hand carried**	☐ **Facsimile**	
☐ **Express**	☐ **Pick-up**	☒ **E-mail Address**	cyang@cccco.edu
☐ **Mail**	☐ **UPS**	☐ **Website Address**	

This Addendum will become part of the Contract Documents. The Contractor shall promptly inform subcontractors and all others performing or supplying any of the Work of all relevant contents of this Addendum. In case of conflicting provisions with previous addenda or communications, provisions in this Addendum supersede only those conflicting issues. It is the responsibility of the Contractor to notify all subcontractors from whom it accepts bids of all changes in the drawings and specifications covering this project. Receipt shall be acknowledged by inserting the addendum number and its date in the bid form.

Distribution	jdawsongarcia@bond.collegeofthedesert.edu		
Prepared by Gensler by	Tim Hall	**Date Signed**	4/19/2024

Instructions / Description / References / Dates

Addendum number of attachments:
7 Attachments
38 Pages

Addendum Item	Reference Item	Description
A02R.01	Bid RFI 01	Clarify Bid Schedule.
A02R.02	Bid RFI 02	Clarify Labor.
A02R.03	Bid RFI 03	Confirm Roof Tie Backs are not required.
A02R.04	Bid RFI 04	Clarify Construction Schedule.
A02R.05	Bid RFI 05	Clarify Alternate 01 is included.
A02R.06	Bid RFI 06	Confirm no Unit Pricing.
A02R.07	Revised Spec Section 27 41 16 Integrated AV Systems and Equipment	Clarify controls for HVAC.

4675 MacArthur Court
Suite 100
Newport Beach CA 92660
Tel: +1 949.863.9434
Fax: +1 949.553.1676

(FOR PRE-BID USE ONLY)

PRE-BID REQUEST FOR INFORMATION
DESERT COMMUNITY COLLEGE DISTRICT

Date of Pre-Bid RFI: 4/10/24 Project Name: Science Building Renovation Bid No: 43-98P-0500-SBR-REBID	Bidder Name: ProWest Constructors

Bidder's Pre-Bid Request for Information (Include references to Drawing Sheet Numbers and/or Sections of the Specifications)

1. Per Paragraph 6.3, section 6.3.1.1 in the General Conditions please provide the bid schedule.

Additional pages attached by Bidder: ___ Yes ___ No
Number of additional pages attached by Bidder: _____

Response to Bidder's Pre-Bid Request for Information

The Bid Schedule is as follows;
1st Advertisement 04.09.2024; 2nd Advertisement 04.16.2024; Mandatory Pre-Bid Conference and Job Walk 04.18.2024; Bid Due Date 05.14.2024 @2:00pm, with Bid opening to follow in North Annex 1A. J. Dawson-Garcia 04.10.2024

Additional pages of RFI Response attached: ___ Yes ___ No
Number of additional RFI Response pages attached: _____

Date of RFI Response: 04.10.2024

Submitted By:
ProWest Constructors
(Bidder Name)

(Signature of Bidder's Authorized Employee, Officer or Representative)

Submittal Date: 4/10/24

Bidder Contact Information:
Aubrie Gray
(Bidder Contact Name)

Phone: 951-678-1038, Fax: 951-678-1083
(Phone and Fax)
agray@prowestconstructors.com
(Email Address)

Pre-BID RFI 002
JDG Received 04.15.2024

(FOR PRE-BID USE ONLY)

PRE-BID REQUEST FOR INFORMATION
DESERT COMMUNITY COLLEGE DISTRICT

Date of Pre-Bid RFI: 4/15/2024
Project Name: Science Building Renovation
Bid No: 43-98P-0500-SBR-REBID

Bidder Name:
Tovey/Shultz Construction, Inc.

Bidder's Pre-Bid Request for Information (Include references to Drawing Sheet Numbers and/or Sections of the Specifications)

-Are there any prequalification requirements? GC? MEP subcontractors?
-Does this project include PLA, CWA, PSA, CBA or any other type or form of labor agreements?
-Are there estimated start and completion dates? What is the anticipated project duration?
-Is this project subject to Davis-Bacon?
-Is STW (Skilled & Trained Workforce) required on this project? (Per public contract code sections 2600 - 2603)
-
-
-

Additional pages attached by Bidder: ___ Yes _X_ No
Number of additional pages attached by Bidder: _____

Response to Bidder's Pre-Bid Request for Information

Refer to Section 00 11 13 Notice Calling for Bids for all of the references to your questions.
-Pre-qualification is the mandatory Pre-Bid Conference for and walk for the GC., as identified in the bid documents and Notice Calling for Bids.
- There are not any labor agreements as you have identified in your question.
-This is a Prevailing Wage project (Davis-Bacon) with Certified Payroll Reporting to the California Department of Industrial Relations (DIR) with all trade payroll.
-The project is 442 calendar days with an estimated start date of 07.01.2024.
- This does not fall into the categories as outlined in Public contract code 2600-2603. Apprenticeships are discussed in General Conditions 00 72 00 Article 4 Section 4.18.4 Apprenticeships. J. Dawson-Garcia, PM 04.15.2024

Additional pages of RFI Response attached: ___ Yes ___ No
Number of additional RFI Response pages attached: _____

Date of RFI Response:_____

Submitted By:
Tovey/Shultz Construction, Inc.
(Bidder Name)

(Signature of Bidder's Authorized Employee, Officer or Representative)

Submittal Date: 4/15/2024

Bidder Contact Information:
Greg Stack
(Bidder Contact Name)

(951) 471-5677
(Phone and Fax)
BidDiscovery@toveyshultz.com
(Email Address)

Pre-Bid RFI 003
Received 04.17.2024 JDG

(FOR PRE-BID USE ONLY)

PRE-BID REQUEST FOR INFORMATION
DESERT COMMUNITY COLLEGE DISTRICT

Date of Pre-Bid RFI: 04/17/2024 Project Name: Science Building Renovation Bid No: 43-98P-0500-SBR-REBID	Bidder Name: Nielsen Construction Ca

Bidder's Pre-Bid Request for Information (Include references to Drawing Sheet Numbers and/or Sections of the Specifications)

Please confirm that the roof tie backs will not be required for this project. We believe that the roof height of the building is not high enough to require it and will add unnecessary cost to the project.

Additional pages attached by Bidder: ___ Yes _X_ No
Number of additional pages attached by Bidder: _____

Response to Bidder's Pre-Bid Request for Information

- Roof tie backs (personal fall arrest anchorage connector devices) or guards are not required for the project since their are no Mechanical Equipment, Systems, and Devices within 10 feet of a roof edge per 2019 CBC 1015.6.
- Also, an internal roof access ladder is not required per 2019 CMC Section 304.3.1 since the building is under 15' tall.

Tim Hall/ Gensler 4/18/2024

Additional pages of RFI Response attached: ___ Yes ___ No
Number of additional RFI Response pages attached: _____

Date of RFI Response:_____

Submitted By:
Nielsen Construction Ca
(Bidder Name)

(Signature of Bidder's Authorized Employee, Officer or Representative)

Submittal Date: 04/17/24

Bidder Contact Information:
Rick Cesena
(Bidder Contact Name)

760-234-2112
(Phone and Fax)

rcesena@nielsencc.com
(Email Address)

Pre-Bid RFI 004
Received 04.17.2024 JDG

(FOR PRE-BID USE ONLY)

PRE-BID REQUEST FOR INFORMATION
DESERT COMMUNITY COLLEGE DISTRICT

Date of Pre-Bid RFI: 04/17/2024 Project Name: Science Building Renovation Bid No: 43-98P-0500-SBR-REBID	Bidder Name: Nielsen Construction Ca

Bidder's Pre-Bid Request for Information (Include references to Drawing Sheet Numbers and/or Sections of the Specifications)

Please confirm that the construction schedule for the project will not require to be cost and resource loaded. In our experience, it only complicates the monthly updates and gives no value to the owner when providing current scheduling information on the project. This is an unnecessary added cost to the project.

Additional pages attached by Bidder: ___ Yes _X_ No
Number of additional pages attached by Bidder: _____

Response to Bidder's Pre-Bid Request for Information

~~Please see section 00 72 00, 7.3.8 regarding cost of scheduling and section 7.3.9 for scheduling software and requirements. A cost and Resource loaded baseline schedule is required. J.Dawson-Garcia 04.17.2024.~~

Additional pages of RFI Response attached: ___ Yes ___ No
Number of additional RFI Response pages attached: _____

Date of RFI Response:_____

Submitted By:
Nielsen Construction Ca
(Bidder Name)

(Signature of Bidder's Authorized Employee, Officer or Representative)

Submittal Date: 04/17/24

Bidder Contact Information:
Rick Cesena
(Bidder Contact Name)

760-234-2112
(Phone and Fax)

rcesena@nielsencc.com
(Email Address)

Pre-Bid RFI 005
Received 04.17.2024 JDG

(FOR PRE-BID USE ONLY)

PRE-BID REQUEST FOR INFORMATION
DESERT COMMUNITY COLLEGE DISTRICT

Date of Pre-Bid RFI: 4/17/2024
Project Name: Science Building Renovation
Bid No: 43-98P-0500-SBR-REBID

Bidder Name:
Tovey/Shultz Construction, Inc.

Bidder's Pre-Bid Request for Information (Include references to Drawing Sheet Numbers and/or Sections of the Specifications)

On Attachment B of the Bid Form, the "1" for the first alternate has a line through it.
Please advise if this alternate was eliminated. See attached.

Additional pages attached by Bidder: ☑ Yes ☐ No
Number of additional pages attached by Bidder: 1

Response to Bidder's Pre-Bid Request for Information

The Alternate No. 1 is included in the bid and that appears to be a typo on the document. The AOR will release a corrected document in the Addm. 2R.
J. Dawson-Garcia 04.17.2024

Alternate 01 is included in the bid, see corrected alternate bid proposal (last page of this RFI)

Tim Hall/ Gensler 4/19/2024

Additional pages of RFI Response attached: ☐ Yes ☐ No
Number of additional RFI Response pages attached: _____

Date of RFI Response: _____

Submitted By:
Tovey/Shultz Construction, Inc.
(Bidder Name)
Alyssa Callaway
(Signature of Bidder's Authorized Employee, Officer or Representative)

Submittal Date: 4/17/2024

Bidder Contact Information:
Alyssa Callaway
(Bidder Contact Name)

(951) 471-5677
(Phone and Fax)
BidDiscovery@toveyshultz.com
(Email Address)

ATTACHMENT B
ALTERNATE BID ITEMS PROPOSAL

Bidder Name: _____

Bidders must provide a proposal price for each Alternate Bid Item set forth herein; failure to do so will result in rejection of the Bid Proposal for non-responsiveness. The amount proposed for each Alternate Bid Item by the above-identified Bidder is set forth herein below:

1. Alternate Bid Item No.1. Removal of polished, sealed concrete throughout lab and lab service rooms approximately 9,050 square feet and in lieu provide vinyl flooring, Armstrong excelon Raffia Stream 55927 (12"x24") throughout labs and lab services approximately 9,050 square feet.

   ☐ Add to Base Bid Proposal Amount

   ☒ Deduct From Base Bid Proposal Amount

   (Check appropriate box indicating additive or deductive cost; failure to do so will result in rejection of Bid Proposal for non-responsiveness)

   $ ☐☐ , ☐☐☐ , ☐☐☐ . ☐☐

   _____ Dollars

   (in words; printed or typed)

2. Alternate Bid Item No.2. Removal and replacement of existing concrete slab from Grid line A to Grid Line F, Grid line L to P and trenching for lab utility removal and replacement approximately 6,600 square feet in lieu of 10,500 square feet removal and replacement of concrete slab.

   ☐ Add to Base Bid Proposal Amount

   ☒ Deduct From Base Bid Proposal Amount

   (Check appropriate box indicating additive or deductive cost; failure to do so will result in rejection of Bid Proposal for non-responsiveness)

   $ ☐☐ , ☐☐☐ , ☐☐☐ . ☐☐

   _____ Dollars

   (in words; printed or typed)

3. Alternate Bid Item No.3. N/A

   ☐ Add to Base Bid Proposal Amount

   ☐ Deduct From Base Bid Proposal Amount

   (Check appropriate box indicating additive or deductive cost; failure to do so will result in rejection of Bid Proposal for non-responsiveness)

   $ ☐☐ , ☐☐☐ , ☐☐☐ . ☐☐

   _____ Dollars

   (in words; printed or typed)

4. Alternate Bid Item No.4. N/A ☐ Add to Base Bid Proposal Amount

   ☐ Deduct From Base Bid Proposal Amount

   (Check appropriate box indicating additive or deductive cost; failure to do so will result in rejection of Bid Proposal for non-responsiveness)

ATTACHMENT B
ALTERNATE BID ITEMS PROPOSAL

Bidder Name: _____

Bidders must provide a proposal price for each Alternate Bid Item set forth herein; failure to do so will result in rejection of the Bid Proposal for non-responsiveness. The amount proposed for each Alternate Bid Item by the above-identified Bidder is set forth herein below:

1. Alternate Bid Item No.1. Removal of polished, sealed concrete throughout lab and lab service rooms approximately 9,050 square feet and in lieu provide vinyl flooring, Armstrong excelon Raffia Stream 55927 (12"x24") throughout labs and lab services approximately 9,050 square feet.

   ☐ Add to Base Bid Proposal Amount

   ☒ Deduct From Base Bid Proposal Amount
   (Check appropriate box indicating additive or deductive cost; failure to do so will result in rejection of Bid Proposal for non-responsiveness)

   $ ☐☐ , ☐☐☐ , ☐☐☐ . ☐☐

   _____ Dollars
   (in words; printed or typed)

2. Alternate Bid Item No.2. Removal and replacement of existing concrete slab from Grid line A to Grid Line F, Grid line L to P and trenching for lab utility removal and replacement approximately 6,600 square feet in lieu of 10,500 square feet removal and replacement of concrete slab.
   ☐ Add to Base Bid Proposal Amount
   ☒ Deduct From Base Bid Proposal Amount
   (Check appropriate box indicating additive or deductive cost; failure to do so will result in rejection of Bid Proposal for non-responsiveness)

   $ ☐☐ , ☐☐☐ , ☐☐☐ . ☐☐

   _____ Dollars
   (in words; printed or typed)

3. Alternate Bid Item No.3. N/A

   ☐ Add to Base Bid Proposal Amount
   ☐ Deduct From Base Bid Proposal Amount
   (Check appropriate box indicating additive or deductive cost; failure to do so will result in rejection of Bid Proposal for non-responsiveness)

   $ ☐☐ , ☐☐☐ , ☐☐☐ . ☐☐

   _____ Dollars
   (in words; printed or typed)

4. Alternate Bid Item No.4. N/A ☐ Add to Base Bid Proposal Amount

   ☐ Deduct From Base Bid Proposal Amount
   (Check appropriate box indicating additive or deductive cost; failure to do so will result in rejection of Bid Proposal for non-responsiveness)

Pre-Bid RFI 006
Received 04.17.2024 JDG

(FOR PRE-BID USE ONLY)

PRE-BID REQUEST FOR INFORMATION
DESERT COMMUNITY COLLEGE DISTRICT

Date of Pre-Bid RFI: 4/17/2024
Project Name: Science Building Renovation
Bid No: 43-98P-0500-SBR-REBID

Bidder Name:
Tovey/Shultz Construction, Inc.

Bidder's Pre-Bid Request for Information (Include references to Drawing Sheet Numbers and/or Sections of the Specifications)

There does not appear to be any unit price items listed on the composite unit price proposal worksheet.
We see that RFI 3 response dated 2/16/24 states no unit costs unless otherwise noted.
Please confirm that no unit pricing is to be included with proposals, and that the composite unit price proposal worksheet can be excluded from bid proposals.

Additional pages attached by Bidder: ☐ Yes ☑ No
Number of additional pages attached by Bidder: _____

Response to Bidder's Pre-Bid Request for Information

Confirming no Unit Pricing. Indicate N/A on the Worksheet and submit with all other Bid Documenets as required. J. Dawson-Garcia 04.17.2024

Additional pages of RFI Response attached: ☐ Yes ☐ No
Number of additional RFI Response pages attached: _____

Date of RFI Response: _____

Submitted By:
Tovey/Shultz Construction, Inc.
(Bidder Name)
(Signature of Bidder's Authorized Employee, Officer or Representative)

Submittal Date: 4/17/2024

Bidder Contact Information:
Alyssa Callaway
(Bidder Contact Name)

(951) 471-5677
(Phone and Fax)
BidDiscovery@toveyshultz.com
(Email Address)

SECTION 23 09 00 – INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. The basis of design for the control system is Distech and mentioned throughout this specification section. Other manufacturers with equal or better performance may be provided. See section 2.1 for list of manufacturers and providers.

B. This Section includes control equipment for HVAC systems and components, including control components for cooling units not supplied with factory-wired controls.

C. Related Sections include the following:

1. Section 230519 "Meters and Gages for HVAC Piping" for measuring equipment that relates to this Section.
2. Section 230993 “Sequences of Operation”

D. Definitions:

1. Alarm: Notification of an abnormal condition.
2. Algorithm: A logical procedure for solving a recurrent mathematical problem.
3. Analog: A continuously varying signal value (temperature current, velocity, etc.)
4. Application Generic Controller (AGC): A networked device or node that contains a complete, configurable application that is generic in nature and suited for various control tasks. The device manufacturer produces this application. The manufacturer exposes a high number of network variables and configuration properties on the device to allow the specific use of the device to be configured with network tools.
5. Application Specific Controller (ASC): A networked device or node that contains a complete, configurable application that is specific to a particular task. This application is normally produced by the device manufacturer and contains a number of configuration parameters that may be adjusted by network tools.
6. Binary: A two-state system where an "on" condition is represented by a high signal level and an "off" condition is represented by a low signal level.
7. Bridge: A device that routes messages or isolates message traffic to a particular segment sub-net or domain of the same physical communication media.
8. Building Management System (BMS): The complete facility control system comprised of all mechanical system automation, and automatic temperature control, etc., as defined in the contract documents. The BAS is built upon a single network infrastructure based upon BACnet protocol. This infrastructure may include field wiring, BACnet wiring, routers,

bridges, raceways, and gateways as required connecting non-interoperable subsystems and devices.

9. Channel: A physical media serving a number of nodes. All nodes on any given channel 'hear' messages produced by other nodes on the channel. The network configuration and node application program determines whether or not a device responds to the messages.
10. Control Unit: A BACnet control product that handles multiple inputs and outputs and more than one control loop. May utilize a supplemental general-purpose microprocessor in addition to the standard BACnet chip to perform additional functions or software applications.
11. Control Wiring: Includes conduit, wire and wiring devices to install complete control systems including motor control circuits, interlocks, thermostats, EP and PE switches and like devices. Includes all wiring from Intelligent Devices and Controllers to all sensors and points defined in the input/output summary shown on the drawings or specified herein and required to execute the sequence of operation.
12. Custom Application Controller (CAC): Programmable control product that incorporates solid-state components to perform control loops or functions. The application in the controller is custom software produced by the Control System Contractor specifically for the project. These applications shall conform to BACnet functional profiles and interoperability standards. Complete documentation including object diagrams, Device Resource Files (DRF), and External Interface Files (XIF) must be submitted EOR (Engineer of Record) when such devices/controllers are used.
13. Deadband: A temperature range over which no heating or cooling energy is supplied, such as 72-78 degrees F, i.e. as opposed to single point changeover or overlap.
14. Device Resource File: External Interface files and BACnet plug-ins that are required to display manufacturer's defined network variables or configuration parameters correctly.
15. DDC: Direct digital control.
16. Distributed Control: A system whereby all control processing is decentralized and independent of a central computer.
17. Diagnostic Program: A machine-executable program with instructions used to detect and isolate system and component malfunctions.
18. Domain: A domain is logical collection of nodes on one or more channels. Communications can only take place among nodes configured in a common domain; therefore, a domain forms a virtual network. Multiple domains can occupy the same channels, so domains may be used.
19. Gateway: A device that contains an I/O software driver to translate data from other protocols to the conforming BACnet standards.
20. Graphical User Interface (GUI): A graphical subset of operator interfaces.
21. HVAC Control Systems: The complete BACnet Control System comprising User Interface, routers, gateways, repeaters, Control Units (CU), software, portable operators terminals, network communications wiring and raceways, and required field hardware, etc.
22. Intelligent Devices: BACnet product that is configured to provide control over a single control loop or to monitor a single or multiple control variable(s); incorporates solid-state components based upon BACNet protocol to perform dedicated functions (ex: actuators, sensors, and switches).
23. Man-Machine Interface (MMI): A graphical, object-oriented method by which an operator is capable of communicating with the system. The Man-Machine interface allows the operator to manage, control, monitor, and configure the system.
24. Network: A system of distributed control devices that are linked together on a communication bus. A network allows sharing of point information between all control devices. Additionally, a network may provide central monitoring and control of the entire system from an MMI/GUI.

25. Node: An intelligent device attached to the network. Usually falls into one of the following categories - sensor, actuator, ASC, AGC, CAC.
26. Operator Interface: A device combination of hardware and software, (PC, laptop or display terminal) which provides client access to the control system, primarily used for network management, configuration, and diagnostics.
27. Operating System (OS): Software which controls the execution of computer programs.
28. Peripheral: External devices used to communicate to and from a computer. Peripherals include CRT, printer, hard drives, disk drives, modems, etc.
29. Point: Group of data, which corresponds to a hardware input, output, or calculated value.
30. Portable Operator's Terminal (POT): Laptop/tablet device that allows local and remote access to the local control network.
31. Router: A device that routes or forwards messages destined for a node on another subnet or domain of the control network. The device controls message traffic based on node address and priority. Routers may also serve as communication interfaces between different channel media. (i.e., powerline, twisted pair, Ethernet\TCP\IP, and RF)
32. Segment: A set of channels connected by bridges or repeaters. A node sees every packet from every other node on its segment.
33. Sensor: Device capable of measuring the condition or value of a variable.
34. Software: Programs and routines used to extend the capabilities of computers hardware.
35. Subnet: A subnet is a logical collection of up to 127 nodes within a domain. Up to 255 subnets can be defined within a single domain. All nodes in a subnet must be on the same segment. Subnets cannot cross-intelligent routers.

E. Abbreviations

1.	AAC	Advanced Application Controllers
2.	AGC	Application Generic Controller
3.	ASC	Application Specific Controller
4.	BAS	Energy Management System
5.	BC	Building Controllers
6.	CAC	Custom Application Controller
7.	DDC	Direct Digital Controller
8.	DRF	Device Resource File
9.	EMS Energy Management System	
10.	FPM	Feet per minute
11.	GPM	Gallons per minute
12.	GUI	Graphical User Interface
13.	I/O	Input/Output
14.	NFPA	National Fire Protection Association
15.	OS	Operating System
16.	OWS	Operating Work Station
17.	PE	Pneumatic-electric
18.	PID	Proportional Integral Derivative
19.	PRV	Pressure Reducing Valve
20.	PSI(g)	Pounds per square inch (gauge)
21.	RAM	Random Access Memory
22.	SA	Smart Actuators
23.	SS	Smart Sensors
24.	TCS	Temperature Control System
25.	TCC	Temperature Control Contractor
26.	UL	Underwriters’ Laboratory

27.	VCS	Voice Communication System
28.	WC	Water Column
29.	XIF	External Interface File

1.3 SYSTEM PERFORMANCE

A. Comply with the following performance requirements:

1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.
2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.
3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.

1.4 QUALITY ASSURANCE

A. The Building Management System (BMS) shall be furnished, engineered and installed by a certified Distech controls system supplier and approved by the College Representative.

B. System Integrator shall:

1. Be in good standing with the Manufacturer.
2. Have on staff, trained Distech Integrators.
3. Have at least four (4) fully trained staff members at all times.
4. Provide training class certifications of staff members if requested.
5. Have direct line of technical support from suppliers.
6. Employ technicians who have completed factory-authorized training.
7. Employ technicians to provide instruction, routine maintenance, and emergency service within 24 hours upon receipt of request.

C. The installing Contractor must be regularly engaged in the service and installation of Distech based systems as specified herein.

D. The installing Contractor shall have an office within 200 miles that is staffed with designers trained in integrating interoperable systems and technicians fully capable of providing instruction and routine emergency maintenance service on all system components.

E. The installing Contractor shall have in house capabilities to provide control strategies for whole building control. This includes HVAC, lighting, access, and security applications etc.

F. The installing Contractor shall have a service facility, staffed with qualified service personnel, capable of providing instructions and routine emergency maintenance service for networked control systems.

1.5 ACTION SUBMITTALS

A. The manufacturer, contractor or supplier shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of this particular specification section.

1. The manufacturer shall resubmit this specification section showing compliance with each respective paragraphs and specified items and features.
2. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.
3. Individual or partial submittals are not acceptable and will be returned without review.

B. The installing Contractor shall provide project list stating completion of no less than three (3) Chilled Water Central Plants projects of similar size or larger within the past five (5) years, which have BacNET based BAS as specified herein installed by the Contractor. These projects must be on-line and functional such that the system can be observed in full operation.

C. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.

1. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
2. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.
3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

D. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Bill of materials of equipment indicating quantity, manufacturer and model number.
2. Schematic flow diagrams showing chillers, cooling tower, pumps, valves and control devices and accessories.
3. Wiring Diagrams: Power, signal and control wiring.
4. Details of control panel faces, including controls, instruments and labeling.
5. Written description of sequence of operation.
6. Schedule of valves including flow characteristics.
7. DDC System Hardware:

    a. Wiring diagrams for control units with termination numbers.
    b. Schematic diagrams and floor plans for field sensors and control hardware.

c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.

8. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
9. Controlled Systems:

a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
c. Written description of sequence of operation including schematic diagram.
d. Points list.

1.6 INFORMATIONAL SUBMITTALS

A. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE 135.

B. Qualification Data: For Installer and manufacturer.

C. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.

D. Field quality-control test reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For direct digital control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017000 "Execution and Closeout Requirements," include the following:

1. Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.
2. Interconnection wiring diagrams with identified and numbered system components and devices.
3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
5. Calibration records and list of set points.

B. Software and Firmware Operational Documentation: Include the following:

1. Software operating and upgrade manuals.
2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.
5. Software license required by and installed for DDC workstations and control systems.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.

B. System Software: Update to latest version of software at Project completion.

1.9 COORDINATION

A. Coordinate location of exposed control sensors with plans and room details before installation.

B. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.

C. Coordinate equipment with Section 262416 "Panelboards" to achieve compatibility with starter coils and annunciation devices.

1.10 COMMISSIONING

A. Commissioning requires the participation of Division 23 BAS work to ensure that all systems are operating in a manner consistent with the DSA Approved for Construction and the design intent. The general commissioning requirements and coordination are detailed in Division 1 and Division 23. This Division shall be familiar with all parts of Division 1 and Division 23 and the commissioning plan issued by the Commissioning Authority and shall execute all commissioning responsibilities assigned to them in the Contract Documents.

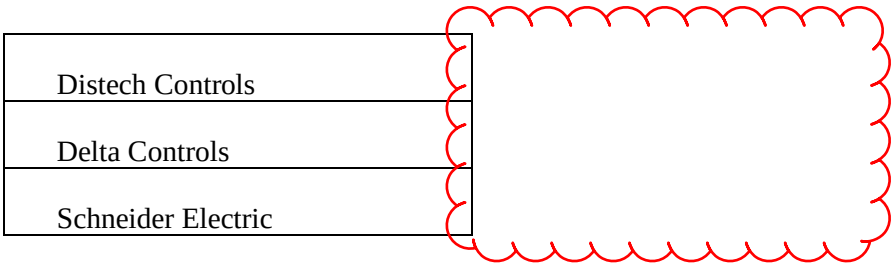
B. The controls contractor is responsible for assisting the commissioning agent throughout the entire commissioning process. The controls work is not complete until the commissioning agent and the District has signed off on the commissioned systems.

PART 2 - PRODUCTS

2.1 CONTROL SYSTEM

A. The basis of design for the control system is Distech and mentioned throughout this specification section. Other manufacturers with equal or better performance may be provided. See below:

Manufacturer
Siemens
ABB Controls
Honeywell
Johnson Controls- FX



B. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems. An operator workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.

C. The selected Distech System Contractor shall be fully responsible to integrate all graphic required under this project onto the College front end. Provide necessary upgrades, modifications, etc. as required for a fully operational direct digital controls (DDC) system.

D. The controls contractor shall comply with all the requirements and certifications listed in paragraph 1.4 B through F.

2.2 COMMUNICATION

A. Control products, communication media, connectors, repeaters, hubs, and routers shall comprise a BACnet internetwork. Controller and operator interface communication shall conform to the latest version of ASHRAE/ANSI Standard 135, BACnet.

B. Install new wiring and network devices as required providing a complete and workable control network.

C. Each controller shall have a communication port for temporary connection to a laptop computer or other operator interface. Connection shall support memory downloads and other commissioning and troubleshooting operations.

D. Internetwork operator interface and value passing shall be transparent to internetwork architecture.

1. An operator interface connected to a controller shall allow the operator to interface with each internetwork controller as if directly connected. Controller information such as data, status, and control algorithms shall be viewable and editable from each internetwork controller.
2. Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be readable by each controller on the internetwork. Program and test all cross-controller links required to execute control strategies specified in this section. An authorized operator shall be able to edit cross-controller links by typing a standard object address or by using a point-and-click interface.

E. Controllers with real-time clocks shall use the BACnet Time Synchronization service. System shall automatically synchronize system clocks daily from an operator-designated controller via

the internetwork. If applicable, system shall automatically adjust for daylight saving and standard time.

F. System shall be expandable to at least twice the required input and output objects with additional controllers, associated devices, and wiring.

G. System shall support Web services data exchange with any other system that complies with XML (extensible markup language) and SOAP (simple object access protocol) standards specified by the Web Services Interoperability Organization (WS-I) Basic Profile 1.0 or higher. Web services support shall as a minimum be provided at the workstation or web server level and shall enable data to be read from or written to the system.

1. System shall support Web services read data requests by retrieving requested trend data or point values (I/O hardware points, analog value software points, or binary value software points) from any system controller or from the trend history database.
2. System shall support Web services write data request to each analog and binary object that can be edited through the system operator interface by downloading a numeric value to the specified object.
3. For read or write requests, the system shall require user name and password authentication and shall support SSL (Secure Socket Layer) or equivalent data encryption.
4. System shall support discovery through a Web services connection or shall provide a tool available through the Operator Interface that will reveal the path/identifier needed to allow a third party Web services device to read data from or write data to any object in the system which supports this service.

2.3 BAS HARDWARE AND SOFTWARE

A. The control system shall be seamlessly integrated to the existing campus control system.

1. The selected Distech Controls System Contractor shall be fully responsible to integrate all graphic required under this project onto the College front end system. Provide necessary upgrades, modifications, etc. as required for a fully operational direct digital controls (DDC) system.

B. Building and energy management application software shall reside and operate in system controllers. Applications shall be editable through operator workstation, web browser interface, or engineering workstation.

C. Scheduling: System shall provide the following schedule options as a minimum:

1. Weekly: Provide separate schedules for each day of the week. Each schedule shall be able to include up to 5 occupied periods (5 start-stop pairs or 10 events).
2. Exception: Operator shall be able to designate an exception schedule for each of the next 365 days. After an exception schedule has executed, system shall discard and replace exception schedule with standard schedule for that day of the week.
3. Holiday: Operator shall be able to define 24 special or holiday schedules of varying length on a scheduling calendar that repeats each year.

D. System Coordination: Operator shall be able to group related equipment based on function and location and to use these groups for scheduling and other applications.

E. Remote Communication: System shall automatically contact operator workstation or server on receipt of critical alarms. If no network connection is available, system shall use a modem connection.

F. Maintenance Management: System shall generate maintenance alarms when equipment exceeds adjustable runtime, equipment starts, or performance limits.

G. Sequencing: Application software shall sequence chillers, pumps, etc. as specified in Sequences of Operation.

H. PID Control: System shall provide direct and reverse acting PID (proportional-integral-derivative) algorithms. Each algorithm shall have anti-windup and selectable controlled variable, setpoint, and PID gains. Each algorithm shall calculate a time-varying analog value that can be used to position an output or to stage a series of outputs.

I. Staggered Start: System shall stagger controlled equipment restart after power outage. Operator shall be able to adjust equipment restart order and time delay between equipment restarts.

J. Energy Calculations:

1. System shall accumulate and convert instantaneous power (kW) or flow rates (gpm) to energy usage data.
2. System shall calculate a sliding-window average (rolling average). Operator shall be able to adjust window interval to 15 minutes, 30 minutes, or 60 minutes.

K. Anti-Short Cycling: Binary output objects shall be protected from short cycling by means of adjustable minimum on-time and off-time settings.

L. On and Off Control with Differential: System shall provide direct and reverse acting on and off algorithms with adjustable differential to cycle a binary output based on a controlled variable and setpoint.

M. Runtime Totalization: System shall provide an algorithm that can totalize runtime for each binary input and output. Operator shall be able to enable runtime alarm based on exceeded adjustable runtime limit.

N. Graphic screens shall be provided for all systems included in the Sequence of Operations and Points List.

O. Control equipment and network failures shall be treated as alarms and annunciated.

P. Alarms shall be visually identified via the HTML graphics pages. Overrides and setpoint changes for all points shall be configured via the HTML interface.

Q. Alarms shall be annunciated in any of the following manners as defined by the user:

1. Screen message text
2. SMS and email message
3. Graphic with flashing alarm object(s)

R. Alarms shall be logged for a period of no less than 1 week

S. The following shall be recorded by the Web Server for each alarm (at a minimum):

1. Time and date
2. Location (building, floor, zone, office number, etc.)
3. Equipment (unit #, access way, etc.)

2.4 DDC CONTROL PRODUCTS

A. General:

1. Provide Building Controllers (BC), Advanced Application Controllers (AAC), Application Specific Controllers (ASC), Smart Actuators (SA), and Smart Sensors (SS) as required to achieve performance specified in this section and the sequence of operations.
2. Every device in the system which executes control logic and directly controls HVAC equipment must conform to a standard BACnet Device profile as specified in latest edition of ASHRAE/ANSI 135, BACnet Annex L. Unless otherwise specified, hardwired actuators and sensors may be used in lieu of BACnet Smart Actuators and Smart Sensors.

B. BACnet:

1. Building Controllers (BCs): Each BC shall conform to BACnet Building Controller (B-BC) device profile as specified in ASHRAE/ANSI 135, BACnet Annex L and shall be listed as a certified B-BC in the BACnet Testing Laboratories (BTL) Product Listing.
2. Advanced Application Controllers (AACs): Each AAC shall conform to BACnet Advanced Application Controller (B-AAC) device profile as specified in ASHRAE/ANSI 135, BACnet Annex L and shall be listed as a certified B-AAC in the BACnet Testing Laboratories (BTL) Product Listing.
3. Application Specific Controllers (ASCs): Each ASC shall conform to BACnet Application Specific Controller (B-ASC) device profile as specified in ASHRAE/ANSI 135, BACnet Annex L and shall be listed as a certified B-ASC in the BACnet Testing Laboratories (BTL) Product Listing.
4. Smart Actuators (SAs): Each SA shall conform to BACnet Smart Actuator (B-SA) device profile as specified in ASHRAE/ANSI 135 , BACnet Annex L and shall be listed as a certified B-SA in the BACnet Testing Laboratories (BTL) Product Listing.
5. Smart Sensors (SSs): Each SS shall conform to BACnet Smart Sensor (B-SS) device profile as specified in ASHRAE/ANSI 135, BACnet Annex L and shall be listed as a certified B-SS in the BACnet Testing Laboratories (BTL) Product Listing.
6. BACnet Communication:

    a. Each BC shall reside on or be connected to a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing.
    b. BACnet routing shall be performed by BCs or other BACnet device routers as necessary to connect BCs to networks of AACs and ASCs.
    c. Each AAC and ASC shall reside on a BACnet network using Arcnet Data Link/Physical layer protocol.
    d. Each SA shall reside on a BACnet network using MS/TP Data Link/Physical layer protocol.
    e. Each SS shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet network using MS/TP Data Link/Physical layer protocol.

C. Communication.

1. Service Port: Each controller shall provide a service communication port for connection to a Portable Operator's Terminal. Connection shall be extended to space temperature sensor ports where shown on drawings.
2. Signal Management: BC and ASC operating systems shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and to allow for central monitoring and alarms.
3. Data Sharing: Each BC and AAC shall share data as required with each networked BC and AAC.
4. Stand-Alone Operation: Each piece of equipment specified this section shall be controlled by a single controller to provide stand-alone control in the event of communication failure. All I/O points specified for a piece of equipment shall be integral to its controller. Provide stable and reliable stand-alone control using default values or other method for values normally read over the network.

D. Environment. Controller hardware shall be suitable for anticipated ambient conditions.

1. Controllers used outdoors or in wet ambient conditions shall be mounted in waterproof enclosures and shall be rated for operation at -20°F to 140°F.
2. Controllers used in conditioned space shall be mounted in dust-protective enclosures and shall be rated for operation at 32°F to 120°F.

E. Keypad: Provide a local keypad and display for each BC and AAC. Operator shall be able to use keypad to view and edit data. Keypad and display shall require password to prevent unauthorized use. If the manufacturer does not normally provide a keypad and display for each BC and AAC, provide the software and any interface cabling needed to use a laptop computer as a Portable Operator's Terminal for the system.

F. Real-Time Clock: Controllers that perform scheduling shall have a real-time clock.

G. Serviceability:

1. Controllers shall have diagnostic LEDs for power, communication, and processor.
2. Wires shall be connected to a field-removable modular terminal strip or to a termination card connected by a ribbon cable.
3. Each BC and AAC shall continually check its processor and memory circuit status and shall generate an alarm on abnormal operation. System shall continuously check controller network and generate alarm for each controller that fails to respond.

H. Memory:

1. Controller memory shall support operating system, database and programming requirements.
2. Each BC and AAC shall retain BIOS and application programming for at least 72 hours in the event of power loss.
3. Each ASC and SA shall use nonvolatile memory and shall retain BIOS and application programming in the event of power loss. System shall automatically download dynamic control parameters following power loss.

I. Immunity to Power and Noise: Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 3 ft.

J. Transformer: ASC power supply shall be fused or current limiting and shall be rated at a minimum of 125% of ASC power consumption.

2.5 INPUT AND OUTPUT INTERFACE

A. General: Hard-wire input and output points to BCs, AACs, ASCs, or SAs.

B. Protection: Shorting an input or output point to itself, to another point, or to ground shall cause no controller damage. Input or output point contact with up to 24 V for any duration shall cause no controller damage.

C. Binary Inputs: Binary inputs shall monitor the on and off signal from a remote device. Binary inputs shall provide a wetting current of at least 12 mA and shall be protected against contact bounce and noise. Binary inputs shall sense dry contact closure without application of power external to the controller.

D. Pulse Accumulation Inputs: Pulse accumulation inputs shall conform to binary input requirements and shall accumulate up to 10 pulses per second.

E. Analog Inputs: Analog inputs shall monitor low-voltage (0-10 Vdc), current (4-20 mA), or resistance (thermistor or RTD) signals. Analog inputs shall be compatible with and field configurable to commonly available sensing devices.

F. Binary Outputs: Binary outputs shall send an on-or-off signal for on and off control. Building Controller binary outputs shall have three-position (on-off-auto) override switches and status lights. Outputs shall be selectable for normally open or normally closed operation.

G. Analog Outputs: Analog outputs shall send a modulating 0-10 Vdc or 4-20 mA signal as required to properly control output devices. Each Building Controller analog output shall have a two-position (auto-manual) switch, a manually adjustable potentiometer, and status lights. Analog outputs shall not drift more than 0.4% of range annually.

H. Tri-State Outputs: Control three-point floating electronic actuators without feedback with tri-state outputs (two coordinated binary outputs). Tri-State outputs may be used to provide analog output control in zone control and terminal unit control applications such as VAV terminal units, duct-mounted heating coils, and zone dampers.

I. Universal Inputs and Universal Outputs or Universal Input/output (UniPut): Inputs and outputs that can be designated as either binary or analog in software shall conform to the provisions of this section that are appropriate for their designated use.

2.6 POWER SUPPLIES AND LINE FILTERING

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

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

    a. Unit shall operate between 32°F and 120°F. EM/RF shall meet FCC Class B and VDE 0871 for Class B and MILSTD 810C for shock and vibration.
    b. Line voltage units shall be UL recognized and CSA listed.

B. Power Line Filtering.

1. Provide internal or external transient voltage and surge suppression for workstations and controllers. Surge protection shall have:
2. Dielectric strength of 1000 V minimum
3. Response time of 10 nanoseconds or less
4. Transverse mode noise attenuation of 65 dB or greater
5. Common mode noise attenuation of 150 dB or greater at 40-100 Hz

2.7 THERMOWELLS

A. When thermowells are required, the sensor and well shall be supplied as a complete assembly including wellhead and Greenfield fitting.

B. Thermowells shall be pressure rated and constructed in accordance with the system working pressure.

C. Thermowells and sensors shall be mounted in a threadolet or 1/2" NPT saddle and allow easy access to the sensor for repair or replacement.

D. Thermowells shall be constructed of machined stainless steel, Type 316.

E. Manufacturer shall be BAPI Model BA/4"M316 or approved equal.

F. Provide Honeywell 107408 heat conductive compound in each thermowell.

2.8 LIQUID IMMERSION TEMPERATURE SENSORS & tRANSMITTER

A. Temperature Sensor BAPI Model 1K8 or approved equal.

1.	Operating Temperature	-40 to 185°F
2.	Sensing Element	1000 Ohm 385 Curve RTD
3.	Accuracy at Calibration Temperature	+/- 0.27 °F

B. Temperature Transmitter Minco Model TT807

1.	Min / Max Span	35°F to 1112°F
2.	Accuracy	+/- 0.1% of Span
3.	Linearity	+/- 0.1% of Span

C. All sensors measuring temperatures in pipes larger than 2 inches in diameter or in pressure vessels shall be supplied with wells properly fabricated for the service. Wells shall be non-corrosive to the medium being measured and shall have sufficient physical strength to withstand pressures and velocities to which they are subjected. Wells shall be installed in the piping at elbows where piping is smaller than the length of the well to affect proper flow across the entire area of the well.

D. Stainless steel, Type 304, socket with minimum insertion length of 4 inches.

2.9 OUTSIDE AIR TEMPERATURE AND HUMIDITY SENSORS

A. Vaisala HUMICAP Outdoor Humidity and Temperature Transmitter HMD60YO. No known equal.

1.	Humidity Operating Range	0-100% RH
2.	Humidity Output Signal	4 to 20 mA, 0 to 100% linear, proportional
3.	Humidity Accuracy	+/- 2.0% RH, 0-90% RH
4.	Humidity Sensing Element	HUMICAP 180
5.	Temperature Range	-40-140°F
6.	Temperature Output Signal	4 to 20 mA, 0 to 100% linear, proportional
7.	Temperature Accuracy	± 0.36°F
8.	Temperature Sensing Element	1K-ohm Platinum RTD 1/3 Class B IEC 751

B. Outdoor installations shall be of weatherproof construction or in appropriate NEMA enclosures. These installations shall be protected from solar radiation and wind effects. They shall also be provided with a solar radiation shield.

2.10 DUCT TYPE TEMPERATURE SENSORS

A. BAPI or approved equal.

1.	Operating Temperature	-40 to 240°F
2.	Sensing Element	NTC 10K (Type III) Thermistor
3.	Accuracy at Calibration Temperature	+/- 1 °F

B. Sensors in ducts shall be mounted in locations to sense the correct temperature of the air only and shall not be located in dead air spaces, in close proximity to coils so as to display inaccurate temperatures, or positions obstructed by ducts, equipment, and so forth. Locations where installed shall be within the vibration and velocity limit of the sensing element.

C. 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. A neoprene grommet (Seal-tite fitting and mounting plate) shall be used on the sensor assembly to prevent air leaks.

D. Duct sensors shall be insertion type and constructed as a complete assembly including lock nut and mounting plate. Duct sensors probe shall be constructed of 304/316 stainless steel.

E. Duct sensors shall not be mounted within 36 inches of heating and cooling coils.

F. Duct temperature sensors mounted within 36 inches of heating and cooling coils shall be either rigid averaging sensors for the full width of the longest dimension of the duct mounted in the middle up to 48" wide. Beyond 48" wide the averaging sensor shall be flexible averaging sensor serpentine across the coil and not physically touching the coil.

G. For outdoor air duct applications, use a weatherproof mounting box with weatherproof cover and gasket.

2.11 AVERAGING DUCT TYPE TEMPERATURE SENSORS

A. Minco 1000 Ohm 375 Platinum Averaging Sensor & T90PNR Temperature Transmitter.

1.	Operating Temperature	-40 to 240°F
2.	Sensing Element	1000 Ohm 375 Curve RTD
3.	Accuracy at Calibration Temperature	+/- 0.6 °F

B. For ductwork that has a dimension greater than 48 inches and/or where air temperature stratification exists, utilize an averaging sensor with multiple sensing points. The averaging sensor shall be installed complete with end cap, compression fittings, gaskets, mounting flange and required accessories.

C. Provide CC-1G-K capillary supports at the sides of the duct to support the sensing string.

D. Thermistor Averaging sensors (NTC 10K (Type III) Thermistor) can also be used with the same accuracy as 2.10 duct sensors.

2.12 ROOM TEMPERATURE SENSORS

A. Room temperature sensors shall be Distech or approved equal.

B. Room sensors are to be provided with a cover to prevent accidental damage.

1.	Operating Temperature	-40 to 240°F
2.	Operating Range, Active Signal Types	40 to 90°F
3.	Temperature Effect	Less than 0.1% per °C
4.	Sensing Element	NTC 10K (Type III) Thermistor
5.	Accuracy at Calibration Temperature	+/- 1 °F

2.13 WATER differential PRESSURE TRANSMITTERs

A. Water differential pressure sensors shall be Setra Model 230 transmitters or approved equal.

B. Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage and to hold calibrated accuracy when subject to a momentary 40% over-range input.

C. Provide:

1. NEMA 1 transmitter housing and locate in accessible local control panels wherever possible.
2. Brass 3-valve manifold assembly with shut-off and shunt valves.
3. Standard Viton/Silicone bleed screw seals.
4. Calibration certificate.

D. The pressure transmitter shall be capable of transmitting a linear electronic signal proportional to the differential of the pressure input signals with the following minimum performance specifications.

1.	Span:	Refer to Points List
2.	Accuracy:	±0.25% of full scale
3.	Non-Repeatability:	0.05%
4.	Non-Linearity:	±0.20%
5.	Response:	30 to 50 ms
6.	Temperature Stability:	Less than 0.02%FS/°F change
7.	Output:	4 to 20mA

2.14 BTU METERS CHILLED AND HEATING HOT WATER

A. Provide Onicon F-3200 Magmeter Flow Sensor with System 10 BTU Interface including matched temperature sensors. Integration shall be through 4-20 mA & pulsed relay contact closure. See Mechanical Drawings for location and sizes.

B. General Water Flow Meter

1. Operating Range: 0.033 to 33 ft/s
2. Pipe Size Range: 1 in. to 48 in.
3. Accuracy: ±0.2% of reading from 1.6 to 33 ft/s, +/- 0.0033 ft/s from 0.033 to 1.6 ft/s
4. Minimum Conductivity: 5 µS/cm
5. Class 150 flanges.
6. Flow tube shall be epoxy coated steel and the sensing electrodes shall be 316 stainless steel.

C. General Flow Meter Electrical

1. Power Requirements - 4 to 20 mA: 24 VDC ±10%, regulated, 22.1 mA max.
2. Frequency: 5 to 24 VDC ±10%, regulated, 15 mA max.
3. Digital (S3L): 5 to 6.5 VDC, 15 mA max.
4. Auxiliary (only required for units with relays): 9 to 24 VDC, 0.4 A max
5. Reverse polarity and short circuit protected
6. Current output (4 to 20 mA): - Loop Accuracy: 32 µA max. error (25 °C @ 24 VDC)
7. Isolation: Low voltage < 48 VAC/DC from electrodes and auxiliary power
8. Maximum Cable: 1000 ft
9. Error condition: 22.1 mA
10. Max. Loop Resistance: 300 Ω
11. Compatible with PLC, PC or similar equipment
12. 4 to 20 mA load needed
13. Frequency Output: - Output Modes: Freq., or Mirror Relay (display version only)

14. Max. Pull-up Voltage: 30 VDC
15. Max. Current Sink: 50 mA, current limited

D. Relay Specifications

1. #1, #2 Type: Mechanical SPDT Rating: 5 A @ 30 VDC max., 5 A @ 250 VDC max.
2. #3 Type: Solid State Rating: 50 mA @ 30 VDC, 50 mA @ 42 VAC
3. Hysteresis: User adjustable for exiting alarm condition
4. Alarm On Trigger Delay: Adjustable (0 to 9999.9 sec.)
5. Relay Modes: Off, Low, High, Window, and Proportional Pulse
6. Relay Source: Flow Rate, Resettable Totalizer
7. Error Condition: Selectable; Fail Open or Closed

E. Display/Controller/Temperature Sensors

1. Provide Onicon System-10 or approved equal.
2. Shall provide the following points both at the integral LCD and as outputs to the BMS:

    a. Energy Total
    b. Energy Rate
    c. Flow Rate
    d. Supply and Return Temperatures

3. Provide BacNet interface.
4. Output shall be either serial network (compliant with the BMS system) or via individual analog and pulse outputs.
5. Temperature sensors shall be loop-powered current based (mA) sensors and shall be bath calibrated and matched (NIST traceable). Sensors shall be matched to an accuracy better than ± 0.15°F
6. Meter shall be provided per section above.
7. Meter shall be re-programmable using the front panel keypad.

F. Max. Temperature/Pressure Rating

1. Storage Temperature: -4 °F to 158 °F
2. Relative Humidity: 0 to 95% (non-condensing)
3. Operating Temperature: Ambient: 14 °F to 158 °F, Media: 32 °F to 185 °F
4. Maximum Operating Pressure: 150 psi @ 77 °F

G. Standards and Approvals

1. NEMA 4X / IP65 Enclosure (with cap installed)

2.15 CURRENT TRANSFORMERS

A. The current transformers shall be provided to be installed or removed without dismantling the primary bus or cables. The transformer shall be of a split core design.

B. The core and windings shall be completely encased in a UL approved thermoplastic rated 94VA. No metal parts shall be exposed other than the terminals.

C. The current transformers shall meet the following specifications.

1. Frequency Limits: 50 to 400 Hz.
2. Insulation: 0.6 KV Class, 10 KV BIL.
3. Accuracy: ± 1 % at 5.0 to 25.0 VA accuracy class with U.P.F. burden.
4. Provide a disconnect switch for each current transformer.

2.16 CURRENT SENSING SWITCHES

A. Current sensing switch shall be self-powered with solid-state circuitry and a dry contact output.

B. Current sensing switches shall consist of a solid state current sensing circuit, adjustable trip point, solid state switch, SPDT relay and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept over current up to twice its trip into range.

2.17 ACTUATORS

A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.

1. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC."
2. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
3. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
4. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.

B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.

1. Manufacturers shall be Belimo Aircontrols (USA), Inc.
2. Valves: Size for torque required for valve close off at maximum pump differential pressure.
3. Coupling: V-bolt and V-shaped, toothed cradle.
4. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
5. Provide external, manual gear release on nonspring-return actuators.
6. Power Requirements (Two-Position): 24-V ac.
7. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
8. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
9. Temperature Rating: 40 to 104 deg F.
10. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F
11. Run Time: 60 seconds.

2.18 CONTROL VALVES

A. Manufacturer shall be Belimo Aircontrols or approved equal.

B. Control Valves: Factory fabricated, of type, body material and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.

C. Ball Valves:

1. NPS 2 and Smaller: 400 psi brass body, nickel plated, stainless steel trim, PTFE seats and screwed ends.
2. NPS 2-1/2 and 4: 400 psi brass body, nickel plated, stainless steel trim, PTFE seats and flanged ends.
3. Sizing:

    a. Two Position: Line size.
    b. Two-Way Modulating: As specified on the Drawings with Tefzel characterizing disc.

4. Flow Characteristics: Two-way valves shall have equal percentage characteristics.
5. Close-Off or Differential Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 200 psig.

D. High Performance Butterfly Valves:

1. Maximum close-off or differential pressure of 150 psig, ASTM A 126 cast-iron or ASTM A 536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals.
2. Body Style: Lug.
3. Disc Type: Nickel-plated ductile iron.
4. Sizing: 1-psig maximum pressure drop at design flow rate.

E. Pressure Independent Control Valves (CV-427& CV-428):

1. Manufacturer shall be Bell and Gossett Ultra Setter PVL-3L-125 or approved equal.
2. Maximum close-off or differential pressure of 175 psig,
3. Body: ASTM A 536 ductile-iron
4. Valve Flow Setting Element: Brass
5. Differential Pressure Regulator: Stainless Steel with stainless steel spring and EPDM rubber diaghragm.
6. Maximum Working Temperature: 248 deg F
7. Maintain flow accuracy to within +/-5% of desired flow rate for the entire control range up to 85PSID.
8. Include two pressure/temperature readout valves to allow measurements of differential pressure.
9. Max flow setting shall be set using a rotation flow setting motion and an external adjustable dial with GPM scale.
10. Close off pressure: Up to 90PSID

2.19 ELECTRICAL BULK MATERIALS

A. The controls contractor shall be fully responsible to provide all wiring (low voltage, 120 volts, etc.) and conduit (3/4" minimum or as required by electrical codes) for connection of all associated DDC central plant and building chilled water control valves, sensors, panels and any other DDC components for a completely operational DDC system.

1. The controls contractor shall be fully responsible to coordinate with their electrical subcontractor, prior to bid, to insure that all necessary electrical power wiring and conduit are provided for the new chilled water and heating hot water 2-way control valves, control panels, etc.

B. Enclosures: Terminal boxes located indoors shall be rated for NEMA 1. Terminal boxes exposed to outdoors shall be rated for NEMA 12. Terminal boxes with potential water leakage shall be rated for NEMA 4X. They shall have protective coatings suitable to the environment in which they are to be installed. All enclosures shall be hinged with lockable doors.

C. Transformers: Provide step-down transformers where control equipment operates at lower than circuit voltage. Transformers serving shall be fed from the fan motor leads, or fed from the nearest distribution panelboard or motor control center, using circuits provided for the purpose. Transformers, other than transformers in bridge circuits, shall have primaries wound for the voltage available and secondaries wound for the correct control circuit voltage. Size transformers so that 80 percent of the rated capacity equals the connected load. Enclose transformers in a steel cabinet with conduit connections. Provide a disconnect switch on the primary side and a fuse cutout on the secondary side. Transformers shall conform to UL 506.

D. The Controls Contractor shall furnish all electrical relays and coordinate with the supplier of magnetic starters for the auxiliary contact requirements. All electrical control devices shall be of a type to meet current, voltage, and switching requirement of their particular application. Relays shall be provided with 24 VAC coils and contacts shall be rated at 10 amps minimum.

E. Wiring:

1. Provide complete electric wiring for all temperature control apparatus, including wiring to transformer primaries, panels, valves, etc.
2. Control circuit conductors which run in same conduit as power circuit conductors shall have same insulation level as power circuit conductors.
3. Circuits operating at more than 100 volts shall be in accordance with Division 26 specifications.
4. Circuits operating at 100 volts or less shall be defined as low voltage and shall be run in rigid or flexible conduit, metallic tubing, metal raceways or wireways, armored cable, or multiconductor cable. Use multiconductor cable for concealed accessible locations only. Provide circuit and wiring protection as required by CEC. Aluminum-sheathed cable or aluminum conduit may be used but shall not be buried in concrete.
5. Provide all exposed wiring shall be in rigid conduit (minimum ¾") or EMT. Refer to Section 260000, "General Electrical Requirements" for different usages of rigid conduit, EMT, or IMT. All wiring in return air plenums shall be plenum rated.
6. For less than nominal 120V service: Cable in control panels for analog loops shall be twisted and shielded two conductor, #16 x 30 stranded with #22 AWG drain wire and aluminum-polyester 100 percent shielding cover for each pair. Cable outside of control panels for analog signal loops shall be single twisted #18 AWG shielded pair. Conductors

shall be copper coated with Class B strand. Insulation shall be 30 mils XPLE rated at 300 volts. Cable for digital signals shall be two conductor, #16 x 30 stranded. Each conductor shall be color coded. Each cable shall have polyethylene jacket.

7. Wire for low voltage DC and electronic circuits carrying less than 0.5 ampere, cable of two or more conductors, shall be not smaller than No. 18 AWG stranded copper (shielded).
8. Shield cables carrying analog signals and install in separate conduit from AC power circuits.
9. Terminate cables in solder or screw type terminal strips. Do not tap cables at intermediate points.
10. Color code or number wires, whether individual or in cables, for identification.
11. Cables terminating in screw type terminal strips shall have pressure type connectors conforming to UL 486A. Wire in physical contact with compression screw is not acceptable.

2.20 NETWORK COMMUNICATION REQUIREMENTS

A. Wired network communication shall follow the published guidelines for twisted pair BacNET network.

B. Communication conduits shall not be installed closer than six feet from high power transformers or run parallel within six feet of electrical high power cables. Care shall be taken to route the cable as far from interference generating devices as possible. Where communication wire must cross high power wire (deemed as 110VAC or greater) it must do so at right angles.

C. All shields shall be grounded (earth ground) at one point only to eliminate ground loops. All shield grounding shall be done at the controller location with the shield at the sensor/device end of the applicable wire being left long and “safed” off in an appropriate manner.

D. There shall be no power wiring, in excess of 30 VAC rms, run in conduit with communications wiring. In cases where signal wiring is run in conduit with communication wiring, all communication wiring and signal wiring shall be run using separate twisted pairs (24awg) in accordance with the manufacturer’s wiring practices.

2.21 INPUT/OUTPUT CONTROL WIRING

A. RTD wiring shall be two-wire or four-wire twisted, shielded, minimum number 22 gauge.

B. Other analog inputs shall be a minimum of number 22 gauge, twisted, (shielding optional).

C. Binary control function wiring shall be a minimum of number 18 gauge.

D. Analog output control functions shall be a minimum of number 18 gauge, twisted, shielded.

E. Binary input wiring shall be a minimum of number 18 gauge.

2.22 SPLICES

A. Splices in shielded cables shall consist of terminations and the use of shielded cable couplers, which maintain the integrity of the shielding. Terminations shall be in accessible locations. Cables shall be harnessed with cable ties as specified herein.

2.23 CONDUIT AND FITTINGS

A. Conduit for Control Wiring, Control Cable and Transmission Cable: Electrical metallic tubing (EMT) with compression fittings, cold rolled steel, zinc coated or zinc-coated rigid steel with threaded connections.

B. Outlet Boxes (Dry Location): Sheradized or galvanized drawn steel suited to each application, in general, four inches square or octagon with suitable raised cover.

C. Outlet Boxes (Exposed to Weather): Threaded hub cast aluminum or iron boxes with gasket device plate.

D. Pull and Junction Boxes: Size according to number, size, and position of entering raceway as required by National Electrical Codes. Enclosure type shall be suited to location.

2.24 RELAYS

A. Relays other than those associated with digital outputs shall be general-purpose, enclosed plug-in type with 8-pin octal plug and protected by a heat and shock resistant duct cover. Number of contacts and operational function shall be as required.

B. Relays associated with digital outputs shall have the ability to override the controlled equipment as a function of the relay. Relays shall be protected by a heat and shock resistant duct cover. Number of contacts and operational function shall be as required.

2.25 IDENTIFICATION

A. Automatic Control Valve Tags

1. For valves, etc., use metal tags with a 2-inch minimum diameter, fabricated of brass, stainless steel or aluminum. Attach tags with chain of same materials. For lubrication instructions, use linen or heavy duty shipping tag.
2. Tag valves with identifying number and system. Number valves by floor level, column location and system served.
3. Prepare lists of all tagged valves showing location, floor level, and tag number, use. Prepare separate lists for each system. Include copies in each maintenance manual.

B. Wire Tags

1. All multi-conductor cables in all pull boxes and terminal strip cabinets shall be tagged.
2. Provide wire Tags as per Division 26.

C. Conduit Tags

1. Provide tagging or labeling of conduit so that it is always readily observable which conduit was installed or used in implementation of this Work.

D. Miscellaneous Equipment Identification

1. Screwed-on, engraved black lamicoid sheet with white lettering on all control panels and remote processing panels. Lettering sizes subject to approval.
2. Inscription, subject to review and acceptance, indicating equipment, system numbers, functions and switches. For panel interior wiring, input/output modules, local control panel device identification.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that systems are ready to receive work.

B. Beginning of installation means installer accepts existing conditions.

C. The project plans shall be thoroughly examined for control device and equipment locations, and any discrepancies, conflicts, or omissions shall be reported to the College Representative for resolution before rough-in work is started.

D. The contractor shall inspect the site to verify that equipment is installable as show, and any discrepancies, conflicts, or omissions shall be reported to the College Representative for resolution before rough-in work is started.

E. The Controls Contractor shall examine the drawings and specifications for other parts of the work, and if head room or space conditions appear inadequate or if any discrepancies occur between the plans and his work and the plans for the work of others, he shall report such discrepancies to the College Representative and shall obtain written instructions for any changes necessary to accommodate his work with the work of others.

3.2 INSTALLATION, GENERAL

A. Install routers and repeaters as required to combine different communication channels onto a central field bus or as required to segment groups of Intelligent Devices and/or Control Units.

B. Install Intelligent Control Devices, Programmable Controllers, and Application Specific Controllers as herein specified, as needed to perform functions indicated in the input/output summaries and sequences of operation, and/or indicated on the HVAC drawings.

C. Install wire, raceway systems, conduit, 24 VDC and/or 24 VAC power supplies and final connections to nodes provided by this contract. Must comply with Division 26 requirements.

D. Provide 120 VAC power to control panel locations. The controls contractor shall be fully responsible to provide all wiring (low voltage, 120 volts, etc.) and conduit (3/4” minimum or as required by electrical codes) for connection of all associated DDC sensors, panels, valves, and any other DDC components for a completely operational DDC system.

E. Install all required devices, sensors, hardware, software, wiring, controllers, etc. including any required and not specifically addressed in this specification but required for system functionality. It shall be the responsibility of the Contractor to provide a complete and functional system.

F. Install all control components in accordance with manufacturer's instructions and recommendations.

G. Mount control panels adjacent to associated equipment on vibration-free walls or freestanding angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide nameplates for instruments and controls inside cabinet and nameplates on cabinet face.

H. After completion of installation, test and adjust control equipment. Submit data showing setpoints and final adjustments of controls.

I. Install end of line resistor as necessary on BACnet MS/TP lines.

J. Install equipment, piping, wiring/conduit parallel to building lines (i.e., horizontal, vertical, and parallel to walls) wherever possible.

K. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.

L. Connect and configure equipment and software to achieve sequence of operation specified.

M. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.

N. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.

O. All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

P. Verify location of temperature, humidity and other sensors, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches above the floor.

1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.

Q. Install labels and nameplates to identify control components according to Section 230553 "Identification for HVAC Piping and Equipment."

R. Install hydronic instrument wells, valves, and other accessories according to Section 232113 "Hydronic Piping."

S. Flow Meters (Gas & Water) must be installed with the required upstream and downstream lengths with no other instrument or fitting installed within that straight length.

T. Chemical Treatment system shall be provided with MODBUS TCP/IP communication option. Refer to points list for points required to be transferred to BMS.

3.3 ELECTRICAL SYSTEM INSTALLATION

A. Comply with all Division 26 Installation Requirements.

B. Install low voltage power and LAN communication trunks in conduit in the following locations regardless of local building code allowances otherwise.

1. Mechanical rooms
2. Electrical rooms
3. Vertical risers (exception: fire rated continuous closet like a telephone closet)
4. Open Areas where the wiring will be exposed to view or tampering

C. Conceal conduit within finished shafts, ceilings and wall as required. Install exposed conduit parallel with or at right angles to the building walls and ceilings.

D. Where Class 2 wires are in concealed and accessible locations including ceiling return air plenums, approved cables not in raceway may be used provided that:

1. Circuits meet CEC Class 2 (current-limited) requirements. (Low-voltage power circuits shall be sub-fused when required to meet Class 2 current-limit.)
2. All cables shall be UL listed for application, i.e., cables used in ceiling plenums shall be UL listed specifically for that purpose.
3. Do not install Class 2 wiring in conduit containing Class 1 wiring. Boxes and panels containing high voltage may not be used for low voltage wiring except for the purpose of interfacing the two (e.g., relays and transformers).
4. Where Class 2 wiring is run exposed, wiring to be run parallel along a surface or perpendicular to it, and NEATLY tied at 3m (10 ft.) intervals minimum.

E. All wire-to-device connections shall be made at a terminal blocks or terminal strip. All wire- to-wire connections shall be at a terminal block, or with a crimped connector. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.

F. Plug or cap all unused conduit openings and stub-ups. Do not use caulking compound.

G. Route all conduit to clear beams, plates, footings and structure members. Do not route conduit through column footings or grade beams.

H. Set conduits as follows:

1. Expanding silicone fire stop material sealed watertight where conduit is run between floors and through walls of fireproof shaft.
2. Cap open ends of conduits until conductors are installed.
3. Where conduit is attached to vibrating or rotating equipment, flexible conduit with a minimum length of 18 inches and maximum length of 36 inches shall be installed and anchored in such a manner that vibration and equipment noise will not be transmitted to the rigid conduit.
4. Where exposed to the elements or in damp or wet locations, waterproof flexible conduit shall be installed. Installation shall be as specified for flexible metal conduit.

3.4 CLEANING

A. The Controls Contractor shall clean up all debris resulting from his or her activities daily. The contractor shall remove all cartons, containers, crates, etc. under his (or his subcontractors) control as soon as their contents have been removed. Waste shall be collected and placed in a location designated by the Construction Manager or General Contractor.

B. At the completion of work in any area, the Controls Contractor shall clean all of his/her work, equipment, etc., making it free from dirt and debris, etc.

C. At the completion of work, all equipment furnished under this Section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be repaired to match the adjacent areas. Any metal cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

3.5 PROTECTION

A. The Controls Contractor shall protect all work and material from damage by his/her work or workers or sub-contractors, and shall be liable for all damage thus caused.

B. The Controls Contractor shall be responsible for his/her work and equipment until finally inspected, tested, and accepted. The Controls Contractor shall protect his/her work against theft or damage, and shall carefully store material and equipment received on-site that is not immediately installed. The Controls Contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

3.6 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
2. Test and adjust controls and safeties.
3. Test each point through its full operating range to verify that safety and operating control set points are as required.
4. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
5. Test each system for compliance with sequence of operation.
6. Test software and hardware interlocks.

B. DDC Verification:

1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
2. Check instruments for proper location and accessibility.
3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
4. Check instrument tubing for proper fittings, slope, material, and support.
5. Check installation of air supply for each instrument.

6. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.
7. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
8. Check temperature instruments and material and length of sensing elements.
9. Check control valves. Verify that they are in correct direction.
10. Check air-operated dampers. Verify that pressure gages are provided and that proper blade alignment, either parallel or opposed, has been provided.
11. Check DDC system as follows:

    a. Verify that DDC controller power supply is from emergency power supply, if applicable.
    b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
    c. Verify that spare I/O capacity has been provided.
    d. Verify that DDC controllers are protected from power supply surges.

C. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.7 ADJUSTING

A. Calibrating and Adjusting:

1. Calibrate instruments.
2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
4. Control System Inputs and Outputs:

    a. Check analog inputs at 0, 50, and 100 percent of span.
    b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
    c. Check digital inputs using jumper wire.
    d. Check digital outputs using ohmmeter to test for contact making or breaking.
    e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.

5. Flow:

    a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
    b. Manually operate flow switches to verify that they make or break contact.

6. Pressure:

    a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
    b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.

7. Temperature:

    a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
    b. Calibrate temperature switches to make or break contacts.

8. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
10. Provide diagnostic and test instruments for calibration and adjustment of system.
11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature and humidity set points.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

3.8 CALIBRATION

A. The following devices shall be factory calibrated prior to installation and calibration certificates shall be provided by the manufacturer. The device will have to be field calibrated (4-20 mA of VDC signal to GUI/Trend value):

1. Water flow meters
2. Air differential pressure sensors
3. Water differential pressure sensors
4. Humidity sensors

B. The following devices shall be factory and field(4-20 mA signal to GUI/Trend value) calibrated after installation:

1. RTD temperature sensors
2. Thermistor Sensors (If it is not an offset calibration but varies with span outside of accuracy, replace the sensor)
3. Current switches
4. Air flow sensors

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls.

3.10 TRENDING

A. All points connected to BMS shall be trended. Analog points shall be trended in 15 mins intervals and all Binary points and setpoints shall be trended at change of value.

3.11 TRAINING

A. Provide a minimum of four (4) classroom training sessions, four (4) hours each, throughout the contract period for personnel designated by the College.

B. Train the College staff to enable them to proficiently operate the system; create, modify and delete programming; add, remove and modify physical points for the system, and perform routine diagnostic and troubleshooting procedures.

C. Additional training shall be available in courses designed to meet objectives as divided into three logical groupings; participants may attend one or more of these, depending on the level of knowledge required:

1. Day-to-day Operators
2. Advanced Operators
3. System Managers/Administrators

D. Provide course outline and materials as per Part 1 of this Section. The instructor(s) shall provide one copy of training material per student.

E. The instructor(s) shall be factory-trained instructors experienced in presenting this material.

F. Classroom training shall be done using a network of working controllers representative of the installed hardware or at the customer's site. This training shall be made available in addition to the interactive audio-visual tutorial, provided with the system.

3.12 ACCEPTANCE

A. The control systems will not be accepted as meeting the requirements of Completion until all tests described in this specification have been performed to the satisfaction of the College Representatives.

B. Any tests that cannot be performed due to circumstances beyond the control of the Contractor may be exempt from the Completion requirements if stated as such in writing by the College's Representative. Such tests shall then be performed as part of the warranty.

END OF SECTION 23 09 00