HAGERSTOWN COMMUNITY COLLEGE

11400 Robinwood Drive · Hagerstown, MD 21742-6514

RFP HCC26-002 for Advanced Technology Center Renovation Project

Addendum 4, posted on October 13, 2025, consists of answers to *some* of the questions received (see attachment). Noelker and Hull's document coordinating with Addendum 4 is also attached.

NOTE: If contractors do not see their question listed, the college and/or the design team is working on answering. Those questions will be answered in a forthcoming addendum.

Upcoming Deadlines:

Proposal responses must be received by **October 22, 2025, at 1:00 PM.** Offerors shall reference the RFP for submission details. Please pay careful attention to the requirement to be registered on Bid Locker to submit a proposal for this project.

Respectfully submitted,

Alicia Cullop

Alicia Cullop
Director of Procurement Services

HAGERSTOWN COMMUNITY COLLEGE RFP26-002
ADVANCED TECHNOLOGY CENTER RENOVATION
ADDENDUM 4 QUESTION & ANSWER

QUESTION #	DOCUMENT / DRAWINGS	QUESTION	ANSWER	AGENCY
1		Specification section 230923, page 9, PART 2, section 2.1 lists only Schneider Electric USA, Inc. as an acceptable building automation system provider. Would Hagerstown Community College accept Automated Logic Controls, an open-source BACnet control system, as an acceptable alternative?	Owner will only accept EcoStruxure Building Operation by Schneider Electric for control system.	HA
2		Spec, Vol 2, 23 09 23—Is there a campus wide DDC system the building will be reporting to? If so, please provide details.	Owner has a campus wide BAS that the building shall be tied into. The campus system is EcoStruxure Building Operation by Schneider Electric.	HA
3		Spec, Vol 2, 23 09 23, PART 2 2.1.A & Spec, Vol 1, 01 25 01—Spec states Schneider as the products to be used, Request to be able to bid Automated Logic under Spec, Vol 2, 23 09 23, PART 2 2.1.A Data sheets and CSI 1.5C are attached as a separate document to the email this RFI was submitted in.	Owner will only accept EcoStruxure Building Operation by Schneider Electric for control system.	HA
4		Drawing Volume 2, Sheet FA002—FA002 shows a basement plan for the Fire Alarm Graphic. There are no drawings showing devices for that floor, just the first and second. Please clarify.	The intent of the overall building plans is to provide guidelines for a graphic representation of the building to be provided at the fire department entrance. Per response to Question 13, flow and tamper switches will be provided in the basement for the existing sprinkler system.	HA
5		Drawing Volume 2, Sheet FA101—FA101 shows monitoring Flow Switches and Tamper Switches for the elevator sprinkler. Yet there is not a riser room with Flows and Tampers. Please clarify.	Fire alarm addressable modules will be added to Sheet FA002 to monitor sprinkler flow and tamper devices in Existing Mechanical 136.	HA

6		What access around existing trees will be there at South and East elevations?	Contractor and all sub-contractors shall visit the site to familiarize themselves with all project-specific conditions. There should be enough room. There is one newer tree at the corner of the parking lot. If the Contractor determines it's in the way, Contractor may remove and replace tree in-kind at Contractor's expense. There may also be potential for temporary access from the southwest corner, but will need to be coordinated with Owner. Refer to Section 024110- Selective Demolition- Site, 3.3, D and Sheet C102- Details and Notes, Root Pruning Detail for required tree pretection.	TRIAD
7		As the building is protected by a wet sprinkler system throughout, please confirm that a minimum of 40 degrees shall be maintained at all times as the system shall be filled with water.	Confirmed. Building shall be maintained at minimum 40 degrees F at all times.	HA
8		Confirm during the construction phase if the existing pendent sprinklers are to be turned from their current pendent position to that of temporary upright sprinklers to provide protection during the construction phase.	Confirmed. Sprinklers shall be turned upright during the construction phase.	HA
9		At the entrance to the building is an existing covered canopy for the sidewalk, please confirm that there is no sprinkler protection to be provided for this canopy. The existing conditions did not have this area protected.	The canopies are constructed of non-combustible materials and therefore sprinkler protection is not required.	HA
10		The existing riser has a backflow preventor and per the latest NFPA-13 requirements, a forward flow test connection is to be provided for the testing of the backflow. The contract documents do not indicate any new forward flow test connection; shall one be provided?	Yes, please provide.	HA
11		The existing sprinkler system is to remain, should an allowance be carried for any possible reworking of the sprinkler system for the new mechanical/electrical/architectural work to be completed? Should other trades anticipate working around the existing sprinkler system?	An allowance shall be carried. Per the notes on the Fire Protection drawings, all sprinklers shall be replaced and branch piping shall be replaced/relocated as required.	HA
12		As this system is an existing sprinkler system that is to remain, it is highly recommended that a pre-work hydrostatic test is provided to verify the integrity of the sprinkler system and to determine the extent of the pressure loss on the system prior to any work occurring. Should this cost be provided as part of the fire sprinkler proposal pricing?	Provide this cost.	HA

13		As a large portion of the project is shown to have floating acoustical ceiling clouds, verify the intent is that both above and below protection for the sprinkler system is to be provided in all of the areas with the floating cloud ceilings.	Where required by NFPA 13, sprinkler coverage shall be provided above and below cloud ceilings.	HA
14		DWG/spec M-801—Please provide connection detail for Fan Powered Boxes on M-801.	See “Single Coil Piping – 3 Way Control Valve” Detail for coil connection to fan powered boxes.	HA
15		DWG/spec M-502—Please confirm DOAS-1 has 2 chilled water coils.	The DOAS-1 has (1) chilled water coil.	HA
16		DWG/spec P-501—Please specify materials for existing to remain systems we are connecting to: below-grade Sanitary and Storm, above-grade Domestic Water, Sanitary, Storm, Chilled Water, and Heating Water.	Contractor to field verify existing to remain pipe materials. Material for all new piping shall be per contract specification. Provide dielectric or transition fittings at connections to dissimilar materials.	HA
17		DWG/spec P-501—Are Trap Guards (or similar) acceptable in lieu of Trap Primers in any locations? Or Applications?	Trap guards are not permitted.	HA
18		L100/Note 5 says the proposed sculpture is to be determined by the owner. Should the GC include an allowance cost for furnish or installation of the scuplture?	Responded to in Addendum 3.	H&R
19		L100 & L101 show decorative boulders throughout the site plan, no dimensions or type is provided for these boulders in spec or plan view. Please provide boulder details.	Responded to in Addendum 3.	H&R
20		Note 14 & 17 on D101-D104 both are listed as Remove Countertop And/Or Casework In Its Entirety. Please remove additional note listed on demo plans.	Responded to in Addendum 3.	NHA
21		075423.2.03 - Please consider substitution request for Sika Plan 60 TPO roofing Membrane. (see attached)	Proposed substitute is acceptable with submitted request form.	NHA
22		086300 – Metal-Framed Skylights: What is the true size of the skylights? Plan D104 shows cutting the roof openings at 11’-6” x 10’-8” and plan S305 (sections 2 & 3) scale the opening portion as 11’-6” x 10’-6 ½”. Which is correct? The spec does not address size.	Use Architectural Plan D104 for called out dimensions and do not scale drawings.	NHA
23		We would like to submit a substitution request form for Corona Group's Elements Porcelain Boards and Tackboards in the 101100 Visual Display Units Section of the specification.	Proposed substitute is acceptable with submitted request form.	NHA
24		Sheet ID201 shows GL. CAB in MECH/ENG/TECH LAB RM120 and CORR and FLAM Cabinets in STORAGE RM120A. Clarify if they are not in our scope and we are only providing the lab casework and resin tops shown on elevations in the lab areas. Would this mean we do not have any of the student lab table and chairs that are not shown in the elevations?	Responded to in Addendum 3.	NHA

25		Exterior Building Plans A401 & A402: We are unable to determine what some of the wall panels identified in the “Panel Façade Systems” Chart compared to the Building Elevations. The slight difference in colors between the types along with the shadowing added to the elevations makes it extremely difficult to determine what the types are on the elevations. Also, the elevations are not type specific in name per the schedule, and you must rely on the coloring. Please identify each type on the elevations to match the panel name type (AP-1, AP-2, AP-3, AP-4, SP-1, CP-2, SP-1) so it is clear where each type is located.	See new Sheets A401A and A402B clarifying panel facde designations.	NHA
26		Fire Drawings—The symbol of a hollow circle with a hollow triangle has no description in the legend. Is this a fire speaker only? There is no exterior horn strobe indicated at the FDC. This is required by code.	Yes, this is a loudspeaker only.	HA
27		Fire drawing FA102: Rooms 210, 211, 212, 213 all appear to have a speaker and speaker/strobe in each room, which would be excessive. Please verify notification device requirements for these rooms.	Concur. Drawings will be revised to eliminate excessive loudspeakers.	HA
28		Fire drawing FA002: Fire alarm graphic map shows a basement floorplan, but there are no drawings for a basement. Please clarify.	Please refer to response to Q12. Fire alarm addressable modules will be added to sheet FA002 to monitor sprinkler flow and tamper devices in Existing Mechanical 136.	HA
29		Division 28 Physical Security Systems—Part 2 Products – 2.1 Camera Specs – Both Panasonic and Axis cameras are mentioned in the specs. Which is correct?	Updated Specs and Drawings will delete Section 281000- Physical Security Systems in it's entirety from the Scope of Work. Owner will provide the Security Camera System under a separate procurement contract. The Contractor shall provide an empty conduit system for the Owner's camera system per spec Section 275800- Conduit and Backboxes for Communications Systems and related drawings. Contractor shall be responsible for coordination.	WE

30		Drawing T001 – per the security legend all camera icons are to be numbered but none of the ones on the drawing are. Please number all cameras per the Technology Legend.	Updated Specs and Drawings will delete Section 281000- Physical Security Systems in it's entirety from the Scope of Work. Owner will provide the Security Camera System under a separate procurement contract. The Contractor shall provide an empty conduit system for the Owner's camera system per spec Section 275800- Conduit and Backboxes for Communications Systems and related drawings. Contractor shall be responsible for coordination.	WE
31		Drawing T003 – please identify camera symbol CX and provide specifications and requirements for it.	Updated Specs and Drawings will delete Section 281000- Physical Security Systems in it's entirety from the Scope of Work. Owner will provide the Security Camera System under a separate procurement contract. The Contractor shall provide an empty conduit system for the Owner's camera system per spec Section 275800- Conduit and Backboxes for Communications Systems and related drawings. Contractor shall be responsible for coordination.	WE

32		Drawing T202 – please identify camera symbol FE and provide specifications and requirements for it.	Updated Specs and Drawings will delete Section 281000- Physical Security Systems in it's entirety from the Scope of Work. Owner will provide the Security Camera System under a separate procurement contract. The Contractor shall provide an empty conduit system for the Owner's camera system per spec Section 275800- Conduit and Backboxes for Communications Systems and related drawings. Contractor shall be responsible for coordination.	WE
33		Drawing T202 – please identify symbol LED and provide specifications and requirements for it.	Updated Specs and Drawings will delete Valcom Emergency Communications Systems LED Displays from the Scope of Work. Owner will provide the Valcom LED Emergency Display and Speaker Mass Notification System under a separate procurement contract. The Contractor shall provide an empty conduit system for the Owner's camera system per spec Section 275800- Conduit and Backboxes for Communications Systems and related drawings. Contractor shall be responsible for coordination.	WE

34		Drawing T202 – please identify symbol S and provide specifications and requirements for it.	Updated Specs and Drawings will delete Valcom Emergency Communications Systems LED Displays from the Scope of Work. Owner will provide the Valcom LED Emergency Display and Speaker Mass Notification System under a separate procurement contract. The Contractor shall provide an empty conduit system for the Owner's camera system per spec Section 275800- Conduit and Backboxes for Communications Systems and related drawings. Contractor shall be responsible for coordination.	WE
35		Drawing T202 – please identify camera symbol 360 and provide specifications and requirements for it.	Updated Specs and Drawings will delete Section 281000- Physical Security Systems in it's entirety from the Scope of Work. Owner will provide the Security Camera System under a separate procurement contract. The Contractor shall provide an empty conduit system for the Owner's camera system per spec Section 275800- Conduit and Backboxes for Communications Systems and related drawings. Contractor shall be responsible for coordination.	WE

36		Drawing T203 – please identify camera symbol FE and provide specifications and requirements for it.	Updated Specs and Drawings will delete Section 281000- Physical Security Systems in it's entirety from the Scope of Work. Owner will provide the Security Camera System under a separate procurement contract. The Contractor shall provide an empty conduit system for the Owner's camera system per spec Section 275800- Conduit and Backboxes for Communications Systems and related drawings. Contractor shall be responsible for coordination.	WE
37		Drawing T203 – please identify symbol LED and provide specifications and requirements for it.	Updated Specs and Drawings will delete Valcom Emergency Communications Systems LED Displays from the Scope of Work. Owner will provide the Valcom LED Emergency Display and Speaker Mass Notification System under a separate procurement contract. The Contractor shall provide an empty conduit system for the Owner's camera system per spec Section 275800- Conduit and Backboxes for Communications Systems and related drawings. Contractor shall be responsible for coordination.	WE

38		Drawing T203 – please identify symbol S and provide specifications and requirements for it.	Updated Specs and Drawings will delete Valcom Emergency Communications Systems LED Displays from the Scope of Work. Owner will provide the Valcom LED Emergency Display and Speaker Mass Notification System under a separate procurement contract. The Contractor shall provide an empty conduit system for the Owner's camera system per spec Section 275800- Conduit and Backboxes for Communications Systems and related drawings. Contractor shall be responsible for coordination.	WE
39		Drawing T203 – please identify camera symbol 360 and provide specifications and requirements for it.	Updated Specs and Drawings will delete Section 281000- Physical Security Systems in it's entirety from the Scope of Work. Owner will provide the Security Camera System under a separate procurement contract. The Contractor shall provide an empty conduit system for the Owner's camera system per spec Section 275800- Conduit and Backboxes for Communications Systems and related drawings. Contractor shall be responsible for coordination.	WE

40		Drawing T504 – please provide camera schedule identifying wall or ceiling mounting for each camera.	Updated Specs and Drawings will delete Section 281000- Physical Security Systems in it's entirety from the Scope of Work. Owner will provide the Security Camera System under a separate procurement contract. The Contractor shall provide an empty conduit system for the Owner's camera system per spec Section 275800- Conduit and Backboxes for Communications Systems and related drawings. Contractor shall be responsible for coordination.	WE
41		281000.2.1.A - Please clarify “1 Genetec SMA or 5 Year Enterprise Camera License” which is not a valid Genetec license. Does that mean 1 Enterprise Camera License with 5-Year SMA so something else.	Updated Specs and Drawings will delete Section 281000- Physical Security Systems in it's entirety from the Scope of Work. Owner will provide the Security Camera System under a separate procurement contract. The Contractor shall provide an empty conduit system for the Owner's camera system per spec Section 275800- Conduit and Backboxes for Communications Systems and related drawings. Contractor shall be responsible for coordination.	WE

42		281000.2.1.A - Please clarify Failover connection requirements – Genetec versions 5.1 and above include failover connections at no cost. Please confirm the system requires Failover licenses.	Updated Specs and Drawings will delete Section 281000- Physical Security Systems in it's entirety from the Scope of Work. Owner will provide the Security Camera System under a separate procurement contract. The Contractor shall provide an empty conduit system for the Owner's camera system per spec Section 275800- Conduit and Backboxes for Communications Systems and related drawings. Contractor shall be responsible for coordination.	WE
43		281000.2.1.A - please provide the SLA and preventative maintenance requirements including OS and Genetec patching, software and firmware upgrades, etc. for the 1-year warranty to ensure all bidders meet the warranty requirements.	Updated Specs and Drawings will delete Section 281000- Physical Security Systems in it's entirety from the Scope of Work. Owner will provide the Security Camera System under a separate procurement contract. The Contractor shall provide an empty conduit system for the Owner's camera system per spec Section 275800- Conduit and Backboxes for Communications Systems and related drawings. Contractor shall be responsible for coordination.	WE

44		281000.2.1.A.1 Please provide Hagerstown Community College’s Genetec System ID so the correct co-term is priced out.	Updated Specs and Drawings will delete Section 281000- Physical Security Systems in it's entirety from the Scope of Work. Owner will provide the Security Camera System under a separate procurement contract. The Contractor shall provide an empty conduit system for the Owner's camera system per spec Section 275800- Conduit and Backboxes for Communications Systems and related drawings. Contractor shall be responsible for coordination.	WE
45		281000.2.1.A.1 Panasonic was rebranded as i-PRO. Please confirm the cameras must be i-PRO.	Updated Specs and Drawings will delete Section 281000- Physical Security Systems in it's entirety from the Scope of Work. Owner will provide the Security Camera System under a separate procurement contract. The Contractor shall provide an empty conduit system for the Owner's camera system per spec Section 275800- Conduit and Backboxes for Communications Systems and related drawings. Contractor shall be responsible for coordination.	WE

46		281000.2.1.A.2 – Please clarify, there are conflicting requirements stating all cameras must be Panasonic while stating the contractor to determine which Axis camera to be installed.	Updated Specs and Drawings will delete Section 281000- Physical Security Systems in it's entirety from the Scope of Work. Owner will provide the Security Camera System under a separate procurement contract. The Contractor shall provide an empty conduit system for the Owner's camera system per spec Section 275800- Conduit and Backboxes for Communications Systems and related drawings. Contractor shall be responsible for coordination.	WE
47		281000.2.1.A.2 - i-PRO and Axis have several series of 5MP cameras with significant differences in performance and costs. Please provide approved models or series of cameras to ensure proposed cameras match current Hagerstown Community College surveillance standards.	Updated Specs and Drawings will delete Section 281000- Physical Security Systems in it's entirety from the Scope of Work. Owner will provide the Security Camera System under a separate procurement contract. The Contractor shall provide an empty conduit system for the Owner's camera system per spec Section 275800- Conduit and Backboxes for Communications Systems and related drawings. Contractor shall be responsible for coordination.	WE

48		281000.2.1.A.2 - Please provide clear and measurable specifications to quantify “optimum video surveillance”. Without clear specifications, the lowest cost 5MP camera can be considered to provide optimum video surveillance.	Updated Specs and Drawings will delete Section 281000- Physical Security Systems in it's entirety from the Scope of Work. Owner will provide the Security Camera System under a separate procurement contract. The Contractor shall provide an empty conduit system for the Owner's camera system per spec Section 275800- Conduit and Backboxes for Communications Systems and related drawings. Contractor shall be responsible for coordination.	WE
49		281000.2.1.A.3 - Please clarify the cameras at each location must be PTZ or fixed cameras. PTZ cameras cost about five times more than fixed cameras and without clear requirements, fixed cameras can be considered to provide optimum video surveillance.	Updated Specs and Drawings will delete Section 281000- Physical Security Systems in it's entirety from the Scope of Work. Owner will provide the Security Camera System under a separate procurement contract. The Contractor shall provide an empty conduit system for the Owner's camera system per spec Section 275800- Conduit and Backboxes for Communications Systems and related drawings. Contractor shall be responsible for coordination.	WE

50		281000.2.1.A.3 - the requirements state to provide “complete and operation security camera system” Does that mean to be completely independent and stand-alone system from the rest of the campus Genetec System? If it needs to be integrated into the existing campus Genetec system, it will not be a complete system.	Updated Specs and Drawings will delete Section 281000- Physical Security Systems in it's entirety from the Scope of Work. Owner will provide the Security Camera System under a separate procurement contract. The Contractor shall provide an empty conduit system for the Owner's camera system per spec Section 275800- Conduit and Backboxes for Communications Systems and related drawings. Contractor shall be responsible for coordination.	WE
51		281000.2.1.B - There are conflicting requirements – “Size each server to server 100% of all cameras (including cameras in alternate) recording continuously 24/7 with 30 days of storage plus 20%s pare capacity for future cameras” and provide “70 TB servers” which is the correct specification?	Updated Specs and Drawings will delete Section 281000- Physical Security Systems in it's entirety from the Scope of Work. Owner will provide the Security Camera System under a separate procurement contract. The Contractor shall provide an empty conduit system for the Owner's camera system per spec Section 275800- Conduit and Backboxes for Communications Systems and related drawings. Contractor shall be responsible for coordination.	WE

52		281000.2.1.B - Please clarify “TWO Genetec StreamVault 1000 Series rackmount appliance & 70 TB storage servers” - Does that mean two Streamvault appliances and two 70TB storage servers or two 70TB Streamvault 1000 series appliances?	Updated Specs and Drawings will delete Section 281000- Physical Security Systems in it's entirety from the Scope of Work. Owner will provide the Security Camera System under a separate procurement contract. The Contractor shall provide an empty conduit system for the Owner's camera system per spec Section 275800- Conduit and Backboxes for Communications Systems and related drawings. Contractor shall be responsible for coordination.	WE
53		281000.2.1.B - If the requirement is to provide two 70TB Streamvault 1000 series appliances, the maximum storage available with the current Genetec Streamvault 1000 series appliances is 48TB. If 70TB per appliance is required, please specify if Streamvault 2000 or 4000 series appliances should be included.	Updated Specs and Drawings will delete Section 281000- Physical Security Systems in it's entirety from the Scope of Work. Owner will provide the Security Camera System under a separate procurement contract. The Contractor shall provide an empty conduit system for the Owner's camera system per spec Section 275800- Conduit and Backboxes for Communications Systems and related drawings. Contractor shall be responsible for coordination.	WE

54		281000.2.1.B - Please provide the level of hardware redundancy required for the Streamvault appliances.	Updated Specs and Drawings will delete Section 281000- Physical Security Systems in it's entirety from the Scope of Work. Owner will provide the Security Camera System under a separate procurement contract. The Contractor shall provide an empty conduit system for the Owner's camera system per spec Section 275800- Conduit and Backboxes for Communications Systems and related drawings. Contractor shall be responsible for coordination.	WE
55		281000.2.1.A – Please clarify, there are conflicting requirements stating all cameras must be Panasonic while stating the contractor to determine which Axis camera to be installed.	Updated Specs and Drawings will delete Section 281000- Physical Security Systems in it's entirety from the Scope of Work. Owner will provide the Security Camera System under a separate procurement contract. The Contractor shall provide an empty conduit system for the Owner's camera system per spec Section 275800- Conduit and Backboxes for Communications Systems and related drawings. Contractor shall be responsible for coordination.	WE
56		Is the glazing package being bid separately due to size? Potentially saving the county hundreds of thousands.	No. GC to bid as part of Base Bid.	NHA

57		Is the TBD - HDMI Plate at digital signage locations 106 & 110 (called out on TA805) to be owner-provided? If it is to be contractor-provided, please provide a part number or product information.	Updated Specs and Drawings will delete Section 274100- Audio Visual Systems in it's entirety from the Scope of Work. Owner will provide the Audio Visual System under a separate procurement contract. The Contractor shall provide an empty conduit system for the Owner's camera system per spec Section 275800- Conduit and Backboxes for Communications Systems and related drawings. Contractor shall be responsible for coordination.	WE
58		Is the TBD Digital Signage Player called out on TA805 to be owner-provided? If it is to be contractor-provided, please provide a part number or product information.	Updated Specs and Drawings will delete Section 274100- Audio Visual Systems in it's entirety from the Scope of Work. Owner will provide the Audio Visual System under a separate procurement contract. The Contractor shall provide an empty conduit system for the Owner's camera system per spec Section 275800- Conduit and Backboxes for Communications Systems and related drawings. Contractor shall be responsible for coordination.	WE
59		The smart lectern on TA801 Bill of Materials is listed as OFE. Is the Spectrum ADA Smart Lectern on TA804 also to be owner-provided?	Updated Specs and Drawings will delete Section 274100- Audio Visual Systems in it's entirety from the Scope of Work. Owner will provide the Audio Visual System under a separate procurement contract. The Contractor shall provide an empty conduit system for the Owner's camera system per spec Section 275800- Conduit and Backboxes for Communications Systems and related drawings. Contractor shall be responsible for coordination.	WE

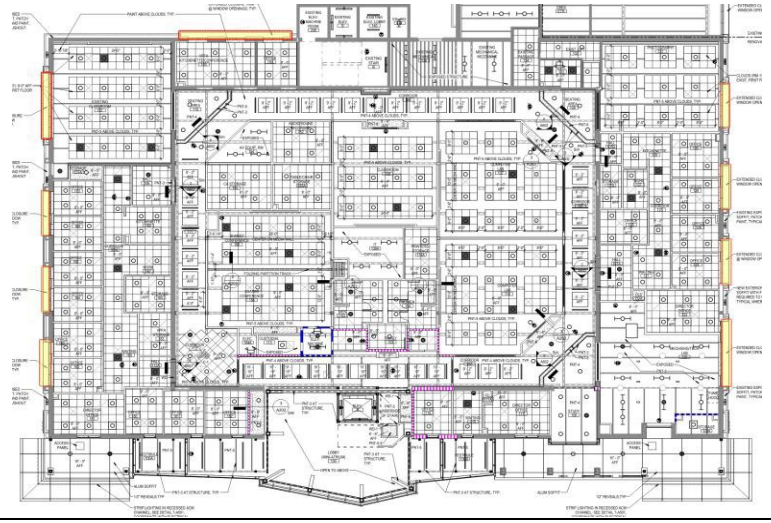
60		The LG 75UH5J-H appears to have been discontinued by LG. Please provide an acceptable substitution.	Updated Specs and Drawings will delete Section 274100- Audio Visual Systems in it's entirety from the Scope of Work. Owner will provide the Audio Visual System under a separate procurement contract. The Contractor shall provide an empty conduit system for the Owner's camera system per spec Section 275800- Conduit and Backboxes for Communications Systems and related drawings. Contractor shall be responsible for coordination.	WE
61	DIV27 270000-2, 1.4 Intent of Drawing, E.2	The above specification limits DIV27 bidders to Certified Berk-Tek/Leviton contractors only. Is the customer open to 25YR manufacturer solutions that are equal to those specified? G Tech would quote a 25YR Hubbell Premise Network solution, fully equal is quality and performance of the Berk-Tek Leviton solution.	Updated Specs and Drawings will delete Section 275100- Communications Horizontal Cabling in it's entirety from the Scope of Work. Owner will provide the Communications Cabling System under a separate procurement contract. The Contractor shall provide an empty conduit system for the Owner's camera system per spec Section 275800- Conduit and Backboxes for Communications Systems and related drawings. Contractor shall be responsible for coordination.	WE
62		I had a couple of different construction companies reach out about this project, but the specs for Division 12 do not include items like the office furniture, classroom furniture, lounge, kitchenette, and computer labs. Do you know if HCC is purchasing these items direct or going through the A/D Firm? If not, can you point me in the right direction?	This is a state project, so furniture must be purchased by the college through MCE.	HCC
63		Door 138 is shown on the door schedule as being only 4’4-7/32” tall. Advise correct door height for this opening.	Responded to in Addendum 3.	NHA
64		Is the Cx scope only for HVAC/Plumbing at this point? Or electrical services as well ?	Commissioning is required for lighting controls.	HA

65		What is the projected project start and completion date?	The projected start date is January 5, 2026 with a completion date of May 7, 2027. This is subject to change based on how long it takes for the state to approve the project award. Construction contract will be calculated for completion 487 days once contractor mobilizes.	HCC
66		DWG/spec P-101, P-602— Is a cleanout fitting required at base of Storm Stack shown in Lower Mech Room?	Yes, See Spec Section 221319 paragraph 3.1.B.	HA
67		DWG/spec P-101, P-602, P-401(3)— Is a cleanout fitting required at base of Sanitary Stack shown in Lower Mech Room?	Yes, See Spec Section 221423 paragraph 3.1.C.	HA
68		DWG/spec P-401— Please provide location for trap primer and cold water connection to serve 4" FD-2 on P-401 detail 3.	Provide Type A trap primer. Mount on wall in Mechanical Room. Supply from nearest cold water line.	HA
69		DWG/spec P-101, P-602— Please confirm intent is to wet vent the 3" FD-1 and P-5 in room 113.	No, this sanitary/vent piping will be corrected in forthcoming addendum.	HA
70		DWG/spec 221519— Please provide connection detail for AC-1 Air Compressor.	We will provide a detail in forthcoming Addendum.	HA
71		Please clarify if there is a specific timeframe or duration for the reroofing work of CBES to occur.	No specific timeframe or duration other than what is required in the specifications. Contractor's means and methods.	NHA
72		Please confirm who is responsible for cost associated with the building permit and inspections.	Responded to in Addendum 3.	NHA
73		Please clarify if 29% M/WBE is a goal or requirement associated with the contracted amount.	It is a goal. If the GC is not going to meet this goal, please provide information in your minority participation plan outlining the percentage goal you plan to meet and the good faith effort you made to achieve the 29% goal.	HCC
74		Please confirm what agencies/certifications are recognized for inclusion with M/WBE participation.	The Maryland Minority Business Enterprise (MBE) program website details MBE eligibility at https://purchase.umd.edu/supplier-resources/business-inclusion-supplier-diversity/mbe-program.	HCC
75		Provide specification/type/size for boulders to provided as part of this project.	Responded to in Addendum 3.	H&R

76		Please confirm that 487 day duration is from contractor mobilization and not from notice to proceed.	Correct. The contract will be 487 days from contractor mobilization.	HCC
77		Please provide anticipated date for notice to proceed.	The anticipated date is December 19, 2025. This is dependent on approval by BPW at one of their December meetings.	HCC
78		Please confirm temporary electric and water will be provided by the Owner with metering and usage fees by the GC.	Responded to in Addendum 3.	NHA
79		Please confirm background checks are not required as part of this project.	This is correct per clarification provided in Addendum 1.	HCC
80		Can you confirm the camera manufacture that you would like to be quoted. It is stated that Panasonic cameras are a must, and then then successful contractor will determine which Axis camera are to be installed. Please clarify.	Updated Specs and Drawings will delete Section 281000- Physical Security Systems in it's entirety from the Scope of Work. Owner will provide the Security Camera System under a separate procurement contract. The Contractor shall provide an empty conduit system for the Owner's camera system per spec Section 275800- Conduit and Backboxes for Communications Systems and related drawings. Contractor shall be responsible for coordination.	WE
81		Can you specify camera model types in more detail. Prints show FE and 360 yet there is no camera schedule to cross reference.	Updated Specs and Drawings will delete Section 281000- Physical Security Systems in it's entirety from the Scope of Work. Owner will provide the Security Camera System under a separate procurement contract. The Contractor shall provide an empty conduit system for the Owner's camera system per spec Section 275800- Conduit and Backboxes for Communications Systems and related drawings. Contractor shall be responsible for coordination.	WE

82		Are the two Genetec Streamvault Servers for this project only for this Renovation and not for anywhere else on campus?	Updated Specs and Drawings will delete Section 281000- Physical Security Systems in it's entirety from the Scope of Work. Owner will provide the Security Camera System under a separate procurement contract. The Contractor shall provide an empty conduit system for the Owner's camera system per spec Section 275800- Conduit and Backboxes for Communications Systems and related drawings. Contractor shall be responsible for coordination.	WE
83		Is Failover for Archiver only or for Directory as well?	Updated Specs and Drawings will delete Section 281000- Physical Security Systems in it's entirety from the Scope of Work. Owner will provide the Security Camera System under a separate procurement contract. The Contractor shall provide an empty conduit system for the Owner's camera system per spec Section 275800- Conduit and Backboxes for Communications Systems and related drawings. Contractor shall be responsible for coordination.	WE
84		Intrusion - it calls out for IDS system to call to County 911, it a direct communication or through a monitoring system.	Updated Specs and Drawings will delete section 281000- Physical Security Systems in it's entirety from the Scope of Work. The Security Alarm System is deleted form the scope of work.	WE
85		Is there a current IDS panel in place in the building or is this net new? If so, can do an approved equal?	Updated Specs and Drawings will delete section 281000- Physical Security Systems in it's entirety from the Scope of Work. The Security Alarm System is deleted form the scope of work.	WE

86		IDS is not shown on drawings but listed in Specifications – Div. 28 Physical Security Systems. Please confirm to include the IDS.	Updated Specs and Drawings will delete section 281000- Physical Security Systems in it's entirety from the Scope of Work. The Security Alarm System is deleted form the Scope of Work.	WE
87		Section 011000-2, Item 1.09B: At the pre-bid meeting it was indicated that background check was not required. Please review item 1.09B and confirm that background check for all employees is required.	Per Addendum 1, background checks will not be required.	HCC
88		Testing & Inspections: Please review specifications and drawing S-100 and confirm that Owner will employ a Third Party for Special Testing and Inspections, see Tables on S100.	Responded to in Addendum 3.	NHA
89		Section 015000 Temporary Utilities: Please review and confirm that GC is responsible for the consumption cost of electrical power, lighting, water, heating and cooling per section 01500 and 015100.	Responded to in Addendum 3.	NHA
90		The existing feature stair that is located in the main lobby currently does not have sprinkler protection located underneath the stairs, please confirm that existing condition shall remain.	Sprinkler protection shall be provided as required by NFPA-13.	HA
91		The RFP and Addendum #1 list the subcontractors to provide a license (if required by trade). Please confirm that only trade licenses are to be submitted with bid.	This is correct.	HCC
92		RFP insurance requirements differ from the ones listed in the Spec section 000350/3.7. Please confirm which are to be carried. If the RFP insurance requirements are to be carried, Do these requirements only pertain to the general contractor? The $1,000,000 Fire Insurance and $10,000,000 each occurrence in commercial umbrella are at times hard to obtain by smaller subcontractors.	The insurance requirements listed in the RFP are correct. They pertain to the general contractor, not subcontractors.	HCC
93		Please provide core test for existing roofing where demo is occurring to properly assume demo cost.	No core testing is available.	NHA
94		We would like to inquire if a rooftop PV system can be an alternative for BIPV if the BIPV is deducted from your bid. Rooftop PV will be a much more cost-effective means of benefiting from solar energy and for the cost of the small BIPV system, a large rooftop PV system could be substituted. If so, we can propose a system based on the available roof space as the current roof design should have enough PSF allowance to support the PV system.	No. Existing roof cannot structurally support any additional load.	NHA
95	A402	Can you detail the material callouts more clearly? Perhaps material tags on elevation sheet A402? It is confusing as there are similar gray colors calling out multiple materials/colors (such as AP-2 and CP-1). Please clarify or provide marked up drawings.	See new Sheets A401A and A402B clarifying panel facde designations.	NHA

96	A202	Will the window head returns shown on A202 (The clouded areas in the snip below) be integrated ACM or just a standard flashing? The Manufacturer recommends ACM fascia return to soffit at these locations with cloud for a clean look. Please clarify. 	Yes, soffit and fascia returns shall be integrated with the panel system.	NHA
97		Can we substitute schedule 40 PVC in leu of the spec'd service weight cast iron for any underground sanitary and storm piping? (see attached PDF)	PVC is not permitted. Provide cast iron per contract specifications.	HA
98		Can Pro Press (Copper waterlines and hydronic piping) and Mega press for steel piping can be accepted? (See attached PDF)	Press fittings are not permitted. Provide fittings/joints per contract specifications.	HA
99		Please provide clarification on what is owner responsibility & GC responsibility related to the Division 27 – Communications scope. Was stated in pre-bid meeting that we would only have raceways & boxes, and the meeting notes only say that this information will be forthcoming.	Updated Specs and Drawings will delete Section 275100- Communications Horizontal Cabling in it's entirety from the Scope of Work. Owner will provide the Communications Cabling System under a separate procurement contract. The Contractor shall provide an empty conduit system for the Owner's camera system per spec Section 275800- Conduit and Backboxes for Communications Systems and related drawings. Contractor shall be responsible for coordination.	WE

100	Div 1	Are Clarifications allowed as a part of the general contractors proposal submission? If permitted, please advise which section of the proposal these may be included.	There is a spot for contractors to write on Attachment A any exceptions taken. The college will have the right to accept or reject those exceptions which could ultimately affect scoring or shortlist determination.	HCC
101	Div 1	Please confirm the project work hours to be assumed for all work, to include noisy work and utility shutdowns.	Responded to in Addendum 3.	NHA
102	Div 1	Please advise if bonding or Subcontractor Default Insurance will be required for subcontractors, or if that will be at the discretion of the GC.	The college will not require bonding or default insurance from subcontractors. This can be at the discretion of the GC.	HCC
103	RFP	Reference RFP Section 2.10 and Section 2.14 - please confirm proposal validity to be 150 calendar days from the date and time designated for receipt of proposals per Section 2.14 in lieu of 150 days from award as stated in Section 2.10.	Proposal validity shall be 150 calendar days from the bid due date.	HCC
104	Div 1, 014533	Reference Section 014533 Code-Required Special Inspections - please confirm if the Contractor or Owner will be responsible and should include the costs for Special Inspections.	Responded to in Addendum 3.	NHA
105	Div 10, 012100	Reference RFP Section 6/Part 5C Allowances and 012100 Allowances/1.03 Allowance Schedule - The Allowances specification lists Allowance No. 3 for Project Identification Sign, which is not included in the RFP Price Proposal Form. Please advise if this allowance is to be included. If so, please adjust the Price Proposal Form.	Responded to in Addendum 3.	NHA
106	A401/A402	The shading legend used to identify the multiple façade elements on Sheets A401/A402 are very similar to each other which makes it difficult to identify which systems are going where. Can the panel façade elements be tagged on the drawing and/or can the colors within the legend be changed to help more clearly identify where each panel system is to be included?	See new Sheets A401A and A402B clarifying panel facde designations.	NHA
107	Div 32, L100	Please provide specification for boulders dimension/weight.	Responded to in Addendum 3.	H&R
108	Div 32, L100	Please provide detail on how to level the boulders that are shown straddling the river rock/paved areas.	See revised Sheet L-100- Landscape Plan.	H&R

109		Can you confirm the camera manufacture that you would like to be quoted. It is stated that Panasonic cameras are a must, and then then successful contractor will determine which Axis camera are to be installed. Please clarify.	Updated Specs and Drawings will delete Section 281000- Physical Security Systems in it's entirety from the Scope of Work. Owner will provide the Security Camera System under a separate procurement contract. The Contractor shall provide an empty conduit system for the Owner's camera system per spec Section 275800- Conduit and Backboxes for Communications Systems and related drawings. Contractor shall be responsible for coordination.	WE
110		Can you specify camera model types in more detail. Prints show FE and 360 yet there is no camera schedule to cross refence.	Updated Specs and Drawings will delete Section 281000- Physical Security Systems in it's entirety from the Scope of Work. Owner will provide the Security Camera System under a separate procurement contract. The Contractor shall provide an empty conduit system for the Owner's camera system per spec Section 275800- Conduit and Backboxes for Communications Systems and related drawings. Contractor shall be responsible for coordination.	WE
111		Are the two Genetec Streamvault Servers for this project only for this Renovation and not for anywhere else on campus?	Updated Specs and Drawings will delete Section 281000- Physical Security Systems in it's entirety from the Scope of Work. Owner will provide the Security Camera System under a separate procurement contract. The Contractor shall provide an empty conduit system for the Owner's camera system per spec Section 275800- Conduit and Backboxes for Communications Systems and related drawings. Contractor shall be responsible for coordination.	WE

112		Is Failover for Archiver only or for Directory as well?	Updated Specs and Drawings will delete Section 281000- Physical Security Systems in it's entirety from the Scope of Work. Owner will provide the Security Camera System under a separate procurement contract. The Contractor shall provide an empty conduit system for the Owner's camera system per spec Section 275800- Conduit and Backboxes for Communications Systems and related drawings. Contractor shall be responsible for coordination.	WE
113		Intrusion - it calls out for IDS system to call to County 911, it a direct communication or through a monitoring system.	Updated Specs and Drawings will delete Section- 281000 Physical Security Systems in it's entirety from the Scope of Work. The Security Alarm System is deleted form the Scope of Work.	WE
114		Is there a current IDS panel in place in the building or is this net new? If so, can do an approved equal?	Updated Specs and Drawings will delete Section- 281000 Physical Security Systems in it's entirety from the Scope of Work. The Security Alarm System is deleted form the Scope of Work.	WE
115		IDS is not shown on drawings but listed in Specifications – Div. 28 Physical Security Systems. Please confirm the IDS.	Updated Specs and Drawings will delete Section- 281000 Physical Security Systems in it's entirety from the Scope of Work. The Security Alarm System is deleted form the Scope of Work.	WE
116		from prebid mtg: confirm electrical and water will be provided by HCC but should be metered and will be paid for by GC.	Responded to in Addendum 3.	NHA
117		from prebid mtg: work hours were stated as 830am-430pm. Typically subcontractors would like to work 7am-3pm. Please confirm if work hours are flexible.	Responded to in Addendum 3.	NHA

118		28.10.00 - Physical Security Systems Specs indicate two pre-qualified security contractors and mentions "or approved equal". Please confirm if any Genetec authorized Vendor is acceptable.	Updated Specs and Drawings will delete Section 281000- Physical Security Systems in it's entirety from the Scope of Work. Owner will provide the Security Camera System under a separate procurement contract. The Contractor shall provide an empty conduit system for the Owner's camera system per spec Section 275800- Conduit and Backboxes for Communications Systems and related drawings. Contractor shall be responsible for coordination.	WE
119		Light Fixture "L1" on the luminaire schedule indicates this fixture is to be 48" in length. The lighting drawings indicate "L1" of varying lengths. Please clarify if the "L1" is to be 48" at each location or if it is to be included as the length of fixture measured on the drawings.	L1 is to be included as the length of the fixture measured on the drwawings. Luminaire schedule on sheet E801 will be revised to reflect this.	HA
120		from prebid mtg: Please confirm all 3rd party testing will be by GC and not owner.	Responded to in Addendum 3.	NHA
121		from prebid mtg: Please confirm there will be no scope associated with the existing elevator.	Confirmed.	NHA
122		from prbid mtg: Please confirm the industrial hygentist should be by the GC and not owner.	Confirmed.	NHA
123		from prebid mtg: Please confirm the commissioning agent will be by the GC and not owner.	Confirmed.	NHA
124		Subcontractors are requesting a fillable AIA305 form be provided by the owner as we unable to give them a copy without it being watermarked as a draft.	In lieu of the AIA A305 form from subcontractors required by shortlisted GC's, subcontractors may list information in PDF format to include experience on 3-5 relevant projects.	HCC
125		Please confirm sub-limits and deductibles associated with the Owner’s Builders Risk (can a copy of the policy be provided for review?). Additionally, who is responsible for the deductible if required?	The college will hold the builder's risk policy and be responsible for the deductible if required. We will attempt to get a quote with sample policy information, however, this cannot be finalized until we have an awarded GC, awarded construction cost, and official start date for the project.	HCC

NOELKER AND HULL ASSOCIATES, INC.

ARCHITECTS

ADDENDUM NO. 4

Date: October 10, 2025 **Project No.:** 24901

Client: Hagerstown Community College

Project: Advanced Technology Center Renovation

This Addendum forms a part of the Contract Documents and modifies the original Bidding Documents, dated September 5, 2025, as noted below.

This Addendum consists of the attached revised Project Manual Section 230923 and revised Sheets L100, P101, P401, P501, and P602, and new Sheets A401A and A402A.

CHANGES TO THE PROJECT MANUAL

1. Section 230923 – Direct Digital Control (DDC) System for HVAC
   A. Delete section in its entirety and replace with attached new section.

CHANGES TO THE DRAWINGS

1. Sheet L100 – Landscape Plan
   A. Delete sheet in its entirety (from Addendum 3) and replace with attached revised sheet.

2. Sheet S100- General Notes
   A. Statement of Special Inspection Notes- second paragraph. Delete “The Owner shall employ” and replace with “The Contractor shall employ”.

3. Sheet A401- Exterior Elevations
   A. Drawing 2-A401 Building Elevation- East. Shift leader line for “Existing Precast Fascia” from panel system above storefront labeled “ETR” to existing precast directly above Door 131B. See new Sheet A401A- Exterior Elevations- Panel Façade Designation for façade panel designation surrounding storefront labeled “ETR”.

4. Sheet A401A- Exterior Elevations- Panel Façade Designation
   A. Delete sheet in its entirety and replace with attached revised sheet.

5. Sheet A402A- Exterior Elevations- Panel Façade Designation
   A. Delete sheet in its entirety and replace with attached revised sheet.

6. Sheet P101- Subslab- Plumbing- New Work Plan
   A. Delete sheet in its entirety and replace with attached revised sheet.

7. Sheet P401- Enlarged Plumbing Plans
   A. Delete sheet in its entirety and replace with attached revised sheet.

8. Sheet P501- Plumbing Details
   A. Delete sheet in its entirety and replace with attached revised sheet.

9. Sheet P602- Plumbing Roser Diagrams
   A. Delete sheet in its entirety and replace with attached revised sheet.

SECTION 230923 - DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Direct digital control (DDC) system for HVAC.

B. Related Requirements:
1. Section 230923.17 "Level Instruments" for liquid-level switches, sensors, and transmitters that connect to DDC systems.
2. Section 230923.22 "Position Instruments" for limit switches that connect to DDC systems.
3. Section 230923.43 "Weather Stations" for weather stations that connect to DDC systems.
4. Section 260553 "Identification for Electrical Systems" for identification requirements for electrical power and communications components

1.2 DEFINITIONS

A. Algorithm: A logical procedure for solving a recurrent mathematical problem. A prescribed set of well-defined rules or processes for solving a problem in a finite number of steps.

B. Analog: A continuously varying signal value, such as current, flow, pressure, or temperature.

C. BACnet Specific Definitions:

1. BACnet: Building Automation Control Network Protocol, ASHRAE 135. A communications protocol allowing devices to communicate data and services over a network.
2. BACnet Interoperability Building Blocks (BIBBs): BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBs are combined to build the BACnet functional requirements for a device.
3. BACnet/IP: Defines and allows using a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP subnetworks that share the same BACnet network number.
4. BACnet Testing Laboratories (BTL): Organization responsible for testing products for compliance with ASHRAE 135, operated under direction of BACnet International.

D. Binary: Two-state signal where a high signal level represents "ON" or "OPEN" condition and a low signal level represents "OFF" or "CLOSED" condition. "Digital" is sometimes used interchangeably with "Binary" to indicate a two-state signal.

E. Controller: Generic term for any standalone, microprocessor-based, digital controller residing on a network, used for local or global control. Three types of controllers are indicated: network controllers, programmable application controllers, and application-specific controllers.

F. Control System Integrator: An entity that assists in expansion of existing enterprise system and support of additional operator interfaces to I/O being added to existing enterprise system.

G. COV: Changes of value.

H. DDC System Provider: Authorized representative of, and trained by, DDC system manufacturer and responsible for execution of DDC system Work indicated.

I. Distributed Control: Processing of system data is decentralized and control decisions are made at subsystem level. System operational programs and information are provided to remote subsystems and status is reported back. On loss of communication, subsystems to be capable of operating in a standalone mode using the last best available data.

J. Gateway: Bidirectional protocol translator that connects control systems that use different communication protocols.

K. HLC: Heavy load conditions.

L. I/O: System through which information is received and transmitted. I/O refers to analog input (AI), binary input (BI), analog output (AO) and binary output (BO). Analog signals are continuous and represent control influences such as flow, level, moisture, pressure, and temperature. Binary signals convert electronic signals to digital pulses (values) and generally represent two-position operating and alarm status. "Digital," (DI) and (DO), is sometimes used interchangeably with "Binary," (BI) and (BO), respectively.

M. I/P: Current to pneumatic.

N. LAN: Local area network.

O. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

P. Mobile Device: A data-enabled phone or tablet computer capable of connecting to a cellular data network and running a native control application or accessing a web interface.

Q. Modbus TCP/IP: An open protocol for exchange of process data.

R. MS/TP: Master-slave/token-passing, ISO/IEC/IEEE 8802-3. Datalink protocol LAN option that uses twisted-pair wire for low-speed communication.

S. MTBF: Mean time between failures.

T. Network Controller: Digital controller, which supports a family of programmable application controllers and application-specific controllers, that communicates on peer-to-peer network for transmission of global data.

U. Network Repeater: Device that receives data packet from one network and rebroadcasts it to another network. No routing information is added to protocol.

V. Peer to Peer: Networking architecture that treats all network stations as equal partners.

W. POT: Portable operator's terminal.

X. RAM: Random access memory.

Y. RF: Radio frequency.

Z. Router: Device connecting two or more networks at network layer.

AA. Server: Computer used to maintain system configuration, historical and programming database.

BB. TCP/IP: Transport control protocol/Internet protocol.

CC. UPS: Uninterruptible power supply.

DD. USB: Universal Serial Bus.

EE. User Datagram Protocol (UDP): This protocol assumes that the IP is used as the underlying protocol.

FF. VAV: Variable air volume.

GG. WLED: White light emitting diode.

1.3 ACTION SUBMITTALS

A. Multiple Submissions:

1. If multiple submissions are required to execute work within schedule, first submit a coordinated schedule clearly defining intent of multiple submissions. Include a proposed date of each submission with a detailed description of submittal content to be included in each submission.
2. Clearly identify each submittal requirement indicated and in which submission the information will be provided.
3. Include an updated schedule in each subsequent submission with changes highlighted to easily track the changes made to previous submitted schedule.

B. Product Data:

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
3. Product description with complete technical data, performance curves, and product specification sheets.
4. Installation, operation, and maintenance instructions including factors effecting performance.

5. Bill of materials of indicating quantity, manufacturer, and extended model number for each unique product.
   a. Servers.
   b. Gateways.
   c. Routers.
   d. DDC controllers.
   e. Enclosures.
   f. Electrical power devices.
   g. Accessories.
   h. Instruments.
   i. Control dampers and actuators.
   j. Control valves and actuators.

6. When manufacturer's product datasheets apply to a product series rather than a specific product model, clearly indicate and highlight only applicable information.
7. Each submitted piece of product literature to clearly cross reference specification and drawings that submittal is to cover.

C. Shop Drawings:

1. General Requirements:

   a. Include cover drawing with Project name, location, COR, Architect, Contractor, and issue date with each Shop Drawings submission.
   b. Include a drawing index sheet listing each drawing number and title that matches information in each title block.

2. Include plans, elevations, sections, and mounting details where applicable.
3. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
4. Detail means of vibration isolation and show attachments to rotating equipment.
5. Plan Drawings indicating the following:

   a. Screened backgrounds of walls, structural grid lines, HVAC equipment, ductwork, and piping.
   b. Room names and numbers with coordinated placement to avoid interference with control products indicated.
   c. Each desktop workstation network port, server, gateway, router, DDC controller, control panel instrument connecting to DDC controller, and damper and valve connecting to DDC controller, if included in Project.
   d. Network communication cable and raceway routing.
   e. Proposed routing of wiring, cabling, conduit, and tubing; coordinated with building services for review before installation.

6. Schematic drawings for each controlled HVAC system indicating the following:

a. I/O points labeled with point names shown. Indicate instrument range, normal operating set points, and alarm set points. Indicate fail position of each damper and valve, if included in Project.
b. I/O listed in table format showing point name, type of device, manufacturer, model number, and cross-reference to product data sheet number.
c. A graphic showing location of control I/O in proper relationship to HVAC system.
d. Wiring diagram with each I/O point having a unique identification and indicating labels for all wiring terminals.
e. Unique identification of each I/O that to be consistently used between different drawings showing same point.
f. Elementary wiring diagrams of controls for HVAC equipment motor circuits including interlocks, switches, relays, and interface to DDC controllers.
g. Narrative sequence of operation.

7. Control panel drawings indicating the following:

a. Panel dimensions, materials, size, and location of field cable, raceways, and tubing connections.
b. Interior subpanel layout, drawn to scale and showing all internal components, cabling and wiring raceways, nameplates, and allocated spare space.
c. Unique drawing for each panel.

8. DDC system network riser diagram indicating the following:

a. Each device connected to network with unique identification for each.
b. Interconnection of each different network in DDC system.
c. For each network, indicate communication protocol, speed, and physical means of interconnecting network devices, such as copper cable type, or optical fiber cable type. Indicate raceway type and size for each.
d. Each network port for connection of an operator workstation or other type of operator interface with unique identification for each.

9. DDC system electrical power riser diagram indicating the following:

a. Each point of connection to field power with requirements (volts/phase//hertz/amperes/connection type) listed for each.
b. Each control power supply including, as applicable, transformers, power-line conditioners, transient voltage suppression and high filter noise units, DC power supplies, and UPS units with unique identification for each.
c. Each product requiring power with requirements (volts/phase//hertz/amperes/connection type) listed for each.
d. Power wiring type and size, race type, and size for each.

10. Monitoring and control signal diagrams indicating the following:

a. Control signal cable and wiring between controllers and I/O.
b. Point-to-point schematic wiring diagrams for each product.
c. Control signal tubing to sensors, switches, and transmitters.
d. Process signal tubing to sensors, switches, and transmitters.

11. Update Existing Color graphics indicating the following:

    a. Itemized list of color graphic displays to be provided.
    b. For each display screen to be provided, a true color copy showing layout of pictures, graphics, and data displayed.
    c. Intended operator access between related hierarchical display screens.

D. System Description:

1. Full description of DDC system architecture, network configuration, operator interfaces and peripherals, servers, controller types and applications, gateways, routers and other network devices, and power supplies.
2. Complete listing and description of each report, log and trend for format and timing, and events that initiate generation.
3. System and product operation under each potential failure condition including, but not limited to, the following:

    a. Loss of power.
    b. Loss of network communication signal.
    c. Loss of controller signals to inputs and outpoints.
    d. Operator workstation failure.
    e. Server failure.
    f. Gateway failure.
    g. Network failure.
    h. Controller failure.
    i. Instrument failure.
    j. Control damper and valve actuator failure.

4. Complete bibliography of documentation and media to be delivered to Owner.
5. Description of testing plans and procedures.
6. Description of Owner training.

7. Supporting documentation showing DDC system design complies with performance requirements indicated, including calculations and other documentation necessary to prove compliance.
8. Schedule and design calculations for control dampers and actuators.

    a. Flow at Project design and minimum flow conditions.
    b. Face velocity at Project design and minimum airflow conditions.
    c. Pressure drop across damper at Project design and minimum airflow conditions.
    d. AMCA 500-D damper installation arrangement used to calculate and schedule pressure drop, as applicable to installation.
    e. Maximum close-off pressure.
    f. Leakage airflow at maximum system pressure differential (fan close-off pressure).
    g. Torque required at worst case condition for sizing actuator.
    h. Actuator selection indicating torque provided.
    i. Actuator signal to control damper (on, close, or modulate).
    j. Actuator position on loss of power.
    k. Actuator position on loss of control signal.

9. Schedule and design calculations for control valves and actuators.

    a. Flow at Project design and minimum flow conditions.
    b. Pressure-differential drop across valve at Project design flow condition.
    c. Maximum system pressure-differential drop (pump close-off pressure) across valve at Project minimum flow condition.
    d. Design and minimum control valve coefficient with corresponding valve position.
    e. Maximum close-off pressure.
    f. Leakage flow at maximum system pressure differential.
    g. Torque required at worst case condition for sizing actuator.
    h. Actuator selection indicating torque provided.
    i. Actuator signal to control damper (on, close or modulate).
    j. Actuator position on loss of power.
    k. Actuator position on loss of control signal.

10. Schedule and design calculations for selecting flow instruments.

    a. Instrument flow range.
    b. Project design and minimum flow conditions with corresponding accuracy, control signal to transmitter, and output signal for remote control.
    c. Extreme points of extended flow range with corresponding accuracy, control signal to transmitter, and output signal for remote control.
    d. Pressure-differential loss across instrument at Project design flow conditions.
    e. Where flow sensors are mated with pressure transmitters, provide information for each instrument separately and as an operating pair.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For DDC system.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

    a. Project Record Drawings of as-built versions of submittal Shop Drawings provided in electronic PDF format.
    b. Testing and commissioning reports and checklists of completed final versions of reports, checklists, and trend logs.
    c. As-built versions of submittal Product Data.
    d. Names, addresses, email addresses, and 24-hour telephone numbers of Installer and service representatives for DDC system and products.
    e. Operator's manual with procedures for operating control systems including logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing set points and variables.
    f. Programming manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
    g. Engineering, installation, and maintenance manuals that explain how to do the following:

1) Design and install new points, panels, and other hardware.
2) Perform preventive maintenance and calibration.
3) Debug hardware problems.
4) Repair or replace hardware.

h. Documentation of all programs created using custom programming language including set points, tuning parameters, and object database.
i. Backup copy of graphic files, programs, and databases on electronic media.
j. List of recommended spare parts with part numbers and suppliers.
k. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
l. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
m. Licenses, guarantees, and warranty documents.
n. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
o. Owner training materials.

1.5 QUALITY ASSURANCE

A. DDC System Manufacturer Qualifications:

1. Nationally recognized manufacturer of DDC systems and products.
2. DDC systems with similar requirements to those indicated for a continuous period of five years within time of bid.
3. DDC systems and products that have been successfully tested and in use on at least five past projects.
4. Having complete published catalog literature, installation, operation, and maintenance manuals for all products intended for use.
5. Having full-time in-house employees for the following:

a. Product research and development.
b. Product and application engineering.
c. Product manufacturing, testing, and quality control.
d. Technical support for DDC system installation training, commissioning, and troubleshooting of installations.
e. Owner operator training.

B. DDC System Provider Qualifications:

1. Authorized representative of, and trained by, DDC system manufacturer.
2. In-place facility located within 100 miles of Project.
3. Demonstrate past experience with installation of DDC system products being installed for period within three consecutive years before time of bid.
4. Demonstrate past experience on five projects of similar complexity, scope, and value.

5. Staffing resources of competent and experienced full-time employees that are assigned to execute work according to schedule.
6. Service and maintenance staff assigned to support Project during warranty period.
7. Product parts inventory to support ongoing DDC system operation for a period of not less than five years after Substantial Completion.
8. DDC system manufacturer's backing to take over execution of the Work if necessary to comply with requirements indicated. Include Project-specific written letter, signed by manufacturer's corporate officer, if requested.

1.6 WARRANTY

A. Special Warranty: Manufacturer and Installer agree to repair or replace products that fail in materials or workmanship within specified warranty period.

1. Adjust, repair, or replace failures at no additional cost or reduction in service to Owner.
2. Include updates or upgrades to software and firmware if necessary to resolve deficiencies.

    a. Install updates only after receiving COR's written authorization.

3. Perform warranty service during normal business hours and commence within 24 hours of Government's warranty service request.
4. Warranty Period: Two year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. EcoStruxure Building Operation by Schneider Electric USA, Inc.

2.2 DDC SYSTEM DESCRIPTION

A. Microprocessor-based monitoring and control including analog/digital conversion and program logic. A control loop or subsystem in which digital and analog information is received and processed by a microprocessor, and digital control signals are generated based on control algorithms and transmitted to field devices to achieve a set of predefined conditions.

1. DDC system consisting of high speed peer-to-peer network of distributed DDC controllers, operator interfaces, and software.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. For renovation projects with existing to remain DDC system, incorporate the new sequence of operations located on the drawings into the existing DDC system in accordance with this

section. Contractor is responsible to provide all labor, materials, etc. to make any upgrades necessary to incorporate the new sequence.

2.3 PERFORMANCE REQUIREMENTS

A. DDC System Speed:

1. Response Time of Connected I/O:

   a. Update AI point values connected to DDC system at least every five seconds for use by DDC controllers. Points used globally to also comply with this requirement.
   b. Update BI point values connected to DDC system at least every five seconds for use by DDC controllers. Points used globally to also comply with this requirement.
   c. AO points connected to DDC system to begin to respond to controller output commands within two seconds. Global commands to also comply with this requirement.
   d. BO point values connected to DDC system to respond to controller output commands within two seconds. Global commands to also comply with this requirement.

2. Display of Connected I/O:

   a. Update and display analog point COV connected to DDC system at least every five seconds for use by operator.
   b. Update and display binary point COV connected to DDC system at least every five seconds for use by operator.
   c. Update and display alarms of analog and digital points connected to DDC system within thirty seconds of activation or change of state.
   d. Update graphic display refresh within four seconds.
   e. Point change of values and alarms displayed from workstation to workstation when multiple operators are viewing from multiple workstations to not exceed graphic refresh rate indicated.

B. Network Bandwidth: Design each network of DDC system to include spare bandwidth with DDC system operating under normal and heavy load conditions indicated. Calculate bandwidth usage, and apply a safety factor to ensure that requirement is satisfied when subjected to testing under worst case conditions.

C. DDC System Data Storage:

1. Include capability to archive not less than 24 consecutive months of historical data for all I/O points connected to system, including alarms, event histories, transaction logs, trends, and other information indicated.
2. Local Storage:

   a. Provide server with data storage indicated. Server(s) to use IT industry standard database platforms and be capable of functions described in "DDC Data Access" Paragraph.

D. DDC Data Access:

1. When logged into the system, operator able to also interact with any DDC controllers connected to DDC system as required for functional operation of DDC system.
2. Use for application configuration; for archiving, reporting, and trending of data; for operator transaction archiving and reporting; for network information management; for alarm annunciation; and for operator interface tasks and controls application management.

E. Input Point Values Displayed Accuracy: Meet following end-to-end overall system accuracy, including errors associated with meter, sensor, transmitter, lead wire or cable, and analog to digital conversion.

1. Energy:

a. Thermal: Within 5 percent of reading.
b. Electric Power: Within 1 percent of reading.
c. Requirements indicated on Drawings for meters not supplied by utility.

2. Flow:

a. Air: Within 5 percent of design flow rate.
b. Air (Terminal Units): Within 10 percent of design flow rate.
c. Water: Within 2 percent of design flow rate.

3. Gas:

a. Carbon Dioxide: Within 50 ppm.
b. Carbon Monoxide: Within 5 percent of reading.
c. Oxygen: Within 5 percent of reading.
d. Refrigerant: Within 5 percent of reading.
e. VOCs: Within 5 percent of reading.

4. Moisture (Relative Humidity):

a. Air: Within 5 percent RH.
b. Space: Within 5 percent RH.
c. Outdoor: Within 5 percent RH.

5. Level: Within 5 percent of reading.
6. Pressure:

a. Air, Ducts and Equipment: 1 percent of instrument range.
b. Space: Within 1 percent of instrument range.
c. Water: Within 1 percent of instrument range.

7. Speed: Within 10 percent of reading.
8. Temperature, Dew Point:

a. Air: Within 1 deg F.
b. Space: Within 1 deg F.
c. Outdoor: Within 3 deg F.

9. Temperature, Dry Bulb:

a. Air: Within 1 deg F.
b. Space: Within 1 deg F.
c. Outdoor: Within 2 deg F.
d. Chilled Water: Within 1 deg F.
e. Heating Hot Water: Within 1 deg F.
f. Temperature Difference: Within 0.1 deg F.
g. Other Temperatures Not Indicated: Within 1 deg F.

10. Temperature, Wet Bulb:

a. Air: Within 1 deg F.
b. Space: Within 1 deg F.
c. Outdoor: Within 2 deg F.

F. Precision of I/O Reported Values: Values reported in database and displayed to have following precision:

1. Current:

a. Milliamperes: Nearest 1/100th of a milliampere.
b. Amperes: Nearest 1/10th of an ampere up to 100 A; nearest ampere for 100 A and more.

2. Energy:

a. Electric Power:

1) Rate (Watts): Nearest 1/10th of a watt through 1000 W.
2) Rate (Kilowatts): Nearest 1/10th of a kilowatt through 1000 kW; nearest kilowatt above 1000 kW.
3) Usage (Kilowatt-Hours): Nearest kilowatt through 10,000 kW; nearest 10 kW between 10,000 and 100,000 kW; nearest 100 kW for above 100,000 kW.

b. Thermal, Rate:

1) Heating: For British thermal units per hour, nearest British thermal unit per hour up to 1000 Btu/h; nearest 10 Btu/h between 1000 and 10,000 Btu/h; nearest 100 Btu/h for above 10,000 Btu/h. For MBh, round to nearest MBh up to 1000 MBh; nearest 10 MBh between 1000 and 10,000 MBh; nearest 100 MBh above 10,000 MBh.
2) Cooling: For tons, nearest ton up to 1000 tons; nearest 10 tons between 1000 and 10,000 tons; nearest 100 tons above 10,000 tons.

c. Thermal, Usage:

1) Heating: For British thermal unit, nearest British thermal unit up to 1000 Btu; nearest 10 Btu between 1000 and 10,000 Btu; nearest 100 Btu for above 10,000 Btu. For MBtu, round to nearest MBtu up to 1000 MBtu; nearest 10 MBtu between 1000 and 10,000 MBtu; nearest 100 MBtu above 10,000 MBtu.
2) Cooling: For ton-hours, nearest ton-hours up to 1000 ton-hours; nearest 10 ton-hours between 1000 and 10,000 ton-hours; nearest 100 tons above 10,000 tons.

3. Flow:

a. Air: Nearest 1/10th of a cubic feet per minute through 100 cfm; nearest cubic feet per minute between 100 and 1000 cfm; nearest 10 cfm between 1000 and 10,000 cfm; nearest 100 cfm above 10,000 cfm.
b. Water: Nearest 1/10th of a gallon per minute through 100 gpm; nearest gallon per minute between 100 and 1000 gpm; nearest 10 gpm between 1000 and 10,000 gpm; nearest 100 gpm above 10,000 gpm.

4. Gas:

a. Carbon Dioxide (ppm): Nearest ppm.
b. Carbon Monoxide (ppm): Nearest ppm.
c. Oxygen (Percentage): Nearest 1/10th of 1 percent.
d. Refrigerant (ppm): Nearest ppm.
e. Volatile Organic Compounds (ppm): Nearest ppm

5. Moisture (Relative Humidity):

a. Relative Humidity (Percentage): Nearest 1 percent.

6. Level: Nearest 1/100th of an inch through 10 inches; nearest 1/10 of an inch between 10 and 100 inches; nearest inch above 100 inches.
7. Speed:

a. Rotation (rpm): Nearest 1 rpm.
b. Velocity: Nearest 1/10th of feet per minute through 100 fpm; nearest feet per minute between 100 and 1000 fpm; nearest 10 fpm above 1000 fpm.

8. Position, Dampers and Valves (Percentage Open): Nearest 1 percent.
9. Pressure:

a. Air, Ducts and Equipment: Nearest 1/10th of an inch water closet.
b. Space: Nearest 1/100th of an inch water closet.
c. Steam: Nearest 1/10th of pounds per square inch gauge through 100 psig; nearest pounds per square inch gauge above 100 psig.
d. Water: Nearest 1/10 of a pound per square inch gauge through 100 psig; nearest pound per square inch gauge above 100 psig.

10. Temperature:

    a. Air, Ducts and Equipment: Nearest 1/10th of a degree.
    b. Outdoor: Nearest degree.
    c. Space: Nearest 1/10th of a degree.
    d. Chilled Water: Nearest 1/10th of a degree.
    e. Heating Hot Water: Nearest degree.
    f. Heat Recovery Runaround: Nearest 1/10th of a degree.

11. Voltage: Nearest 1/10 V up to 100 V; nearest volt above 100 V.

G. Environmental Conditions for Controllers, Gateways, and Routers, Instruments, and Actuators:

1. Products to operate without performance degradation under ambient environmental temperature, pressure, and humidity conditions encountered for installed location.

    a. If product alone cannot comply with requirement, install product in a protective enclosure that is isolated and protected from conditions impacting performance. Enclosure to be internally insulated, electrically heated, cooled, and ventilated as required by product and application.

2. Protect products with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. House products not available with integral enclosures complying with requirements indicated in protective secondary enclosures. Installed location dictates the following NEMA 250 enclosure requirements:

    a. Outdoors, Protected: Type 3 or Type 12.
    b. Outdoors, Unprotected: Type 4 or Type 4X.
    c. Indoors, Heated with Filtered Ventilation: Type 1 or Type 2.
    d. Indoors, Heated with Nonfiltered Ventilation: Type 2 or Type 12.
    e. Indoors, Heated and Air-Conditioned: Type 1.
    f. Mechanical Equipment Rooms:

        1) Chiller and Boiler Rooms: Type 12, Type 4 or Type 4X.
        2) Air-Moving Equipment Rooms: Type 1, Type 2 or Type 12.

    g. Localized Areas Exposed to Washdown: Type 4 or Type 4X.
    h. Within Duct Systems and Air-Moving Equipment Not Exposed to Possible Condensation: Type 2, Type or Type 12.
    i. Within Duct Systems and Air-Moving Equipment Exposed to Possible Condensation: Type 4 or Type 4X.

H. Backup Power Source:

1. Serve DDC system products that control HVAC systems and equipment served by a backup power source also from a backup power source.

2.4 SYSTEM ARCHITECTURE

A. Provide dedicated DDC system LANs that are not shared with other building systems and tenant data and communication networks.

B. Provide modular system architecture with inherent ability to expand to no less than 1.5 times system size indicated with no impact to performance indicated.

C. Configure architecture to minimize need to remove and replace existing network equipment for system expansion.

D. Make number of LANs and associated communication transparent to operator. Configure all I/O points residing on any LAN to be capable of global sharing between all system LANs.

E. Design system to eliminate dependence on any single device for system alarm reporting and control execution. Design each controller to operate independently by performing own control, alarm management, and historical data collection.

F. Special Network Architecture Requirements:

1. Air-Handling Systems: For control applications of an air-handling system that consists of air-handling unit(s) and VAV terminal units, include a dedicated LAN of application-specific controllers serving VAV terminal units connected directly to controller that is controlling air-handling-system air-handling unit(s). Basically, create DDC system LAN that aligns with air-handling system being controlled.

2.5 DDC SYSTEM OPERATOR INTERFACES

A. Operator Means of System Access: Existing campus operator interface to remain.

B. Make access to system, regardless of operator means used, transparent to operator.

C. Critical Alarm Reporting:

1. Send operator-selected critical alarms to notify operator of critical alarms that require immediate attention.
2. Send alarm notification to multiple recipients that are assigned for each alarm.
3. Notify recipients by any or all means, including email, text message, and prerecorded phone message to mobile and landline phone numbers.

2.6 NETWORKS

A. Acceptable networks for connecting workstations, mobile devices, and network controllers include the following:

1. IP.
2. ISO/IEC/IEEE 8802-3, Ethernet.

B. Acceptable networks for connecting programmable application controllers include the following:

1. BACnet IP.
2. IP.
3. ISO/IEC/IEEE 8802-3, Ethernet.

C. Acceptable networks for connecting application-specific controllers include the following:

1. BACnet MS/TP.
2. BACnet IP.
3. Modbus TCP/IP.
4. Modbus RTU.

2.7 NETWORK COMMUNICATION PROTOCOL

A. Use network communication protocol(s) that are open to Government and available to other companies for use in making future modifications to DDC system.

B. ASHRAE 135 Protocol:

1. Use ASHRAE 135 communication protocol as sole and native protocol used throughout entire DDC system.
2. DDC system to not require use of gateways except to integrate HVAC equipment and other building systems and equipment; not required to use ASHRAE 135 communication protocol.
3. If used, gateways to connect to DDC system using ASHRAE 135 communication protocol and Project object properties and read/write services indicated by interoperability schedule.
4. Use operator workstations, controllers, and other network devices that are tested and listed by BTL.

C. Industry Standard Protocols:

1. Use any one or a combination of the following industry standard protocols for network communication while complying with other DDC system requirements indicated:

   a. ASHRAE 135.
   b. Modbus Application Protocol Specification V1.1b3.

2. Operator workstations and network controllers are to communicate through ASHRAE 135 protocol.
3. Provide portions of DDC system networks using ASHRAE 135 communication protocol as an open implementation of network devices complying with ASHRAE 135. Use network devices that are tested and listed by BTL.
4. Provide portions of DDC system networks using Modbus Application Protocol Specification V1.1b3 communication protocol as an open implementation of network

devices and technology complying with Modbus Application Protocol Specification V1.1b3.

5. Use gateways to connect networks and network devices with different protocols.

2.8 DESKTOP WORKSTATIONS

A. Modify existing to incorporate new controls shown on the drawings.

2.9 SYSTEM SOFTWARE

A. System Software Minimum Requirements:

1. Real-time multitasking and multiuser 64-bit operating system that allows concurrent multiple operator workstations operating and concurrent execution of multiple real-time programs and custom program development.
2. Operating system capable of operating Microsoft Windows applications.
3. Database management software to manage all data on an integrated and non-redundant basis. Additions and deletions to database are to be without detriment to existing data. Include cross linkages so no data required by a program can be deleted by an operator until that data have been deleted from respective programs.
4. Network communications software to manage and control multiple network communications to provide exchange of global information and execution of global programs.
5. Operator interface software to include day-to-day operator transaction processing, alarm and report handling, operator privilege level and data segregation control, custom programming, and online data modification capability.
6. Scheduling software to schedule centrally based time and event, temporary, and exception day programs.

B. Operator Interface Software:

1. Make operator sign-off a manual operation or, if no keyboard or mouse activity takes place, an automatic sign-off.
2. Make automatic sign-off period programmable from one to 60 minutes in one-minute increments on a per operator basis.
3. Record operator sign-on and sign-off activity and send to printer.
4. Security Access:

    a. Use password control for operator access to DDC system.
    b. Assign an alphanumeric password (field assignable) to each operator.
    c. Grant operators access to DDC system by entry of proper password.
    d. Use same operator password regardless of which computer or other operator interface means are used.
    e. Automatically update additions or changes made to passwords.

f. Assign each operator an access level to restrict access to data and functions the operator is cable of performing.
g. Provide software with at least five access levels.
h. Assign each menu item an access level so that a one-for-one correspondence between operator assigned access level(s) and menu item access level(s) is required to gain access to menu item.
i. Display menu items to operator with those capable of access highlighted. Make menu and operator access level assignments online programmable and under password control.

5. Operators able to perform commands including, but not limited to, the following:

a. Start or stop selected equipment.
b. Adjust set points.
c. Add, modify, and delete time programming.
d. Enable and disable process execution.
e. Lock and unlock alarm reporting for each point.
f. Enable and disable totalization for each point.
g. Enable and disable trending for each point.
h. Override control loop set points.
i. Enter temporary override schedules.
j. Define holiday schedules.
k. Change time and date.
l. Enter and modify analog alarm limits.
m. Enter and modify analog warning limits.
n. View limits.
o. Enable and disable demand limiting.
p. Enable and disable duty cycle.
q. Display logic programming for each control sequence.

6. Reporting:

a. Generated automatically and manually.
b. Sent to displays, printers and disc files.
c. Types of Reporting:

1) General listing of points.
2) List points currently in alarm.
3) List of off-line points.
4) List points currently in override status.
5) List of disabled points.
6) List points currently locked out.
7) List weekly schedules.
8) List holiday programming.
9) List of limits and deadbands.

7. Summaries: For specific points, for a logical point group, for an operator selected group(s), or for entire system without restriction due to hardware configuration.

C. Graphic Interface Software:

1. Include a full interactive graphical selection means of accessing and displaying system data to operator. Include at least five levels with the penetration path operator assignable (for example, site, building, floor, air-handling unit, and supply temperature loop). Native language descriptors assigned to menu items are to be operator defined and modifiable under password control.
2. Include a hierarchical-linked dynamic graphic operator interface for accessing and displaying system data and commanding and modifying equipment operation. Interface is to use a pointing device with pull-down or penetrating menus, color, and animation to facilitate operator understanding of system.
3. Make descriptors for graphics, points, alarms, and such modifiable through operator's workstation under password control.
4. Make graphic displays online user definable and modifiable using the hardware and software provided.
5. Make data displayed within a graphic assignable regardless of physical hardware address, communication, or point type.
6. Make graphics online programmable and under password control.
7. Make points assignable to multiple graphics where necessary to facilitate operator understanding of system operation.
8. Graphics to also contain software points.
9. Penetration within a graphic hierarchy is to display each graphic name as graphics are selected to facilitate operator understanding.
10. Provide a back-trace feature to permit operator to move upward in the hierarchy using a pointing device. Back trace to show all previous penetration levels. Include operator with option of showing each graphic full-screen size with back trace as horizontal header or by showing a "stack" of graphics, each with a back trace.
11. Display operator accessed data on the monitor.
12. Provide operator with ability to select further penetration using pointing device to click on a site, building, floor, area, equipment, and so on. Display defined and linked graphic below that selection.
13. Include operator with means to directly access graphics without going through penetration path.
14. Make dynamic data assignable to graphics.
15. Display points (physical and software) with dynamic data provided by DDC system with appropriate text descriptors, status or value, and engineering unit.
16. Use color, rotation, or other highly visible means, to denote status and alarm states. Make colors variable for each class of points, as chosen by operator.
17. Provide dynamic points with operator adjustable update rates on a per point basis from one second to over a minute.
18. For operators with appropriate privilege, command points directly from display using pointing device.

    a. For an analog command point such as set point, display current conditions and limits so operator can position new set point using pointing device.
    b. For a digital command point such as valve position, show valve in current state such as open or closed so operator could select alternative position using pointing device.
    c. Include a keyboard equivalent for those operators with that preference.

19. Give operator ability to split or resize viewing screen into quadrants to show one graphic on one quadrant of screen and other graphics or spreadsheet, bar chart, word processing, curve plot, and other information on other quadrants on screen. This feature allows real-time monitoring of one part of system while displaying other parts of system or data to better facilitate overall system operation.
20. Help Features:

    a. Online context-sensitive help utility to facilitate operator training and understanding.
    b. Bridge to further explanation of selected keywords and contain text and graphics to clarify system operation.

        1) If help feature does not have ability to bridge on keywords for more information, provide a complete set of user manuals in an indexed word-processing program, which runs concurrently with operating system software.

    c. Available for Every Menu Item:

        1) Index items for each system menu item.

D. Update Project-Specific Graphics: Graphics documentation including, but not limited to, the following:

1. Site plan showing each building, and additional site elements, which are being controlled or monitored by DDC system.
2. Plan for each building floor, including interstitial floors, and each roof level of each building, showing the following:

    a. Room layouts with room identification and name.
    b. Locations and identification of all monitored and controlled HVAC equipment and other equipment being monitored and controlled by DDC system.
    c. Location and identification of each hardware point being controlled or monitored by DDC system.

3. Control schematic for each of following, including a graphic system schematic representation with point identification, set point and dynamic value indication, and sequence of operation.
4. Graphic display for each piece of equipment connected to DDC system through a data communications link. Include dynamic indication of all points associated with equipment.
5. DDC system network riser diagram that shows schematic layout for entire system including all networks and all controllers, gateways, operator workstations, and other network devices.

E. Update Alarm Handling Software:

1. Include alarm handling software to report all alarm conditions monitored and transmitted through DDC controllers**.**

2. Include first in, first out handling of alarms in accordance with alarm priority ranking, with most critical alarms first, and with buffer storage in case of simultaneous and multiple alarms.
3. Make alarm handling active at all times to ensure that alarms are processed even if an operator is not currently signed on to DDC system.
4. Alarms display is to include the following:

    a. Indication of alarm condition such as "Abnormal Off," "Hi Alarm," and "Low Alarm."
    b. "Analog Value" or "Status" group and point identification with native language point descriptor such as "Space Temperature, Building 110, 2nd Floor, Room 212."
    c. Discrete per point alarm action message, such as "Call Maintenance Dept. Ext-5561."
    d. Include extended message capability to allow assignment and printing of extended action messages. Capability is to be operator programmable and assignable on a per point basis.

5. Direct alarms to appropriate operator workstations, printers, and individual operators by privilege level and segregation assignments.
6. Ability to send email alarm messages to designated operators.
7. Ability to send end email, page, text, and voice messages to designated operators for critical alarms.
8. Categorize and process alarms by class.

    a. Class 1:

        1) Associated with fire, security, and other extremely critical equipment monitoring functions; have alarm, trouble, return to normal, and acknowledge conditions printed and displayed.
        2) Unacknowledged alarms to be placed in unacknowledged alarm buffer.
        3) All conditions make an audible alarm sound and require individual acknowledgment to silence audible sound.

    b. Class 2:

        1) Critical, but not life-safety related, and processed same as Class 1 alarms, except do not require individual acknowledgment.
        2) Acknowledgement may be through a multiple alarm acknowledgment.

    c. Class 3:

        1) General alarms; printed, displayed, and placed in unacknowledged alarm buffer queues.
        2) Configure so each new alarm received makes an audible alarm sound that are silenced by "acknowledging" alarm or by pressing a "silence" key.
        3) Make acknowledgement of queued alarms either on an individual basis or through a multiple alarm acknowledgement.

4) Print alarms returning to normal condition without an audible alarm sound or require acknowledgment.

d. Class 4:

1) Routine maintenance or other types of warning alarms.
2) Alarms to be printed only, with no display, no audible sound and no acknowledgment required.

9. Include an unacknowledged alarm indicator on display to alert operator that there are unacknowledged alarms in system. Operator able to acknowledge alarms on an individual basis or through a multiple alarm acknowledge key, depending on alarm class.

F. Update Reports and Logs:

1. Include reporting software package that allows operator to select, modify, or create reports using DDC system I/O point data available.
2. Setup each report so data content, format, interval, and date are operator definable.
3. Sample and store report data on DDC controller, within storage limits of DDC controller, and then uploaded to archive on workstation or server for historical reporting.
4. Make it possible for operators to obtain real-time logs of all I/O points by type or status, such as alarm, point lockout, or normal.
5. Store reports and logs on workstations and/or servers hard drives in a format that is readily accessible by other standard software applications, including spreadsheets and word processing.
6. Make reports and logs readily printable and set to be print either on operator command or at a specific time each day.

G. Update Standard Reports: Provide standard DDC system reports with operator ability to customize reports later.

1. All I/O: With current status and values.
2. Alarm: All current alarms, except those in alarm lockout.
3. Disabled I/O: All I/O points that are disabled.
4. Alarm Lockout I/O: All I/O points in alarm lockout, whether manual or automatic.
5. Alarm Lockout I/O in Alarm: All I/O in alarm lockout that are currently in alarm.
6. Logs:

a. Alarm history.
b. System messages.
c. System events.
d. Trends.

H. Update Custom Reports: Operator able to easily define and prepare any system data into a daily, weekly, monthly, annual, or other historical report. Reports to include a title with time and date stamp.

I. Update Standard Trends:

1. Trend all I/O point present values, set points, and other parameters indicated for trending.
2. Associate trends into groups, and setup a trend report for each group.
3. Store trends within DDC controller and uploaded to hard drives automatically on reaching 75 percent of DDC controller buffer limit, or by operator request, or by archiving time schedule.
4. Preset trend intervals for each I/O point after review with Owner.
5. Make trend intervals operator selectable from 10 seconds up to 60 minutes. Make minimum number of consecutive trend values stored at one time 100 per variable.
6. When drive storage memory is full, overwrite oldest data with most recent data.
7. Make archived and real-time trend data available for viewing numerically and graphically by operators.

J. Update Custom Trends: Operator-definable custom trend log for any I/O point in DDC system.

1. Include each trend with interval, start time, and stop time.
2. Sample and store data on DDC controller, within reaching 75 percent storage limits of DDC controller, and then uploaded to archive on workstation or server hard drives.
3. Make data retrievable for use in spreadsheets and standard database programs.

K. Update Programming Software:

1. Include programming software to execute sequences of operation indicated.
2. Include programming routines in simple and easy to follow logic with detailed text comments describing what the logic does and how it corresponds to sequence of operation.

    a. Graphic Based: Use a library of function blocks made from preprogrammed code designed for DDC control systems.

        1) Assemble function blocks with interconnection lines that represent to control sequence in a flowchart.
        2) Make programming tools viewable in real time to show present values and logical results of each function block.

    b. Menu Based: Done by entering parameters, definitions, conditions, requirements, and constraints.
    c. Line by Line and Text Based: Programming is to declare variable types such as local, global, real, integer, and so on, at the beginning of the program. Use descriptive comments frequently to describe programming code.

3. Include means for detecting programming errors and testing software control strategies with a simulation tool before implementing in actual control. Simulation tool may be inherent with programming software or as a separate product.

2.10 ASHRAE 135 GATEWAYS

A. Include BACnet communication ports, whenever available as an equipment OEM standard option, for integration via a single communication cable. BACnet-controlled plant equipment includes, but is not limited to, boilers, chillers, and variable-speed drives.

B. Include gateways to connect BACnet to legacy systems where indicated, existing non-BACnet devices, and existing non-BACnet DDC-controlled equipment.

C. Include with each gateway an interoperability schedule showing each point or event on legacy side that BACnet "client" will read, and each parameter that BACnet network will write to. Describe this interoperability of BACnet services, or BIBBs, defined in ASHRAE 135, Annex K.

D. Gateway Minimum Requirements:

1. Read and view all readable object properties on non-BACnet network to BACnet network, and vice versa, where applicable.
2. Write to all writable object properties on non-BACnet network from BACnet network, and vice versa, where applicable.
3. Include single-pass (only one protocol to BACnet without intermediary protocols) translation from non-BACnet protocol to BACnet, and vice versa.
4. Comply with requirements of Data Sharing Read Property, Data Sharing Write Property, Device Management Dynamic Device Binding-B, and Device Management Communication Control BIBBs in accordance with ASHRAE 135.
5. Hardware, software, software licenses, and configuration tools for operator-to-gateway communications.
6. Backup programming and parameters on CD media with ability to modify, download, backup, and restore gateway configuration.

2.11 DDC CONTROLLERS

A. DDC system consisting of a combination of network controllers, programmable application controllers, and application-specific controllers to satisfy performance requirements indicated.

B. DDC controllers to perform monitoring, control, energy optimization, and other requirements indicated.

C. DDC controllers are to use a multitasking, multiuser, real-time digital control microprocessor with a distributed network database and intelligence.

D. Each DDC controller is capable of full and complete operation as a completely independent unit and as a part of DDC system wide distributed network.

E. Environment Requirements:

1. Controller hardware suitable for anticipated ambient conditions.
2. Controllers located in conditioned space rated for operation at 32 to 120 deg F

3. Controllers located outdoors rated for operation at 40 to 150 deg F.

F. Power and Noise Immunity:

1. Operate controller at 90 to 110 percent of nominal voltage rating and perform an orderly shutdown below 80 percent of nominal voltage.
2. Protect against electrical noise of 5 to 120 Hz and from keyed radios with up to 5 W of power located within 36 inches of enclosure.

G. I/O Point Interface:

1. Connect hardwired I/O points to network, programmable application, and application-specific controllers.
2. Protect I/O points so shorting of point to itself, to another point, or to ground will not damage controller.
3. Protect I/O points from voltage up to 24 V of any duration so that contact will not damage controller.
4. AIs:

   a. Include monitoring of low-voltage (0 to 10 V dc), current (4 to 20 mA) and resistance signals from thermistor and RTD sensors.
   b. Compatible with, and field configurable to, sensor and transmitters installed.
   c. Capable of being individually calibrated for zero and span.
   d. Incorporate common-mode noise rejection of at least 50 dB from 0 to 100 Hz for differential inputs, and normal-mode noise rejection of at least 20 dB at 60 Hz from a source impedance of 10000 ohms.

5. AOs:

   a. Output signals range of 4 to 20 mA dc or 0 to 10 V dc as required to include proper control of output device.
   b. Capable of being individually calibrated for zero and span.
   c. Drift is to be not greater than 0.4 percent of range per year.

6. BIs:

   a. Accept contact closures and ignore transients of less than 5 ms duration.
   b. Isolate and protect against an applied steady-state voltage of up to 180 V ac peak.
   c. Include a wetting current of at least 12 mA to be compatible with commonly available control devices and protected against effects of contact bounce and noise.
   d. Sense "dry contact" closure without external power (other than that provided by controller) being applied.
   e. Pulse accumulation input points complying with all requirements of BIs and accept up to 10 pulses per second for pulse accumulation. Include buffer to totalize pulses. Pulse accumulator is to accept rates of at least 20 pulses per second. Reset the totalized value to zero on operator's command.

7. BOs:

a. Include relay contact closures or triac outputs for momentary and maintained operation of output devices.

1) Relay contact closures to have a minimum duration of 0.1 second and at least 180 V of isolation.
2) Include electromagnetic interference suppression on all output lines to limit transients to non-damaging levels.
3) Minimum contact rating to be 1 A at 24 V ac.
4) Triac outputs to have at least 180 V of isolation and minimum contact rating of 1 A at 24 V ac.

b. Include BOs with two-state operation or a pulsed low-voltage signal for pulse-width modulation control.
c. BOs to be selectable for either normally open or normally closed operation.
d. Include tristate outputs (two coordinated BOs) for control of three-point, floating-type electronic actuators without feedback.
e. Limit use of three-point floating devices to VAV terminal unit control applications**.** Control algorithms to operate actuator to one end of its stroke once every 12 hours for verification of operator tracking.

2.12 NETWORK CONTROLLERS

A. General:

1. Include adequate number of controllers to achieve performance indicated.
2. Provide one or more independent, standalone, microprocessor-based network controllers to manage global strategies indicated.
3. Include enough memory to support its operating system, database, and programming requirements with spare memory indicated.
4. Share data between networked controllers and other network devices.
5. Operating system of controller to manage I/O communication signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
6. Include network controllers with a real-time clock.
7. Controller to continually check status of its processor and memory circuits. If an abnormal operation is detected, controller is to assume a predetermined failure mode and generate an alarm notification.
8. Make controllers fully programmable.

B. Communication:

1. Network controllers communicate with other devices on DDC system.
2. Network controller to also perform routing if connected to network of programmable application controllers and application-specific controllers.

C. Operator Interface:

1. Equip controllers with a service communications port for connection to desktop operator's workstation, portable operator's workstation, POT, or mobile device.

2.13 PROGRAMMABLE APPLICATION CONTROLLERS

A. General:

1. Include adequate number of controllers to achieve performance indicated.
2. Provide enough memory to support its operating system, database, and programming requirements with spare memory indicated.
3. Share data between networked controllers and other network devices.
4. Include controller with operating system to manage I/O communication signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
5. Include controllers with a real-time clock.
6. Controller is to continually check status of its processor and memory circuits. If an abnormal operation is detected, controller assumes a predetermined failure mode and generates an alarm notification.
7. Fully programmable.

B. Communication:

1. Programmable application controllers are to communicate with other devices on network.

C. Operator Interface:

1. Equip controllers with a service communications port for connection to desktop workstation, portable operator's workstation, POT, or mobile device.

D. Serviceability:

1. Equip controller with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
2. Connect wiring and cable connections to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
3. Maintain BIOS and programming information in event of power loss for at least 72 hours.

2.14 APPLICATION-SPECIFIC CONTROLLERS

A. Description: Microprocessor-based controllers, which through hardware or firmware design are dedicated to control a specific piece of equipment or system. Controllers are not fully user-programmable but are configurable and customizable for operation of equipment they are designed to control.

1. Capable of standalone operation and continued control functions without being connected to network.

2. Share data between networked controllers and other network devices.

B. Communication: Application-specific controllers are to communicate with other application-specific controllers and devices on network, and to programmable application controllers and network controllers.

C. Operator Interface: Equip controllers with a service communications port for connection to desktop workstation, portable operator's workstation, POT, or mobile device. Connection is to extend to port on space temperature sensor that is connected to controller.

D. Serviceability:

1. Equip controller with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
2. Connect wiring and cable connections to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
3. Use nonvolatile memory and maintain all BIOS and programming information in event of power loss.

2.15 CONTROLLER SOFTWARE

A. General:

1. Software applications are to reside and operate in controllers. Edit applications through operator workstations.
2. Identify I/O points by up to 30-character point name and up to 16-character point descriptor. Use same names throughout, including at operator workstations.
3. Execute control functions within controllers using DDC algorithms.
4. Configure controllers to use stored default values to ensure fail-safe operation. Use default values when there is a failure of a connected input instrument or loss of communication of a global point value.

B. Security:

1. Secure operator access using individual security passwords and user names.
2. Passwords restrict operator to points, applications, and system functions as assigned by system manager.
3. Record operator log-on and log-off attempts.
4. Protect from unauthorized use by automatically logging off after last keystroke. Make the delay time operator-definable.

C. Scheduling: Include capability to schedule each point or group of points in system. Each schedule is to consist of the following:

1. Weekly Schedules:

a. Include separate schedules for each day of week.

b. Each schedule should include capability for start, stop, optimal start, optimal stop, and night economizer.
c. Each schedule may consist of up to 10 events.
d. When a group of objects are scheduled together, include capability to adjust start and stop times for each member.

2. Exception Schedules:

a. Include ability for operator to designate any day of the year as an exception schedule.
b. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed, it will be discarded and replaced by regular schedule for that day of week.

3. Holiday Schedules:

a. Include capability for operator to define up to 99 special or holiday schedules.
b. Place schedules on scheduling calendar with ability to repeated each year.
c. Operator able to define length of each holiday period.

D. System Coordination:

1. Include standard application for proper coordination of equipment.
2. Include operator with a method of grouping together equipment based on function and location.
3. Include groups that may be for use in scheduling and other applications.

E. Binary Alarms:

1. Set each binary point to alarm based on operator-specified state.
2. Include capability to automatically and manually disable alarming.

F. Analog Alarms:

1. Provide each analog object with both high and low alarm limits.
2. Include capability to automatically and manually disable alarming.

G. Alarm Reporting:

1. Include ability for operators to determine action to be taken in event of an alarm.
2. Route alarms to appropriate operator workstations based on time and other conditions.
3. Include ability for alarms to start programs, print, be logged in event logs, generate custom messages, and display graphics.

H. Remote Communication:

1. Include ability for system to notify operators by phone message, text message, and email in event of an alarm.

I. Maintenance Management: Monitor equipment status and generate maintenance messages based on operator-designated run-time, starts, and calendar date limits.

J. Sequencing: Include application software based on sequences of operation indicated to properly sequence chillers, boilers, and other applicable HVAC equipment.

K. Control Loops:

1. Support any of the following control loops, as applicable to control required:

a. Two-position (on/off, open/close, slow/fast) control.
b. Proportional control.
c. Proportional plus integral (PI) control.
d. Proportional plus integral plus derivative (PID) control.

1) Include PID algorithms with direct or reverse action and anti-windup.
2) Algorithm to calculate a time-varying analog value used to position an output or stage a series of outputs.
3) Make controlled variable, set point, and PID gains operator-selectable.

e. Adaptive (automatic tuning).

L. Staggered Start: Prevent all controlled equipment from simultaneously restarting after a power outage. Make the order which equipment (or groups of equipment) is started, along with the time delay between starts, operator-selectable.

M. Energy Calculations:

1. Include software to allow instantaneous power or flow rates to be accumulated and converted to energy usage data.
2. Include algorithm that calculates a sliding-window average (rolling average). Make algorithm flexible to allow window intervals to be operator specified (such as 15, 30, or 60 minutes).
3. Include algorithm that calculates a fixed-window average. Use a digital input signal to define start of window period (such as signal from utility meter) to synchronize fixed-window average with that used by utility.

N. Anti-Short Cycling:

1. Protect BO points from short cycling.
2. Feature to allow minimum on-time and off-time to be selected.

O. On and Off Control with Differential:

1. Include algorithm that allows BO to be cycled based on a controlled variable and set point.
2. Use direct- or reverse-acting algorithm and incorporate an adjustable differential.

P. Run-Time Totalization:

1. Include software to totalize run-times for all BO points.
2. Assign a high run-time alarm, if required, by operator.

2.16 ENCLOSURES

A. General:

1. House each controller and associated control accessories in an enclosure. Enclosure is to serve as central tie-in point for control devices such as switches, transmitters, transducers, power supplies, and transformers.
2. Include enclosure door with key locking mechanism. Key locks alike for all enclosures and include one pair of keys per enclosure.
3. Freestanding enclosures maximum of 48 inches wide and 72 inches high.
4. Include wall-mounted enclosures with brackets suitable for mounting enclosures to wall or freestanding support stand as indicated.
5. Supply each enclosure with complete set of as-built schematics, tubing, and wiring diagrams and product literature located in pocket on inside of door.

B. Internal Arrangement:

1. Arrange internal layout of enclosure to group and protect electric, and electronic components associated with controller, but not an integral part of controller.
2. Arrange layout to group similar products together.
3. Include a barrier between line-voltage and low-voltage electrical and electronic products.
4. Factory or shop install products, tubing, cabling, and wiring complying with requirements and standards indicated.
5. Terminate field cable and wire using heavy-duty terminal blocks.
6. Include spade lugs for stranded cable and wire.
7. Install maximum of two wires on each side of terminal.
8. Include enclosure field electric power supply with toggle-type switch located at entrance inside enclosure to disconnect power.
9. Include enclosure with line-voltage nominal 20 A GFCI duplex receptacle for service and testing tools. Wire receptacle on hot side of enclosure disconnect switch and include with 5 A circuit breaker.
10. Mount products within enclosure on removable internal panel(s).
11. Include products mounted in enclosures with nameplates (black letters on a white background). Nameplates are to have at least 1/4-inch high lettering.
12. Route tubing cable and wire located inside enclosure within a raceway with continuous removable cover.
13. Label each end of cable, wire, and tubing in enclosure following an approved identification system that extends from field I/O connection and all intermediate connections throughout length to controller connection.

C. Wall-Mounted, NEMA 250, Type 1:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. B-Line; a division of Eaton, Electrical Sector.
b. Hammond Mfg. Co. Inc.
c. Hoffman; brand of nVent Electrical plc.
d. Saginaw Control and Engineering.

2. NRTL listed in accordance with UL 50 or UL 50E.
3. Construct enclosure of steel, not less than the following:

a. Enclosure Size Less Than 24 Inches: 0.053 inch or 0.067 inch thick.
b. Enclosure Size 24 Inches and Larger: 0.067 inch or 0.093 inch thick.

4. Finish enclosure inside and out with polyester powder coating that is electrostatically applied and then baked to bond to substrate.

a. Exterior Color: Manufacturer's standard.
b. Interior Color: Manufacturer's standard.

5. Hinged door full size of front face of enclosure and supported using the following:

a. Enclosures Sizes Less Than 36 Inches Tall: Multiple butt hinges.
b. Enclosures Sizes 36 Inches Tall and Larger: Continuous piano hinges.

6. Removable internal panel with white or gray polyester powder coating that is electrostatically applied and then baked to bond to substrate.

a. Size Less Than 24 Inches: Solid or perforated steel, 0.053 inch thick.
b. Size 24 Inches and Larger: Solid aluminum, 0.10 inch or steel, 0.093 inch thick.

7. Internal panel mounting hardware, grounding hardware, and sealing washers.
8. Grounding stud on enclosure body.
9. Thermoplastic pocket on inside of door for record Drawings and Product Data.

D. Wall-Mounted, NEMA 250, Types 4 and 12:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. B-Line; a division of Eaton, Electrical Sector.
b. Hammond Mfg. Co. Inc.
c. Hoffman; brand of nVent Electrical plc.
d. Saginaw Control and Engineering.

2. NRTL listed in accordance with UL 508A.
3. Seam and joints are continuously welded and ground smooth.
4. Where recessed enclosures are indicated, include enclosures with face flange for flush mounting.
5. Externally formed body flange around perimeter of enclosure face for continuous perimeter seamless gasket door seal.
6. Single-door enclosure sizes up to 60 inches tall by 36 inches wide.

7. Double-door enclosure sizes up to 36 inches tall by 60 inches wide.
8. Construct enclosure of steel, not less than the following:

    a. Size Less Than 24 Inches: 0.053 inch or 0.067 inch thick.
    b. Size 24 Inches and Larger: 0.067 inch thick.

9. Finish enclosure with polyester powder coating that is electrostatically applied and then baked to bond to substrate.

    a. Exterior Color: Manufacturer's standard.
    b. Interior Color: Manufacturer's standard.

10. Corner-formed door, full size of enclosure face, supported using multiple concealed hinges with easily removable hinge pins.

    a. Sizes through 24 Inches Tall: Two hinges.
    b. Sizes between 24 Inches through 48 Inches Tall: Three hinges.
    c. Sizes Larger Than 48 Inches Tall: Four hinges.

11. Double-door enclosures with overlapping door design to include unobstructed full-width access.

    a. Single-door enclosures 48 inches and taller, and all double-door enclosures, with three-point (top, middle and bottom) latch system.

12. Removable internal panel with white or gray polyester powder coating that is electrostatically applied and then baked to bond to substrate.

    a. Size Less Than 24 Inches: Solid or perforated steel, 0.053 inch thick.
    b. Size 24 Inches and Larger: Solid aluminum, 0.10 inch or steel, 0.093 inch thick.

13. Internal panel mounting studs with hardware, grounding hardware, and sealing washers.
14. Grounding stud on enclosure body.
15. Thermoplastic pocket on inside of door for record Drawings and Product Data.

E. Wall-Mounted, NEMA 250, Type 4X-SS:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Crouse-Hinds; brand of Eaton, Electrical Sector.
    b. Hammond Mfg. Co. Inc.
    c. Hoffman; brand of nVent Electrical plc.
    d. Saginaw Control and Engineering.

2. NRTL listed in accordance with UL 508A.
3. Seams and joints are continuously welded and ground smooth.
4. Externally formed body flange around perimeter of enclosure face for continuous perimeter seamless gasket door seal.

5. Construct enclosure of Type 304 or Type 316L stainless steel, not less than the following:

    a. Size Less Than 24 Inches: 0.053 inch thick.
    b. Size 24 Inches and Larger: 0.067 inch thick.

6. Outside body and door of enclosure with brushed No. 4 finish.
7. Corner-formed door, full size of enclosure face, supported using multiple concealed hinges with easily removable hinge pins.

    a. Sizes through 24 Inches Tall: Two hinges.
    b. Sizes between 24 Inches through 48 Inches Tall: Three hinges.
    c. Sizes Larger Than 48 Inches Tall: Four hinges.

8. Doors fitted with three-point (top, middle, and bottom) latch system with single, heavy-duty, liquidtight, stainless steel handle with integral locking mechanism.
9. Removable internal panel of 0.093-inch stainless steel.
10. Internal panel mounting studs and hardware, grounding hardware, and sealing washers.
11. Install corrosion-resistant polyester vent drain in a stainless steel sleeve at bottom of enclosure.
12. Include enclosure with stainless steel mounting brackets.

F. Freestanding, NEMA 250, Type 1:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. B-Line; a division of Eaton, Electrical Sector.
    b. Hammond Mfg. Co. Inc.
    c. Hoffman; brand of nVent Electrical plc.
    d. Saginaw Control and Engineering.

2. NRTL listed in accordance with UL 508A.
3. Seams and joints are continuously welded and ground smooth.
4. Externally formed body flange around perimeter of enclosure face.
5. Single-door enclosure sizes up to 84 inches tall by 36 inches wide.
6. Double-door enclosure sizes up to 84 inches tall by 72 inches wide.
7. Construct enclosure of steel, not less than 0.067 inch thick.
8. Finish enclosure with polyester powder coating that is electrostatically applied and then baked to bond to substrate.

    a. Exterior Color: Manufacturer's standard.
    b. Interior Color: Manufacturer's standard.

9. Corner-formed flush door, full size of enclosure face, supported using four concealed hinges with easily removable hinge pins.
10. Double-door enclosures with overlapping door design to include unobstructed full-width access.
11. Doors with three-point (top, middle, and bottom) latch system with single heavy-duty handle and integral locking mechanism.
12. Removable back covers.

13. Removable solid steel internal panel, 0.093 inch thick, with white or gray polyester powder coating that is electrostatically applied and then baked to bond to substrate.
14. Internal panel mounting studs with hardware, grounding hardware, and sealing washers.
15. Grounding stud on enclosure body.
16. Thermoplastic pocket on inside of door for record Drawings and Product Data.
17. Nominal 4-inch- tall integral lifting base, not less than 0.123 inch thick, with predrilled holes for attachment to mounting surface.
18. Equip each top end of enclosure with lifting tabs, not less than 0.172 inch thick, or not less than two lifting eyes.
19. Internal rack-mount shelves and angles, as required by application.

G. Freestanding, NEMA 250, Types 4 and 12:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. B-Line; a division of Eaton, Electrical Sector.
    b. Hammond Mfg. Co. Inc.
    c. Hoffman; brand of nVent Electrical plc.
    d. Saginaw Control and Engineering.

2. NRTL listed in accordance with UL 508A.
3. Seams and joints are continuously welded and ground smooth.
4. Externally formed body flange around perimeter of enclosure face.
5. Type 12 Enclosure Sizes:

    a. Single-door enclosure sizes up to 90 inches tall by 36 inches wide.
    b. Double-door enclosure sizes up to 90 inches tall by 72 inches.

6. Type 4 Enclosure Sizes:

    a. Single-door enclosure sizes up to 72 inches tall by 36 inches wide.
    b. Double-door enclosure sizes larger than 36 inches wide.

7. Construct enclosure of steel, not less than 0.093 inch thick.
8. Finish enclosure with polyester powder coating that is electrostatically applied and then baked to bond to substrate.

    a. Exterior Color: Manufacturer's standard.
    b. Interior Color: Manufacturer's standard.

9. Corner-formed door with continuous perimeter oil-resistant gasket supported using continuous piano hinge full length of door.
10. Doors fitted with three-point (top, middle, and bottom) latch system with latching rod rollers and single, heavy-duty, oiltight handle with integral locking mechanism.
11. Removable solid steel internal panel, 0.093 inch thick, with white or gray polyester powder coating that is electrostatically applied and then baked to bond to substrate.
12. Internal panel mounting studs with hardware, grounding hardware, and sealing washers.
13. Grounding stud on enclosure body.

14. Thermoplastic pocket on inside of door for record Drawings and Product Data.
15. Equip top of enclosure with no fewer than two lifting eyes.
16. Internal rack-mount shelves and angles, as required by application.

H. Freestanding, NEMA 250, Type 4X-SS:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Crouse-Hinds; brand of Eaton, Electrical Sector.
    b. Hammond Mfg. Co. Inc.
    c. Hoffman; brand of nVent Electrical plc.
    d. Saginaw Control and Engineering.

2. NRTL listed in accordance with UL 508A.
3. Seams and joints are continuously welded and ground smooth.
4. Externally formed body flange around perimeter of enclosure face for continuous perimeter seamless gasket door seal.
5. Construct enclosure of Type 304 or Type 316L stainless steel, not less than the following:

    a. Size Less Than 24 Inches: 0.053 inch thick.
    b. Size 24 Inches and Larger: 0.067 inch thick.

6. Outside enclosure and door of enclosure with brushed No. 4 finish.
7. Doors:

    a. Single-door enclosure sizes up to 36 inches wide.
    b. Double-door enclosure sizes larger than 36 inches wide.
    c. Corner-formed door(s) with continuous perimeter oil-resistant gasket, full size of enclosure face, supported using continuous piano hinge full length of door.
    d. Doors fitted with three-point (top, middle, and bottom) latch system with single, heavy-duty, liquidtight, Type 304 or Type 316L stainless steel handle with integral locking mechanism.

8. Removable internal panel of 0.093-inch stainless steel.
9. Internal panel mounting studs and hardware, grounding hardware, and sealing washers.
10. Install corrosion-resistant polyester vent drain in a stainless steel sleeve at bottom of enclosure.
11. Include enclosure with stainless steel mounting brackets.
12. Thermoplastic pocket on inside of door for record Drawings and Product Data.
13. Equip top of enclosure with no fewer than two lifting eyes.
14. Internal rack-mount shelves and angles, as required by application.

I. Accessories:

1. Electric Heater:

    a. Aluminum housing with brushed finish.
    b. Thermostatic control with adjustable set point from 0 to 100 deg F.

c. Capacity: 100, 200, 400, and 800 W, as required by application.
d. Fan draws cool air from bottom of enclosure and passes air across thermostat and heating elements before being released into enclosure cavity. Heated air is discharged through the top of heater.

2. Ventilation Fans, Filtered Intake, and Exhaust Grilles:

a. Number and size of fans, filters, and grilles, as required by application.
b. Compact cooling fans engineered for 50,000 hours of continuous operation without lubrication or service.
c. Fans capable of being installed on any surface and in any position within enclosure for spot cooling or air circulation.
d. Thermostatic control with adjustable set point from 32 to 140 deg F.
e. Airflow Capacity at Zero Pressure:

1) 4-Inch Fan: 100 cfm.
2) 6-Inch Fan: 240 cfm.
3) 10-Inch Fan: 560 cfm.

f. Maximum operating temperature of 158 deg F.
g. 4-inch fan thermally protected and provided with permanently lubricated ball-bearings.
h. 6- and 10-inch fans with ball-bearing construction and split capacitor motors thermally protected to avoid premature failure.
i. Dynamically balanced impellers molded from polycarbonate material.
j. Fan furnished with power cord and polarized plug for power connection.
k. Fan brackets, finger guards, and mounting hardware provided with fans to complete installation.
l. Removable Intake and Exhaust Grilles: ABS plastic or stainless steel, of size to match fan size and suitable for NEMA 250, Types 1 and 12 enclosures.
m. Filters for NEMA 250, Type 1 Enclosures: Washable foam or aluminum, of size to match intake grille.
n. Filters for NEMA 250, Type 12 Enclosures: Disposable, of size to match intake grille.

3. Air Conditioner:

a. Electric-powered, self-contained, air-conditioning unit specially designed for electrical enclosures to maintain temperature inside enclosure below ambient temperature outside enclosure.
b. Thermostatic control with adjustable set point from 60 to 120 deg F.
c. Enclosure side or top mounting with unit capacity, as required by application.
d. Designed for closed-loop cooling with continuous operation in ambient environments up to 125 deg F.
e. HFC refrigerant.
f. Reusable and washable air filter.
g. High-performance, industrial-grade, and high-efficiency fans.
h. Furnished with power cord and polarized plug for power connection.
i. Condensate management system with base pan side drain.

j. Mounting hardware, gaskets, mounting template, and instruction manual furnished with unit.
k. Outdoor units equipped with head pressure control for low ambient operation, compressor heater, coated condenser coil, and thermostat.

4. Thermoelectric Humidifier:

a. ABS plastic enclosure.
b. Capacity of 8 oz. of water per 24 hours.
c. Built-in drain captures moisture and plastic hose directs moisture to outside enclosure through a drain.
d. Controlled to maintain enclosure relative humidity at adjustable set point.
e. Unit power supply is internally wired to enclosure electrical power source.

5. Framed Fixed Window Kit for NEMA 250, Types 4, 4X, and 12 Enclosures:

a. 0.25-inch- thick, scratch-resistant acrylic or polycarbonate window mounted in a metal frame matching adjacent door material.
b. Enclosure types, except NEMA 250 Type 1, to have continuous gasket material around perimeter of window and frame to provide watertight seal.
c. Window kit to be factory or shop installed before shipment to Project.

6. Frameless Fixed Window Kit for NEMA 250, Type 1 Enclosures:

a. 0.125-inch- thick, polycarbonate window mounted in enclosure door material.
b. Window attached to door with screw fasteners and continuous strip of high-strength, double-sided tape around window perimeter.
c. Window kit is factory or shop installed before shipment to Project.

7. Frame Fixed or Hinged Window Kit for NEMA 250, Types 1 and 12 Enclosures:

a. 0.25-inch- thick, scratch-resistant acrylic or polycarbonate window mounted in a metal frame matching adjacent door material.
b. Enclosure types, except NEMA 250 Type 1, to have continuous gasket material around perimeter of window and frame to provide watertight seal.
c. Window kit to be factory or shop installed before shipment to Project.

8. Bar handle with keyed cylinder lock set.

2.17 RELAYS

A. General-Purpose Relays:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Allen Bradley; by Rockwell Automation.
b. Eaton.

c. IDEC Corporation.
d. Omron Americas.
e. Siemens Industry, Inc., Building Technologies Division.
f. Square D; Schneider Electric USA.

2. NRTL listed.
3. Heavy-duty, electromechanical type; rated for at least 10 A at 250 V ac and 60 Hz.
4. SPDT, DPDT, or three-pole double-throw, as required by control application.
5. Plug-in-style relay with 8-pin octal or multiblade plug for DPDT relays and 11-pin octal or multiblade plug for three-pole double-throw relays.
6. Construct contacts of silver, silver alloy, or gold.
7. Enclose relay in a clear transparent polycarbonate dust-tight cover.
8. Include LED indication and push-to-test button to test manual operation of relay without power on coil.
9. Performance:

a. Mechanical Life: At least 10 million cycles.
b. Electrical Life: At least 100,000 cycles at rated load.
c. Pickup Time: 20 ms or less.
d. Dropout Time: 20 ms or less.
e. Pull-in Voltage: 85 percent of rated voltage.
f. Dropout Voltage: 10 percent of nominal rated voltage.
g. Power Consumption: 5 VA or less.
h. Ambient Operating Temperatures: Minus 40 to 115 deg F.

10. Equip relays with coil transient suppression to limit transients to non-damaging levels.
11. Plug each relay into industry-standard, 35 mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
12. Include relay socket with screw terminals. Mold into socket the coincident screw terminal numbers.

B. Multifunction Time-Delay Relays:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Allen Bradley; by Rockwell Automation.
b. Eaton.
c. IDEC Corporation.
d. Omron Americas.
e. Siemens Industry, Inc., Building Technologies Division.
f. Square D; Schneider Electric USA.

2. NRTL listed.
3. Continuous-duty type, rated for at least 10 A at 240 V ac and 60 Hz.
4. Relay with up to 4 programmable functions to provide on/off delay, interval, and recycle timing functions.
5. Plug-in-style relay with either multi-pin or blade plug.
6. Construct contacts of silver, silver alloy, or gold.

7. Enclose relay in a dust-tight cover.
8. Include knob and dial scale for alternative digital interface for setting delay time.
9. Visual Status Indication: Power "On" status.
10. Performance:

    a. Mechanical Life: At least 10 million cycles.
    b. Electrical Life: At least 100,000 cycles at rated load.
    c. Timing Ranges: Multiple ranges from 0.1 seconds to 100 minutes.
    d. Repeatability: Within 2 percent.
    e. Recycle Time: 45 > ms.
    f. Minimum Pulse-Width Control: 50 ms.
    g. Power Consumption: 5 VA or less.
    h. Ambient Operating Temperatures: Minus 40 to 115 deg F.

11. Equip relays with transient suppression to limit transients to non-damaging levels.
12. Plug each relay into industry-standard, 35 mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
13. Include relay socket with screw terminals. Mold into socket the coincident screw terminal numbers.

C. Latching Relays:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Allen Bradley; by Rockwell Automation.
    b. Eaton.
    c. IDEC Corporation.
    d. Omron Americas.
    e. Siemens Industry, Inc., Building Technologies Division.
    f. Square D; Schneider Electric USA.

2. NRTL listed.
3. Continuous-duty type, rated for at least 10 A at 250 V ac and 60 Hz.
4. SPDT, DPDT, or three-pole double-throw, as required by control application.
5. Plug-in-style relay with either multi-pin or blade plug.
6. Construct contacts of silver, silver alloy, or gold.
7. Enclose relay in a clear transparent polycarbonate dust-tight cover.
8. Performance:

    a. Mechanical Life: At least 10 million cycles.
    b. Electrical Life: At least 100,000 cycles at rated load.
    c. Pickup Time: 20 ms or less.
    d. Dropout Time: 20 ms or less.
    e. Pull-in Voltage: 85 percent of rated voltage.
    f. Dropout Voltage: 50 percent of nominal rated voltage.
    g. Power Consumption: 5 VA or less.
    h. Ambient Operating Temperatures: Minus 40 to 115 deg F.

9. Equip relays with coil transient suppression to limit transients to non-damaging levels.
10. Plug each relay into industry-standard, 35 mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
11. Relay socket with screw terminals. Mold into socket the coincident screw terminal numbers.

D. Current Sensing Relays:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Eaton.
    b. Functional Devices Inc.
    c. NK Technologies.
    d. Square D; Schneider Electric USA.

2. NRTL listed.
3. Monitors ac current.
4. Independent adjustable controls for pickup and dropout current.
5. Energized when supply voltage is present and current is above pickup setting.
6. De-energizes when monitored current is below dropout current.
7. Dropout current is adjustable from 50 to 95 percent of pickup current.
8. Visual indication of contact status.
9. Include current transformer, if required for application.
10. House current sensing relay and current transformer if required in its own enclosure. Use NEMA 250, Type 1 or Type 12 enclosure for indoors applications and NEMA 250, Type 4 or Type 4X for outdoor applications.

E. Combination On-Off Status Sensor and On-Off Control Relays:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Functional Devices Inc.
    b. Veris Industries.

2. Description:

    a. On-off control and on-off status indication in a single device.
    b. LED status indication of activated relay and current trigger.
    c. Closed-Open-Auto override switch located on the load side of relay.

3. Performance:

    a. Ambient Temperature: Minus 30 to 140 deg F.
    b. Voltage Rating: Single-phase loads rated for 300 V ac. Three-phase loads rated for 600 V ac.

4. Status Indication:

a. Current Sensor: Integral sensing for single-phase loads up to 20 A and external solid or split sensing ring for three-phase loads up to 150 A.
b. Current Sensor Range: As required by application.
c. Current Set Point: Fixed or adjustable, as required by application.
d. Current Sensor Output:

1) Solid-state, SPDT contact rated for 30 V ac and dc and for 0.4 A.
2) Or Solid-state, SPDT contact rated for 120 V ac and 1.0 A.
3) Or Analog, 0 to 5 or 10 V dc.
4) Or Analog, 4 to 20 mA, loop powered.

5. Relay: SPDT, continuous-duty coil; rated for 10-million mechanical cycles.
6. Enclosure: NEMA 250, Type 1 or Type 12 enclosure for indoor applications; NEMA 250, Type 4 or Type 4X enclosure for outdoor applications.

2.18 ELECTRICAL POWER DEVICES

A. Control Transformers:

1. Sizing Criteria: Size control transformers for total connected load, plus additional 25 percent of connected load for future spare capacity.
2. Transformer Minimum Capacity: 40 VA.
3. Protection: Provide transformers with both primary and secondary fuses. (Integral circuit breaker is acceptable in lieu of fuses.)
4. Enclosure: House control transformers in NEMA 250 enclosures, type as indicated in "Performance Requirements" Article for application.

B. DC Power Supplies:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Acopian Technical Company.
b. Emerson Electric Co., Automation Solutions.
c. IDEC Corporation.
d. Omron Americas.

2. Description: Linear or switched, regulated power supplies with ac input to one or multiple dc output(s).

a. Include both line and load regulation to ensure stable output.
b. To protect both power supply and load, include power supply with an automatic current limiting circuit.

3. Features:

a. Connection: Plug-in style suitable for mating with standard socket. Include power supply with mating mounting socket.

b. Housing: Enclose circuitry in a housing.
c. Local Adjustment: Include screw adjustment on exterior of housing for dc voltage output.
d. Mounting: DIN rail.
e. Visual status indicator.

4. Performance:

a. Input Voltage: Nominally 120 V ac, 60 Hz.
b. Output Voltage: Nominally 24 V dc with plus or minus 1 V dc adjustment.
c. Output Current: Minimum 100 mA.
d. Load Regulation: Within 0.1 percent.
e. Line Regulation: Within 0.05 percent.
f. Stability: Within 0.1 percent of rated volts after warmup period.
g. Ripple: 1 mV rms.

2.19 PRESSURE INSTRUMENT SIGNAL AIR PIPING AND TUBING

A. Products in this article are intended for use with the following:

1. Signal air between pressure instruments, such as sensors, switches, transmitters, controllers, and accessories.

B. Copper Tubing:

1. Seamless phosphor deoxidized copper, drawn tempered, or soft annealed, with chemical and physical properties in accordance with ASTM B75.
2. Performance, dimensions, weight, and tolerance in accordance with ASTM B280.
3. Diameter, as required by application, not less than nominal 1/4 inch.
4. Wall thickness, as required by application, but not less than 0.030 inch.
5. Copper Tubing Connectors and Fittings - Brass, Compression Type:

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) BrassCraft Manufacturing Co.; a Masco company.
2) DK-LOK USA.
3) Mid-America Fittings, LLC; A Midland Industries Company.
4) Parker (Parker Hannifin).

b. Single or double ferrule design creating a constant tension between fitting body and fitting nut for leak-free seal.

6. Copper Tubing Connectors and Fittings - Copper, Solder-Joint Type:

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Elkhart Products Corporation; a part of Aalberts Integrated Piping Systems.
2) NIBCO INC.
3) Paul Mueller Company.

b. Copper Solder-Joint Fittings: Cast, ASME B16.18 or wrought, ASME B16.22.

C. Galvanized-Steel Piping (for Pneumatic/Pressure Instrument Signal Air):

1. Pipe: ASTM A53, Schedule 40.
2. Fittings: Galvanized malleable iron, ASME B16.3, Class 150.

D. Polyethylene Tubing: (Pressure Instrument Signal Air).

1. Fire-resistant, black virgin polyethylene in accordance with ASTM D1248, Type 1, Class C, and Grade 5.
2. Complying with stress crack test in accordance with ASTM D1693.
3. Diameter, as required by application, of not less than nominal 1/4 inch.
4. Polyethylene Tubing Connectors and Fittings - Brass, Barb Fittings:

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) BrassCraft Manufacturing Co.; a Masco company.
2) DK-LOK USA.
3) Mid-America Fittings, LLC; A Midland Industries Company.
4) Parker (Parker Hannifin).

b. Tapered and beaded hose barbs of push-on design; intended for low-pressure applications only.

5. Polyethylene Tubing Connectors and Fittings - Brass, Compression Type:

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) BrassCraft Manufacturing Co.; a Masco company.
2) DK-LOK USA.
3) Mid-America Fittings, LLC; A Midland Industries Company.
4) Parker (Parker Hannifin).

b. Specially designed for jointing polyethylene tubing to provide leak-free seal without twisting or weakening polyethylene tubing.

2.20 PROCESS TUBING

A. Products in this article are intended for signals to instruments connected to liquid and steam systems.

B. Copper Tubing:

1. Seamless phosphor deoxidized copper, drawn tempered with chemical and physical properties in accordance with ASTM B75.
2. Performance, dimensions, weight, and tolerance in accordance with ASTM B280.
3. Diameter, as required by application, of not less than nominal 1/2 inch.
4. Wall thickness, as required by application, but not less than 0.030 inch.
5. Copper Tubing Connectors and Fittings (for Process Tubing) - Brass, Compression Type:

    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

        1) BrassCraft Manufacturing Co.; a Masco company.
        2) DK-LOK USA.
        3) Mid-America Fittings, LLC; A Midland Industries Company.
        4) Parker (Parker Hannifin).

    b. Single or double ferrule design creating a constant tension between fitting body and fitting nut for leak-free seal.

6. Copper Tubing Connectors and Fittings (for Process Tubing) - Brass, Solder-Joint Type:

    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

        1) Elkhart Products Corporation; a part of Aalberts Integrated Piping Systems.
        2) NIBCO INC.

    b. Copper Solder-Joint Fittings: Cast, ASME B16.18 or wrought, ASME B16.22.

C. Stainless Steel Tubing (for Process Tubing):

1. Seamless Type 316 stainless steel, Grade TP, cold drawn, annealed and pickled, and free from scale.
2. Chemical and physical properties in accordance with ASTM A269.
3. Diameter, as required by application, of not less than nominal 1/2 inch.
4. Wall thickness, as required by application, but not less than 0.035 inch.
5. Furnish stainless steel tubing in 20 ft. straight random lengths.

D. Stainless Steel Tubing Connectors and Fittings (for Process Tubing) - Stainless Steel, Compression Type:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. DK-LOK USA.
    b. Parker (Parker Hannifin).
    c. Sizto Tech Corporation (STC).

2. Connectors and fittings constructed from Type 316 stainless steel, with collets, flareless type.

3. Single or double ferrule design creating a constant tension between fitting body and fitting nut for leak-free seal.
4. Connect instruments to tubing with connectors having compression connector on one end and IPS or NPT thread on other end.

2.21 CONTROL WIRE AND CABLE

A. Wire: Single conductor control wiring above 24 V.

1. Wire Size: Minimum 14 AWG.
2. Conductors: 7/24 soft annealed copper strand with 2- to 2.5-inch lay.
3. Conductor Insulation: 600 V, Type THWN or Type THHN, and 90 deg C in accordance with UL 83.
4. Conductor Insulation Colors: Black (hot), white (neutral), and green (ground).
5. Furnish on spools.

B. Single, Twisted-Shielded, Instrumentation Cable above 24 V:

1. Wire Size: Minimum 18 AWG.
2. Conductors: Twisted, 7/24 soft annealed copper strand with a 2- to 2.5-inch lay.
3. Conductor Insulation: Type THHN/THWN or Type TFN rating.
4. Conductor Insulation Colors:

    a. Twisted Pair: Black and white.
    b. Twisted Triad: Black, red, and white.

5. Shielding: 100 percent type, 0.35/0.5-mil aluminum/Mylar tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
6. Outer Jacket Insulation: 600 V, 90 deg C rating, and Type TC cable.
7. Furnish on spools.

C. Single, Twisted-Shielded, Instrumentation Cable 24 V and Less:

1. Wire Size: Minimum 22 AWG.
2. Conductors: Twisted, 7/24 soft annealed copper stranding with a 2- to 2.5-inch lay.
3. Conductor Insulation: Nominal 15-mil thickness, constructed from flame-retardant PVC.
4. Conductor Insulation Colors:

    a. Twisted Pair: Black and white.
    b. Twisted Triad: Black, red, and white.

5. Shielding: 100 percent type, 1.35-mil aluminum/polymer tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
6. Outer Jacket Insulation: 300 V, 105 deg C rating, and Type PLTC cable.
7. Furnish on spools.

D. LAN and Communication Cable: Comply with DDC system manufacturer requirements for network being installed.

1. Comply with following requirements for balanced twisted pair cable described in Section 260523 "Control-Voltage Electrical Power Cables."

    a. Plenum rated.
    b. Unique color that is different from other cables used on Project.

2.22 RACEWAYS

A. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems" and Section 260533.16 "Boxes and Covers for Electrical Systems" for electrical power raceways and boxes.

B. Comply with requirements in Section 270528 "Pathways for Communications Systems" for raceways for balanced twisted pair cables and optical fiber cables.

2.23 ACCESSORIES

A. Pneumatic Pressure Gauges:

1. Face Size: 1.5-inch- diameter face for pressures up through 30 psig and 2.5-inch-diameter face for greater pressures.
2. Face Markings: White dial face with black printing; 1 psig increment for scale ranges through 30 psig and 2 psig increment for larger ranges.
3. Accuracy: Within 1 percent of full-scale range.
4. Applications: Include separate gauges for branch pressure and main pressure tubing.

B. Pressure Electric Switches:

1. Description: Diaphragm-operated, snap-acting switch.
2. Performance:

    a. Rating: Resistance loads at 120 V ac.
    b. Set Point: Adjustable from 3 to 20 psig.
    c. Differential: Adjustable from 2 to 6 psig.

3. Body and Switch Housing: Metal.

C. Control Damper Blade Limit Switches:

1. Application: Sense positive open and/or closed position of damper blades.
2. NEMA 250, Type 13, oiltight construction. Install in instrument enclosure where required for additional environmental protection.
3. Arrange for mounting application, and to prevent "over-center" operation.

2.24 IDENTIFICATION

A. Instrument Air Pipe and Tubing:

1. Engraved tag bearing the following information:

    a. Service (Example): "Instrument Air."
    b. Pressure Range (Example): 0 to 30 psig.

2. Letter size minimum of high.
3. Engraved phenolic consisting of three layers of rigid laminate. Top and bottom layers color-coded blue with contrasting white center exposed by engraving through outer layer.
4. Include tag with brass grommet, chain, and S-hook.

B. Control Equipment, Instruments, and Control Devices:

1. Laminated acrylic or melamine plastic sign bearing unique identification.

    a. Include instruments with unique identification identified by equipment being controlled or monitored, followed by point identification.

2. Letter size as follows:

    a. Servers: Minimum of 0.5 inch high.
    b. DDC Controllers: Minimum of 0.5 inch high.
    c. Gateways: Minimum of 0.5 inch high.
    d. Repeaters: Minimum of 0.5 inch high.
    e. Enclosures: Minimum of 0.5 inch high.
    f. Electrical Power Devices: Minimum of 0.25 inch high.
    g. UPS units: Minimum of 0.5 inch high.
    h. Accessories: Minimum of 0.25 inch high.
    i. Instruments: Minimum of 0.25 inch high.
    j. Control Damper and Valve Actuators: Minimum of 0.25 inch high.

3. Engraved phenolic consisting of three layers of rigid laminate. Top and bottom layers color-coded black with contrasting white center exposed by engraving through outer layer.
4. Instruments, control devices, and actuators with Project-specific identification tags having unique identification numbers following requirements indicated and provided by original manufacturer do not require additional identification.

C. Valve Tags:

1. Brass tags and brass chains attached to valve.
2. Tag Size: Minimum 1.5 inches in diameter.
3. Include tag with unique valve identification indicating control influence such as flow, level, pressure, or temperature; followed by location of valve, and followed by three-digit sequential number.
4. Valves with Project-specific identification tags having unique identification numbers following requirements indicated and provided by original manufacturer do not require an additional tag.

D. Raceway and Boxes:

1. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
2. Paint cover plates on junction boxes and conduit same color as tape banding for conduits. After painting, label cover plate "HVAC Controls" using engraved phenolic tag.
3. For raceways housing air signal tubing, add phenolic tag labeled "HVAC Air Signal Tubing."

E. Equipment Warning Labels:

1. Self-adhesive label with pressure-sensitive adhesive back and peel-off protective jacket.
2. Lettering size at least 14-point type with white lettering on red background.
3. Warning label to read "CAUTION-Equipment operated under remote automatic control and may start or stop at any time without warning. Switch electric power disconnecting means to OFF position before servicing."
4. Lettering to be enclosed in a white line border. Edge of label is to extend at least 0.25 inch beyond white border.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. Verify compatibility with and suitability of substrates.

B. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.

C. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.

D. Examine walls, floors, roofs, and ceilings for suitable conditions where product will be installed.

E. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 DDC SYSTEM INTERFACE WITH OTHER SYSTEMS AND EQUIPMENT

A. Communication Interface to Equipment with Integral Controls:

1. DDC system has communication interface with equipment having integral controls and having communication interface for remote monitoring or control.

2. Equipment to be connected are included in the sequence of operation located on the drawings.

3.3 PREINSTALLATION INTEGRATION TESTING

A. Perform the following pretesting of other systems and equipment integration with DDC system before field installation:

1. Test all communications in a controlled environment to ensure connectivity.
2. Load software and demonstrate functional compliance with each control sequence of operation indicated.
3. Using simulation, demonstrate compliance with sequences of operation and other requirements indicated including, but not limited to, the following:

    a. HVAC equipment controlled through DDC system, such as boilers, chillers, pumps, and air-handling units.
    b. Equipment faults and system recovery with fault annunciation.
    c. Analog and Boolean value alarming and annunciation.

4. Develop a method for testing interfaces before deployment.
5. Submit documentation supporting compliance upon request.

3.4 DDC SYSTEM INTERFACE WITH EXISTING SYSTEMS

A. Interface with Existing Systems:

1. Interface DDC systems with existing campus wide systems to achieve integration indicated.
2. Monitoring and Control of DDC System by Existing Control System:

    a. Satisfy DDC system performance requirements when monitoring and controlling DDC system by existing control system.
    b. Operator of existing system to upload, download, monitor, trend, control, and program every I/O point in DDC system from existing control system using existing control system software and operator workstations.
    c. Make interface so operator of existing system is not required to learn new software for remote monitoring and control from existing control system.
    d. Make interface of DDC system into existing control system transparent to operators of existing control system and allow operators to monitor and control DDC system from any operator workstation connected to existing control system.

3.5 CONTROL DEVICES FOR INSTALLATION BY INSTALLERS

A. Deliver selected control devices, specified in indicated HVAC instrumentation and control device Sections, to identified equipment and systems manufacturers for factory installation and to identified installers for field installation.

B. Deliver the following to duct fabricator and Installer for installation in ductwork. Include installation instructions to Installer and supervise installation for compliance with requirements.

1. Control dampers, which are specified in Section 230923.12 "Control Dampers."
2. Airflow sensors and switches, which are specified in Section 230923.14 "Flow Instruments."
3. Pressure sensors, which are specified in Section 230923.23 "Pressure Instruments."

C. Deliver the following to plumbing and HVAC piping installers for installation in piping. Include installation instructions to Installer and supervise installation for compliance with requirements.

1. Control valves, which are specified in Section 230923.11 "Control Valves."
2. Pipe-mounted flow meters, which are specified in Section 230923.14 "Flow Instruments."
3. Pipe-mounted sensors, switches, and transmitters. Flow meters are specified in Section 230923.14 "Flow Instruments."
4. Tank-mounted sensors, switches, and transmitters. Pressure sensors, switches, and transmitters are specified in Section 230923.23 "Pressure Instruments."
5. Liquid and steam temperature sensors, switches, and transmitters are specified in Section 230923.27 "Temperature Instruments."
6. Pipe- and tank-mounted thermowells. Liquid and steam thermowells are specified in Section 230923.27 "Temperature Instruments."

3.6 CONTROL DEVICES FOR EQUIPMENT MANUFACTURER FACTORY INSTALLATION

A. Deliver the following to air-handling unit manufacturer for factory installation. Include installation instructions to air-handling unit manufacturer.

1. Programmable application or application-specific controller.
2. Unit-mounted DDC control dampers and actuators, which are specified in Section 230923.12 "Control Dampers."
3. Unit-mounted airflow sensors, switches, and transmitters, which are specified in Section 230923.14 "Flow Instruments."
4. Unit-mounted gas sensors, and transmitters, which are specified in Section 230923.16 "Gas Instruments."
5. Unit-mounted leak-detection switches, which are specified in Section 230923.18 "Leak Detection Instruments."
6. Unit-mounted pressure sensors, switches, and transmitters, which are specified in Section 230923.23 "Pressure Instruments."
7. Unit-mounted speed sensors, switches, and transmitters, which are specified in Section 230923.24 "Speed Instruments."
8. Unit-mounted temperature sensors, switches, and transmitters. Air-temperature sensors, switches, and transmitters are specified in Section 230923.27 "Temperature Instruments."
9. Relays.

B. Deliver the following to terminal unit manufacturer for factory installation. Include installation instructions to terminal unit manufacturer.

1. Application-specific controller.
2. Electric damper actuator. Damper actuators are specified in Section 230923.12 "Control Dampers."
3. Unit-mounted flow and pressure sensors, transmitters, and transducers. Flow sensors, transmitters, and transducers are specified in Section 230923.14 "Flow Instruments." Pressure sensors, switches, and transmitters are specified in Section 230923.23 "Pressure Instruments."
4. Unit-mounted temperature sensors. Air-temperature sensors, switches, and transmitters are specified in Section 230923.27 "Temperature Instruments."
5. Relays.

C. Deliver the following to fan-coil unit manufacturer for factory installation. Include installation instructions to fan-coil unit manufacturer.

1. Application-specific controller.
2. Unit-mounted temperature sensors. Air-temperature sensors, switches, and transmitters are specified in Section 230923.27 "Temperature Instruments."
3. Flow and pressure switches. Air and liquid flow sensors, transmitters, and transducers are specified in Section 230923.14 "Flow Instruments." Pressure sensors, switches, and transmitters are specified in Section 230923.23 "Pressure Instruments."
4. Leak-detection switches, which are specified in Section 230923.18 "Leak Detection Instruments."
5. Relays.

3.7 GENERAL INSTALLATION REQUIREMENTS

A. Install products to satisfy more stringent of all requirements indicated.

B. Install products level, plumb, parallel, and perpendicular with building construction.

C. Support products, tubing, piping wiring, and raceways.

D. If codes and referenced standards are more stringent than requirements indicated, comply with requirements in codes and referenced standards.

E. Fabricate openings and install sleeves in ceilings, floors, roof, and walls required by installation of products. Before proceeding with drilling, punching, and cutting, check for concealed work to avoid damage. Patch, flash, grout, seal, and refinish openings to match adjacent condition.

F. Firestop Penetrations Made in Fire-Rated Assemblies: Comply with requirements in Section 078413 "Penetration Firestopping."

G. Seal penetrations made in acoustically rated assemblies. Comply with requirements in Section 079200 "Joint Sealants."

H. Welding Requirements:

1. Restrict welding and burning to supports and bracing.

2. No equipment is cut or welded without approval. Welding or cutting will not be approved if there is risk of damage to adjacent Work.
3. Welding, where approved, is to be by inert-gas electric arc process and is to be performed by qualified welders in accordance with applicable welding codes.
4. If requested on-site, show satisfactory evidence of welder certificates indicating ability to perform welding work intended.

I. Fastening Hardware:

1. Wrenches, pliers, and other tools that damage surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening fasteners.
2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

J. If product locations are not indicated, install products in locations that are accessible and that will permit service and maintenance from floor, equipment platforms, or catwalks without removal of permanently installed furniture and equipment.

K. Corrosive Environments:

1. Avoid or limit use of materials in corrosive airstreams and environments including, but not limited to, the following:

   a. Laboratory exhaust-air streams.

2. When conduit is in contact with a corrosive airstream and environment, use Type 316 stainless steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment. Comply with requirements for installation of raceways and boxes specified in Section 260533.13 "Conduits for Electrical Systems," Section 260533.16 "Boxes and Covers for Electrical Systems," and Section 260533.23 "Surface Raceways for Electrical Systems."
3. Where instruments are located in a corrosive airstream and are not already corrosive resistant from instrument manufacturer, field install products in NEMA 250, Type 4X instrument enclosure constructed of Type 316L stainless steel.

3.8 INSTALLATION OF WORKSTATIONS

A. Color Graphics Application:

1. Use system schematics indicated on Drawings as starting point to create graphics.
2. Develop Project-specific library of symbols for representing system equipment and products.
3. Incorporate digital images of Project-completed installation into graphics where beneficial to enhance effect.
4. Submit sketch of graphic layout with description of all text for each graphic for Owner's review before creating graphic using graphics software.
5. Seek Owner input in graphics development once using graphics software.

6. Make final editing on-site with Owner's review and feedback.
7. Refine graphics as necessary for Owner acceptance.
8. On receiving Owner acceptance, print a PDF file of each graphic and include with softcopy of DDC system operation and maintenance manual.

3.9 INSTALLATION OF SERVERS

A. Install server(s) at location(s) indicated on Drawings.

B. Install software indicated on server(s) and verify that software functions properly.

C. Develop Project-specific graphics, trends, reports, logs, and historical database.

D. Power servers through dedicated UPS unit. Locate UPS adjacent to server. Install rack-mounted UPS units for powering rack-mounted servers and tower UPS units for tower servers.

3.10 INSTALLATION OF GATEWAYS

A. Install gateways as required for DDC system communication interface requirements indicated.

B. Test gateways to verify that communication interface functions properly.

3.11 INSTALLATION OF ROUTERS

A. Install routers as required for DDC system communication interface requirements indicated.

B. Test routers to verify that communication interface functions properly.

3.12 INSTALLATION OF CONTROLLERS

A. Install controllers in enclosures to comply with indicated requirements.

B. Connect controllers to field power supply[and to UPS units where indicated].

C. Install controllers with latest version of applicable software and configure to execute requirements indicated.

D. Test and adjust controllers to verify operation of connected I/O to achieve performance indicated requirements while executing sequences of operation.

E. Installation of Network Controllers:

1. DDC system provider and DDC system manufacturer to determine quantity and location of network controllers to satisfy requirements indicated.
2. Install controllers in a protected location that is easily accessible by operators.
3. Locate top of controller within 72 inches of finished floor.

F. Installation of Programmable Application Controllers:

1. DDC system provider and DDC system manufacturer to determine quantity and location of programmable application controllers to satisfy requirements indicated.
2. Install controllers in a protected location that is easily accessible by operators.
3. Locate top of controller within 72 inches of finished floor, except where dedicated controllers are installed at terminal units.

G. Application-Specific Controllers:

1. DDC system provider and DDC system manufacturer to determine quantity and location of application-specific controllers to satisfy requirements indicated.
2. For controllers not mounted directly on equipment being controlled, install controllers in a protected location that is easily accessible by operators.

3.13 INSTALLATION OF WIRELESS ROUTERS FOR OPERATOR INTERFACE

A. Install wireless routers to achieve optimum performance and best possible coverage.

B. Mount wireless routers in a protected location that is within 60 inches of floor and easily accessible by operators.

C. Connect wireless routers to field power supply and to UPS units if network controllers are powered through UPS units.

D. Install wireless router with latest version of applicable software and configure wireless router with security and password protection. Create access password with not less than 12 characters consisting of letters and numbers and at least one special character. Document password in operations and maintenance manuals for reference by operators.

E. Test and adjust wireless routers for proper operation with all types (such as, laptops, smartphones, and tablets) of wireless devices intended for use by operators.

3.14 INSTALLATION OF ENCLOSURES

A. Install the following items in enclosures, to comply with indicated requirements:

1. Gateways.
2. Routers.
3. Controllers.
4. Electrical power devices.
5. Relays.
6. Accessories.
7. Instruments.
8. Actuators.

B. Attach wall-mounted enclosures to wall using the following types of steel struts:

1. For NEMA 250 Enclosures: Type 1; use painted steel, galvanized-steel or corrosion-resistant-coated steel strut and hardware as required.
2. For NEMA 250 Enclosures and Enclosures Located Outdoors: Type 4 or Type 4X; use stainless steel strut and hardware.
3. Install plastic caps on exposed cut edges of strut.

C. Align top or bottom of adjacent enclosures.

D. Install floor-mounted enclosures located in mechanical equipment rooms on concrete housekeeping pads. Attach enclosure legs using galvanized-steel or stainless steel anchors as required.

E. Install continuous and fully accessible wireways to connect conduit, wire, and cable to multiple adjacent enclosures. Wireways used for application are to have protection equal to NEMA 250 rating of connected enclosures.

3.15 ELECTRIC POWER CONNECTIONS

A. Connect electrical power to DDC system products requiring electrical power connections.

B. Design of electrical power to products not indicated with electric power is delegated to DDC system provider and installing trade to provide a fully functioning DDC system. Work is to comply with NFPA 70 and other requirements indicated. Connect electrical power to nearest 120 volt panel of power system appropriate for HVAC related loads.

C. Comply with requirements in Section 262416 "Panelboards" for electrical power circuit breakers.

D. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical power conductors and cables.

E. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems," Section 260533.16 "Boxes and Covers for Electrical Systems," and Section 260533.23 "Surface Raceways for Electrical Systems" for electrical power raceways and boxes.

3.16 NETWORK NAMING AND NUMBERING

A. Coordinate with COR and provide unique naming and addressing for networks and devices.

B. ASHRAE 135 Networks:

1. MAC Address:

a. Assign and document a MAC address unique to its network for every network device.
b. Ethernet Networks: Document MAC address assigned at its creation.
c. MS/TP Networks: Assign from 00 to 64.

2. Network Numbering:

    a. Assign unique numbers to each new network.
    b. Provide ability for changing network number through device switches or operator interface.
    c. DDC system, with all possible connected LANs, can contain up to 65,534 unique networks.

3. Device Object Identifier Property Number:

    a. Assign unique device object identifier property numbers or device instances for each device network.
    b. Provide for future modification of device instance number by device switches or operator interface.
    c. LAN is to support up to 4,194,302 unique devices.

4. Device Object Name Property Text:

    a. Device object name property field to support 32 minimum printable characters.
    b. Assign unique device "Object Name" property names with plain-English descriptive names for each device.

        1) Example 1: Device object name for device controlling heating water boiler plant at Building 1000 would be "Heating Water System Bldg. 1000."
        2) Example 2: Device object name for VAV terminal unit controller could be "VAV Unit 102."

5. Object Name Property Text for Other Than Device Objects:

    a. Object name property field is to support 32 minimum printable characters.
    b. Assign object name properties with plain-English names descriptive of application.

        1) Example 1: "Zone 1 Temperature."
        2) Example 2 "Fan Start and Stop."

6. Object Identifier Property Number for Other Than Device Objects:

    a. Assign object identifier property numbers according to Drawings indicated.
    b. If not indicated, object identifier property numbers may be assigned at Installer's discretion but must be approved by Owner in advance, be documented, and be unique for like object types within device.

3.17 INSTALLATION OF AIR SIGNAL PIPING AND TUBING

A. Above-Grade Air Signal Piping and Tubing Installation:

1. Material Application:

    a. Install copper tubing, except as follows:

1) Tubing Exposed to View: Polyethylene tubing installed in raceways may be used in lieu of copper tubing.
2) Concealed Tubing: Polyethylene tubing may be used in lieu of copper tubing when concealed behind accessible ceilings and concealed in walls and connecting wall-mounted instruments with recessed connections.

b. Install copper tubing**,** unless other accessible materials are indicated, for air signals to instruments including, but not limited to, the following:

1) Sensors.
2) Switches.
3) Transmitters.

c. Install drawn-temper copper tubing, except within 36 inches of device terminations tubing is to be annealed-tempered copper tubing.
d. Install compression fittings to connect copper tubing to instruments, control devices, and accessories.
e. Install barbed or compression fittings to connect polyethylene tubing to instruments, control devices, and accessories.

2. Routing:

a. Do not expose tubing in finished spaces, such as spaces with ceilings; occupied spaces, offices, and conference rooms, unless expressly approved in writing by Architect. Tubing may be exposed in areas without ceilings.
b. Where tubing is installed in finished occupied spaces, install the tubing in surface metal raceway with appropriate fittings only where not feasible to conceal in wall, above ceiling, or behind architectural enclosures or covers.
c. Install piping and tubing plumb and parallel to and at right angles with building construction.
d. Install multiple runs of tubing or piping in equally spaced parallel lines.
e. Install piping and tubing not to interfere with access to valves, equipment, duct, and equipment access doors, or obstruct personnel access and passageways of any kind.
f. Coordinate with other trades before installation to prevent proposed piping and tubing from interfering with pipe, duct, terminal equipment, light fixtures, conduit, and cable tray space. If changes to Shop Drawings are necessary due to field coordination, document changes on Record Drawings.
g. Install vibration loops in copper tubing when connecting to instruments and actuators that vibrate.

3. Support:

a. Space supports in accordance with MSS SP-58, except support spacing not to exceed 60 inches.
b. Support copper tubing with copper hangers, clips, and tube trays.
c. Do not use tape for support or dielectric isolation.
d. Install supports at each change in direction and at each branch take-off.

e. Attached supports to building structure independent of work of other trades. Support from ducts, pipes, cable trays, and conduits is prohibited.
f. Attached support from building structure with threaded rods, structural shapes, or channel strut.
g. Install and brace supports to carry static load plus a safety margin, which will allow tubing to be serviced.
h. Brace supports to prevent lateral movement.
i. Paint steel support members that are not galvanized or zinc coated.
j. Support polyethylene tubing same as copper tubing.

4. Do not attach piping and tubing to equipment that may be removed frequently for maintenance or that may impart vibration and expansion from temperature change.
5. Joining and Makeup:

a. Where joining and mating dissimilar metals where galvanic action could occur, install dielectric isolation.
b. Install dirt leg with an isolation valve and threaded plug at each main air, connection to panel, pneumatic pilot positioner, and PRV station.
c. Make threaded joints for connecting to instrument equipment with connectors with a compression tubing connector on one end and threaded connection on the other end.
d. Make tubing bends with tube-bending tool. Hard-bends or wrinkled or flattened bends are unacceptable.
e. Install tube fittings in accordance with manufacturer's written instructions.
f. Do not make tubing connections to a fitting before completing makeup of the connection.
g. Align tubing with fitting. Avoid springing tube into position; this may result in excessive stress on both tubing and fitting with possible resulting leaks.
h. Do not install fittings close to a bend. A length of straight tubing, not deformed by bending, is required for proper connection.
i. Check tubing for correct diameter and wall thickness.
j. Cut tube ends square and deburr. Exercise care during cutting to keep tubing round.
k. Thread pipe on a threading machine. Ream inner edges of pipe ends, and file and grind to remove burrs.
l. Wrap pipe threads with single wrap of PTFE tape.
m. Protect piping and tubing from entrance of foreign matter.

6. Do not exceed 50 percent fill capacity where tubing is installed in conduit. Support conduit in accordance with NFPA 70 unless otherwise indicated.

B. Identify above-grade piping and tubing as follows:

1. Every 50 ft. of straight run.
2. At least once for each branch within 36 inches of main tee.
3. At each change in direction.
4. Within 36 inches of each ceiling, floor, roof, and wall penetration.
5. Where exposed to and where concealed from view, including above ceiling plenums, shafts, and chases.

6. At each valve.
7. Mark each instrument tube connection with a number-coded identification. Each unique tube is to have same unique number at instrument connection and termination at opposite end of tube.

3.18 INSTALLATION OF PROCESS TUBING

A. Install process tubing for signal to instruments in liquid systems. Instruments include, but are not limited to, the following:

1. Meters.
2. Sensors.
3. Switches.
4. Transmitters.

B. Support tubing in accordance with MSS SP-58, but at intervals no more than 60 inches apart.

C. Install minimum 1/2 inch process tubing for industrial-grade sensors, transmitters, and switches. Install bushings where required.

D. Make smooth tubing bends with a bending tool. Flattened or wrinkled bends are unacceptable.

E. Support tubing independent of other trades.

F. Route tubing parallel to and at right angles to building construction.

G. Install tubing concealed in areas with ceilings.

H. Install dirt leg with an isolation valve and threaded plug-in drain valve at each connection to a transmitter and switch.

I. Insulate process piping and tubing connected to hot water and steam systems for personnel protection if surface temperature exceeds 120 deg F. Only insulate piping and tubing within maintenance personnel reach from floor, platform, or catwalk.

J. Wrap pipe threads of fitting in process tubing with service temperatures below 350 deg F with single wrap of PTFE tape.

K. Coat pipe threads of fittings on process tubing in services with temperatures exceeding 350 deg F with pipe compound before being made up to reduce possibility of galling.

L. Do not make tubing connections to a fitting before completing makeup of connection.

M. Check tubing for correct diameter and wall thickness. Cut the tube ends square and deburred. Exercise care during cutting to keep tubing round.

N. Do not install fittings close to a bend. Straight length of tubing, not deformed by bending, is required for proper connection.

O. Align tubing with fitting when installed. Avoid springing tube into position.

P. Install tubing with extreme care to keep foreign matter out of system. Plug open tubing ends to keep out dust, dirt, and moisture.

Q. Do not attach tubing to equipment that may be removed frequently for maintenance or may impart vibration and expansion from temperature change.

3.19 INSTALLATION OF CONTROL WIRE, CABLE, AND RACEWAY

A. Comply with NECA 1.

B. Wire and Cable Installation:

1. Comply with installation requirements in Section 260523 "Control-Voltage Electrical Power Cables."
2. Install cables with protective sheathing that is waterproof and capable of withstanding continuous temperatures of 90 deg C with no measurable effect on physical and electrical properties of cable.
    a. Provide shielding to prevent interference and distortion from adjacent cables and equipment.
3. Terminate wiring in a junction box.
    a. Clamp cable over jacket in a junction box.
    b. Individual conductors in the stripped section of cable is to be slack between the clamping point and terminal block.
4. Terminate field wiring and cable not directly connected to instruments and control devices having integral wiring terminals using terminal blocks.
5. Install signal transmission components in accordance with IEEE C2, REA Form 511a, NFPA 70, and as indicated.
6. Use shielded cable to transmitters.
7. Use shielded cable to temperature sensors.
8. Perform continuity and meager testing on wire and cable after installation.

C. Conduit Installation:

1. Comply with Section 260533.13 "Conduits for Electrical Systems," Section 260533.16 "Boxes and Covers for Electrical Systems," and Section 260533.23 "Surface Raceways for Electrical Systems" for control-voltage conductors.
2. Comply with Section 270528 "Pathways for Communications Systems" for balanced twisted pair cabling and optical fiber installation.

3.20 DDC SYSTEM I/O CHECKOUT PROCEDURES

A. Check installed products before continuity tests, leak tests, and calibration.

B. Check instruments for proper location and accessibility.

C. Check instruments for proper installation on direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.

D. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material, and support.

E. Control Damper Checkout:

1. Verify that control dampers are installed correctly for flow direction.
2. Verify that proper blade alignment, either parallel or opposed, has been provided.
3. Verify that damper frame attachment is properly secured and sealed.
4. Verify that damper actuator and linkage attachment are secure.
5. Verify that actuator wiring is complete, enclosed, and connected to correct power source.
6. Verify that damper blade travel is unobstructed.

F. Control Valve Checkout:

1. Verify that control valves are installed correctly for flow direction.
2. Verify that valve body attachment is properly secured and sealed.
3. Verify that valve actuator and linkage attachment are secure.
4. Verify that actuator wiring is complete, enclosed, and connected to correct power source.
5. Verify that valve ball, disc, or plug travel is unobstructed.
6. After piping systems have been tested and put into service, but before insulating and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks. Replace valve if leaks persist.

G. Instrument Checkout:

1. Verify that instrument is correctly installed for location, orientation, direction, and operating clearances.
2. Verify that attachment is properly secured and sealed.
3. Verify that conduit connections are properly secured and sealed.
4. Verify that wiring is properly labeled with unique identification, correct type, and size and is securely attached to proper terminals.
5. Inspect instrument tag against approved submittal.
6. For instruments with tubing connections, verify that tubing attachment is secure and isolation valves have been provided.
7. For flow instruments, verify that recommended upstream and downstream distances have been maintained.
8. For temperature instruments, verify the following:

    a. Sensing element type and proper material.
    b. Length and insertion.

3.21 DDC SYSTEM I/O ADJUSTMENT, CALIBRATION, AND TESTING

A. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.

B. Provide written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.

C. For each analog instrument, make three-point test of calibration for both linearity and accuracy.

D. Equipment and procedures used for calibration to comply with instrument manufacturer's written instructions.

E. Provide diagnostic and test equipment for calibration and adjustment.

1. Use field testing and diagnostic instruments and equipment with an accuracy at least twice the instrument accuracy of instrument to be calibrated. For example, test and calibrate an installed instrument with accuracy of 1 percent using field testing and diagnostic instrument with accuracy of 0.5 percent or better.

F. Calibrate each instrument in accordance with instruction manual supplied by instrument manufacturer.

G. If after calibration the indicated performance cannot be achieved, replace out-of-tolerance instruments.

H. Comply with field testing requirements and procedures indicated by ASHRAE's Guideline 11, "Field Testing of HVAC Controls Components," in the absence of specific requirements, and to supplement requirements indicated.

I. Analog Signals:

1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.
3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistant source.

J. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact making or breaking.

K. Control Dampers:

1. Stroke and adjust control dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.
2. For control dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

L. Control Valves:

1. Stroke and adjust control valves following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.
2. For control valves equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

M. Meters: Check meters at zero, 50, and 100 percent of Project design values.

N. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.

O. Switches: Calibrate switches to make or break contact at set points indicated.

P. Transmitters:

1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.
2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistant source.

3.22 DDC SYSTEM CONTROLLER CHECKOUT

A. Verify power supply.

1. Verify voltage, phase, and hertz.
2. Verify that protection from power surges is installed and functioning.
3. Verify that ground fault protection is installed.
4. If applicable, verify if connected to UPS unit.
5. If applicable, verify if connected to backup power source.
6. If applicable, verify that power conditioning units are installed.

B. Verify that wire and cabling are properly secured to terminals and labeled with unique identification.

C. Verify that spare I/O capacity is provided.

3.23 DDC CONTROLLER I/O CONTROL LOOP TESTS

A. Testing:

1. Test every I/O point connected to DDC controller to verify that safety and operating control set points are as indicated and as required to operate controlled system safely and at optimum performance.
2. Test every I/O point throughout its full operating range.
3. Test every control loop to verify that operation is stable and accurate.
4. Adjust control loop proportional, integral, and derivative settings to achieve optimum performance while complying with performance requirements indicated. Document testing of each control loop's precision and stability via trend logs.

5. Test and adjust every control loop for proper operation according to sequence of operation.
6. Test software and hardware interlocks for proper operation. Correct deficiencies.
7. Operate each analog point at the following:

    a. Upper quarter of range.
    b. Lower quarter of range.
    c. At midpoint of range.

8. Exercise each binary point.
9. For every I/O point in DDC system, read and record each value at operator workstation, at DDC controller, and at field instrument simultaneously. Value displayed at operator workstation, at DDC controller, and at field instrument must match.
10. Prepare and submit report documenting results for each I/O point in DDC system and include in each I/O point a description of corrective measures and adjustments made to achieve desire results.

3.24 VERIFICATION OF DDC SYSTEM WIRELESS NETWORK

A. DDC system Installer is to design wireless DDC system networks to comply with performance requirements indicated.

B. Verify wireless network performance through field testing and document results in a field test report.

C. Testing and verification of all wireless devices to include, but not be limited to, the following:

1. Speed.
2. Online status.
3. Signal strength.

3.25 FINAL REVIEW

A. Submit written request to COR and Construction Manager when DDC system is ready for final review. State the following:

1. DDC system has been thoroughly inspected for compliance with Contract Documents and found to be in full compliance.
2. DDC system has been calibrated, adjusted, and tested and found to comply with requirements of operational stability, accuracy, speed, and other performance requirements indicated.
3. DDC system monitoring and control of HVAC systems results in operation according to sequences of operation indicated.
4. DDC system is complete and ready for final review.

B. Upon receipt of written request for final review, COR and Construction Manager to start review within reasonable period and upon completion issue field report(s) documenting observations and deficiencies.

C. Take prompt action to remedy deficiencies indicated in reviewer's field report(s) and submit second written request after all deficiencies have been corrected. Repeat process until no deficiencies are reported.

D. Compensation for Subsequent Reviews: Should more than two reviews be required, DDC system manufacturer and Installer to compensate entity/entities performing reviews for total costs (labor and expenses) associated with subsequent reviews. Estimated cost of each subsequent review to be submitted and approved by DDC system manufacturer and Installer before review.

E. Prepare and submit closeout submittals when no deficiencies are reported.

F. Part of DDC system final review to include demonstration to parties participating in final review.

1. Provide staff familiar with DDC system installed to demonstrate operation of DDC system during final review.
2. Provide testing equipment to demonstrate accuracy and other performance requirements of DDC system that is requested by reviewers during final review.
3. Demonstration to include, but not be limited to, the following:

    a. Accuracy and calibration of 10 I/O points randomly selected by reviewers. If review finds that some I/O points are not properly calibrated and not satisfying performance requirements indicated, additional I/O points may be selected by reviewers until total I/O points being reviewed that satisfy requirements equals quantity indicated.
    b. HVAC equipment and system hardwired and software safeties and life-safety functions are operating according to sequence of operation. Up to 10 I/O points to be randomly selected by reviewers. Additional I/O points may be selected by reviewers to discover problems with operation.
    c. Correct sequence of operation after electrical power interruption and resumption after electrical power is restored for randomly selected HVAC systems.
    d. Operation of randomly selected dampers and valves in normal-on, normal-off, and failed positions.
    e. Reporting of alarm conditions for randomly selected alarms, including different classes of alarms, to ensure that alarms are properly received by operators and operator workstations.
    f. Trends, summaries, logs, and reports set up for Project.
    g. For up to three HVAC systems randomly selected by reviewers, use graph trends to show that sequence of operation is executed in correct manner and that HVAC systems operate properly through complete sequence of operation including different modes of operations indicated. Show that control loops are stable and operating at set points and respond to changes in set point of 20 percent or more.
    h. Software's ability to communicate with controllers, operator workstations, and uploading and downloading of control programs.

i. Software's ability to edit control programs offline.
j. Data entry to show Project-specific customizing capability including parameter changes.
k. Step through penetration tree, display all graphics, demonstrate dynamic update, and direct access to graphics.
l. Execution of digital and analog commands in graphic mode.
m. Spreadsheet and curve plot software and its integration with database.
n. Online user guide and help functions.
o. Multitasking by showing different operations occurring simultaneously on four quadrants of split screen.
p. System speed of response compared to requirements indicated.
q. For Each Controller: Applies to network and programmable application controllers.

    1) Memory: Programmed data, parameters, trend, and alarm history collected during normal operation are not to be lost during power failure.
    2) Operator Interface: Ability to connect directly to each type of digital controller with portable workstation and mobile device. Show that maintenance personnel interface tools perform as indicated in manufacturer's technical literature.
    3) Standalone Ability: Demonstrate that controllers provide stable and reliable standalone operation using default values or other method for values normally read over network.
    4) Electric Power: Ability to disconnect any controller safely from its power source.
    5) Wiring Labels: Match control drawings.
    6) Network Communication: Ability to locate controller's location on network and communication architecture matches Shop Drawings.
    7) Nameplates and Tags: Accurate and permanently attached to control panel doors, instrument, actuators, and devices.

r. For Each Operator Workstation:

    1) I/O points lists agree with naming conventions.
    2) Graphics are complete.
    3) UPS unit, if applicable, operates.

s. Communications and Interoperability: Demonstrate proper interoperability of data sharing, alarm and event management, trending, scheduling, and device and network management. Use ASHRAE 135 protocol analyzer to help identify devices, view network traffic, and verify interoperability. Requirements must be met even if only one manufacturer's equipment is installed.

    1) Data Presentation: On each operator workstation, demonstrate graphic display capabilities.
    2) Reading of Any Property: Demonstrate ability to read and display any used readable object property of any device on network.
    3) Set-Point and Parameter Modifications: Show ability to modify set points and tuning parameters indicated. Modifications are made with messages

and write services initiated by operator using workstation graphics, or by completing a field in menu with instructional text.

4) Peer-to-Peer Data Exchange: Network devices are installed and configured to perform without need for operator intervention to implement Project sequence of operation and to share global data.
5) Alarm and Event Management: Alarms and events are installed and prioritized according to COR. Demonstrate that time delays and other logic are set up to avoid nuisance tripping. Show that operators with sufficient privileges are permitted.
6) Schedule Lists: Schedules are configured for start and stop, mode change, occupant overrides, and night setback as defined in sequence of operations.
7) Schedule Display and Modification: Ability to display any schedule with start and stop times for calendar year. Show that all calendar entries and schedules are modifiable from any connected operator workstation by an operator with sufficient privilege.
8) Archival Storage of Data: Data archiving is handled by operator workstation and server and local trend archiving and display is accomplished.
9) Modification of Trend Log Object Parameters: Operator with sufficient privilege can change logged data points, sampling rate, and trend duration.
10) Device and Network Management:

    a) Display of network device status.
    b) Display of BACnet object information.
    c) Silencing devices transmitting erroneous data.
    d) Time synchronization.
    e) Remote device re-initialization.
    f) Backup and restore network device programming and master database(s).
    g) Configuration management of routers.

3.26 DEMONSTRATION

A. Engage a factory-authorized service representative with complete knowledge of Project-specific system installed to train Government's maintenance personnel to adjust, operate, and maintain DDC system.

B. Extent of Training:

1. Base extent of training on scope and complexity of DDC system indicated and training requirements indicated. Provide extent of training required to satisfy requirements indicated even if more than minimum training requirements are indicated.
2. Inform COR of anticipated training requirements if more than minimum training requirements are indicated.
3. Minimum Training Requirements:

    a. Provide not less than five days of training total.
    b. Stagger training over multiple training classes to accommodate Government's requirements. All training to occur before end of warranty period.

c. Break down total days of training into not more than two separate training classes.
d. Schedule training so each training class is not less than one consecutive day(s).

C. Training Schedule:

1. Schedule training with COR 20 business days before expected Substantial Completion.
2. Schedule training to provide COR with at least 10 business days of notice in advance of training.
3. Training to occur within normal business hours at mutually agreed on time. Unless otherwise agreed to, training to occur Monday through Friday, except on U.S. Federal holidays, with two morning sessions and two afternoon sessions. Each morning session and afternoon session to be split in half with 30-minute break between sessions. Morning and afternoon sessions to be separated by 60-minute lunch period. Training, including breaks and excluding lunch period, are not to exceed eight hours per day.
4. Provide staggered training schedule as requested by COR.

D. Training Attendee List and Sign-in Sheet:

1. Request from COR in advance of training a proposed attendee list with name, phone number, and email address.
2. Provide preprinted sign-in sheet for each training session with proposed attendees listed and no fewer than six blank spaces to add additional attendees.
3. Include preprinted sign-in sheet with training session number, date and time, instructor name, phone number, email address, and brief description of content to be covered during session. List attendees with columns for name, phone number, and email address and a column for attendee signature or initials.
4. Circulate sign-in sheet at beginning of each session and solicit attendees to sign or initial in applicable location.
5. At end of each training day, send COR an email with attachment of scanned copy (PDF) of circulated sign-in sheet for each session. Indicate which attendees, if any, joined for only part of training sessions.

E. Training Attendee Headcount:

1. Plan in advance of training for five attendees.
2. Make allowance for Government to add up to two attendee(s) at time of training.
3. Headcount may vary depending on training content covered in session. Attendee access may be restricted to some training content for purposes of maintaining system security.

F. Attendee Training Manuals:

1. Provide each attendee with color hard copy of all training materials and visual presentations.
2. Organize hard-copy materials in three-ring binder with table of contents and individual divider tabs marked for each logical grouping of subject matter. Organize material to provide space for attendees to take handwritten notes within training manuals.
3. In addition to hard-copy materials included in training manual, provide each binder with a sleeve or pocket that includes a flash drive with PDF copy of all hard-copy materials.

G. Instructor Requirements:

1. One or multiple qualified instructors, as required, to provide training.
2. Use instructors who have provided not less than five years of instructional training on not less than five past projects with similar DDC system scope and complexity to DDC system installed.

H. Organization of Training Sessions:

1. Organize training sessions into logical groupings of technical content and to reflect different levels of operators having access to system. Plan training sessions to accommodate the following three levels of operators:

   a. Daily operators.
   b. Advanced operators.
   c. System managers and administrators.

2. Plan and organize training sessions to group training content to protect DDC system security. Some attendees may be restricted to some training sessions to ensure DDC system security.

I. Training Outline:

1. Submit training outline for COR review at least 10 business day before scheduling training.
2. Include in outline a detailed agenda for each training day that is broken down into training sessions that day, training objectives for each training session, and synopses for each lesson planned.

J. On-Site Training:

1. Government will provide conditioned classroom or workspace with ample desks or tables, chairs, power, and data connectivity for instructor and each attendee.
2. Provide training materials, projector, and other audiovisual equipment used in training.
3. Provide as much of training located on-site as deemed feasible and practical by COR.
4. Include on-site training with regular walk-through tours, as required, to observe each unique product type installed with hands-on review of operation, calibration, and service requirements.
5. Use operator workstation that is to be used with DDC system in the training. If operator workstations are unavailable, provide temporary workstation to convey training content.

K. Off-Site Training:

1. Provide conditioned training rooms and workspace with ample tables desks or tables, chairs, power, and data connectivity for each attendee.
2. Provide capability to remotely access to Project DDC system for use in training.
3. Provide operator workstation for use by each attendee.

L. Training Content for Daily Operators:

1. Basic operation of system.
2. Understanding DDC system architecture and configuration.
3. Understanding each unique product type installed including performance and service requirements for each.
4. Understanding operation of each system and equipment controlled by DDC system including sequences of operation, each unique control algorithm, and each unique optimization routine.
5. Operating operator workstations, printers, and other peripherals.
6. Logging on and off system.
7. Accessing graphics, reports, and alarms.
8. Adjusting and changing set points and time schedules.
9. Recognizing DDC system malfunctions.
10. Understanding content of operation and maintenance manuals including control drawings.
11. Understanding physical location and placement of DDC controllers and I/O hardware.
12. Accessing data from DDC controllers.
13. Operating portable operator workstations.
14. Review of DDC testing results to establish basic understanding of DDC system operating performance and HVAC system limitations as of Substantial Completion.
15. Running each specified report and log.
16. Displaying and demonstrating each data entry to show Project-specific customizing capability. Demonstrating parameter changes.
17. Stepping through graphics penetration tree, displaying all graphics, demonstrating dynamic updating, and direct access to graphics.
18. Executing digital and analog commands in graphic mode.
19. Demonstrating control loop precision and stability via trend logs of I/O for not less than 10 percent of I/O installed.
20. Demonstrating DDC system performance through trend logs and command tracing.
21. Demonstrating scan, update, and alarm responsiveness.
22. Demonstrating spreadsheet and curve plot software, and its integration with database.
23. Demonstrating on-line user guide, and help function and mail facility.
24. Demonstrating multitasking by showing dynamic curve plot, and graphic construction operating simultaneously via split screen.
25. Demonstrating the following for HVAC systems and equipment controlled by DDC system:

    a. Operation of HVAC equipment in normal-off, normal-on, and failed conditions while observing individual equipment, dampers, and valves for correct position under each condition.
    b. For HVAC equipment with factory-installed software, show that integration into DDC system is able to communicate with DDC controllers or gateways, as applicable.
    c. Using graphed trends, show that sequence of operation is executed in correct manner, and HVAC systems operate properly through complete sequence of operation including seasonal change, occupied and unoccupied modes, warm-up and cool-down cycles, and other modes of operation indicated.
    d. Hardware interlocks and safeties function properly and DDC system performs correct sequence of operation after electrical power interruption and resumption after power is restored.

e. Reporting of alarm conditions for each alarm, and confirm that alarms are received at assigned locations, including operator workstations.
f. Each control loop responds to set-point adjustment and stabilizes within time period indicated.
g. Sharing of previously graphed trends of all control loops to demonstrate that each control loop is stable and set points are being maintained.

M. Training Content for System Managers and Administrators:

1. DDC system software maintenance and backups.
2. Uploading, downloading, and offline archiving of all DDC system software and databases.
3. Interface with Project-specific, third-party operator software.
4. Understanding password and security procedures.
5. Adding new operators and making modifications to existing operators.
6. Operator password assignments and modification.
7. Operator authority assignment and modification.
8. Workstation data segregation and modification.

N. Video of Training Sessions:

1. Provide digital video and audio recording of each training session. Create separate recording file for each session.
2. Stamp each recording file with training session number, session name, and date.
3. Provide Government with copies of digital files on cloud and flash drives for later reference and for use in future training.
4. Government retains right to make additional copies for intended training purposes without having to pay royalties.

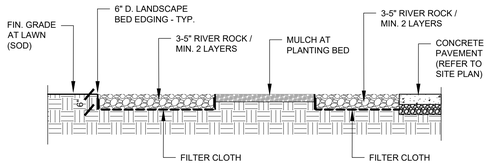
END OF SECTION 230923

TABLE WITH BENCH SEATS

(Global Industrial to match existing)
PROVIDE 2 STD / 1 ADA

TRASH RECEPTABLE

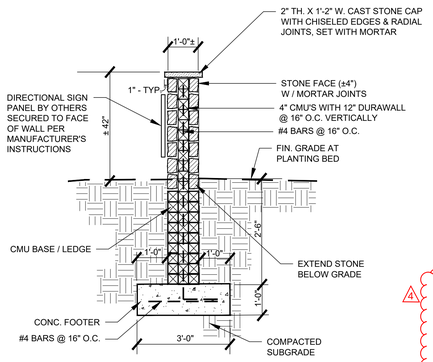
RELOCATE (2) EXISTING
(final locations to be determined by HCC)



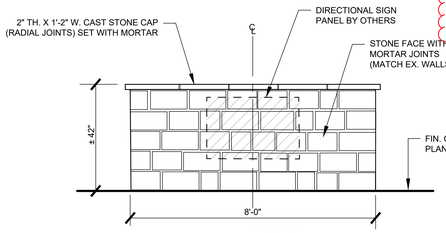
TYPICAL SECTION
RIVER ROCK/PLANTING BED
SCALE: 1/2" = 1'-0"

STONE WALL EXAMPLE

NOTE: CAST STONE CAP, FACE STONES, AND MORTAR TO MATCH EXISTING WALLS ELSEWHERE ON CAMPUS.

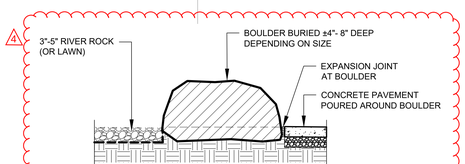


TYPICAL SECTION
STONE SIGN WALL
SCALE: 1/2" = 1'-0"

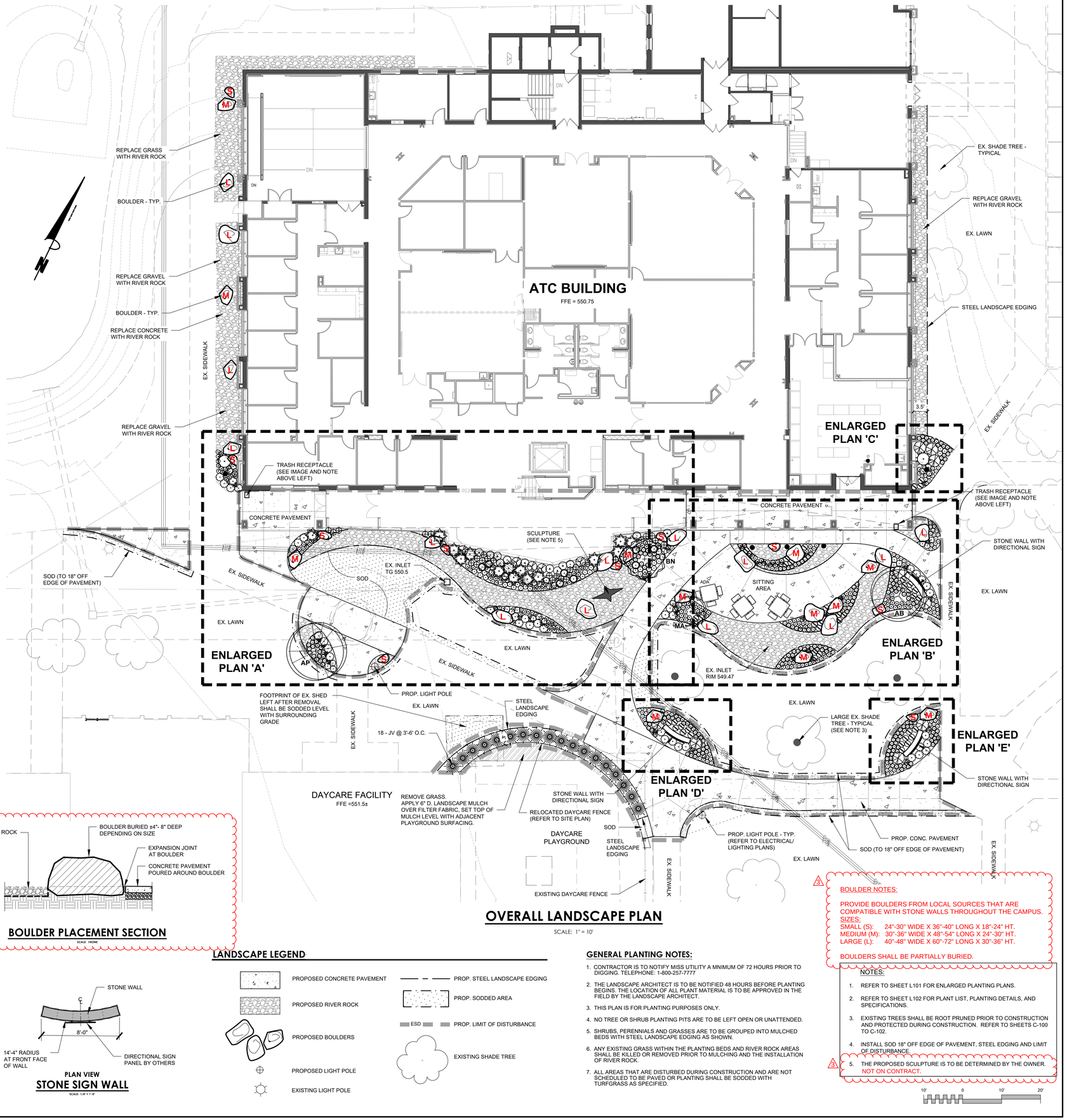


ELEVATION
STONE SIGN WALL
SCALE: 1/2" = 1'-0"

PLAN VIEW
STONE SIGN WALL
SCALE: 1/4" = 1'-0"



BOULDER PLACEMENT SECTION
SCALE: 1"=1'-0"



OVERALL LANDSCAPE PLAN

SCALE: 1" = 10'

LANDSCAPE LEGEND

- PROPOSED CONCRETE PAVEMENT
- PROPOSED RIVER ROCK
- PROPOSED BOULDERS
- PROPOSED LIGHT POLE
- EXISTING LIGHT POLE
- PROP. STEEL LANDSCAPE EDGING
- PROP. SODDED AREA
- ESD — PROP. LIMIT OF DISTURBANCE
- EXISTING SHADE TREE

GENERAL PLANTING NOTES:

1. CONTRACTOR IS TO NOTIFY MISS UTILITY A MNIMUM OF 72 HOURS PRIOR TO DIGGING. TELEPHONE: 1-800-257-7777
2. THE LANDSCAPE ARCHITECT IS TO BE NOTIFIED 48 HOURS BEFORE PLANTING BEGINS. THE LOCATION OF ALL PLANT MATERIAL IS TO BE APPROVED IN THE FIELD BY THE LANDSCAPE ARCHITECT.
3. THIS PLAN IS FOR PLANTING PURPOSES ONLY.
4. NO TREE OR SHRUB PLANTING PITS ARE TO BE LEFT OPEN OR UNATTENDED.
5. SHRUBS, PERENNIALS AND GRASSES ARE TO BE GROUPED INTO MULCHED BEDS WITH STEEL LANDSCAPE EDGING AS SHOWN.
6. ANY EXISTING GRASS WITHIN THE PLANTING BEDS AND RIVER ROCK AREAS SHALL BE KILLED OR REMOVED PRIOR TO MULCHING AND THE INSTALLATION OF RIVER ROCK.
7. ALL AREAS THAT ARE DISTURBED DURING CONSTRUCTION AND ARE NOT SCHEDULED TO BE PAVED OR PLANTING SHALL BE SODDED WITH TURFGRASS AS SPECIFIED.

3 BOULDER NOTES:

PROVIDE BOULDERS FROM LOCAL SOURCES THAT ARE COMPATIBLE WITH STONE WALLS THROUGHOUT THE CAMPUS.
SIZES:
SMALL (S): 24"-30" WIDE X 36"-40" LONG X 18"-24" HT.
MEDIUM (M): 30"-36" WIDE X 48"-54" LONG X 24"-30" HT.
LARGE (L): 40"-48" WIDE X 60"-72" LONG X 30"-36" HT.

BOULDERS SHALL BE PARTIALLY BURIED.

NOTES:

1. REFER TO SHEET L101 FOR ENLARGED PLANTING PLANS.
2. REFER TO SHEET L102 FOR PLANT LIST, PLANTING DETAILS, AND SPECIFICATIONS.
3. EXISTING TREES SHALL BE ROOT PRUNED PRIOR TO CONSTRUCTION AND PROTECTED DURING CONSTRUCTION. REFER TO SHEETS C-100 TO C-102.
4. INSTALL SOD 18" OFF EDGE OF PAVEMENT, STEEL EDGING AND LIMIT OF DISTURBANCE.
3 5. THE PROPOSED SCULPTURE IS TO BE DETERMINED BY THE OWNER. NOT ON CONTRACT.

10' 0 10' 20'

NOELKER AND HULL ASSOCIATES, INC.
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The Contract Documents for the indicated public improvement were prepared under my supervision and, to the best of my knowledge and belief, they comply with the relevant building codes of the State of Maryland.
Signature _____ Date _____
License # _____, Expiration Date ___/___/___

PROJECT TITLE

ADVANCED TECHNOLOGY CENTER RENOVATION

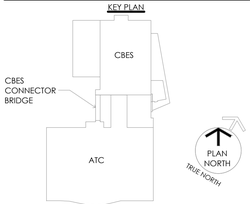
PROJECT ADDRESS

11400 ROBINWOOD DRIVE
HAGERSTOWN, MD 21742

PROJECT OWNER

HAGERSTOWN COMMUNITY COLLEGE
Maryland DEPARTMENT OF GENERAL SERVICES

KEY PLAN



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	BID SUBMISSION	09/05/2025
3	ADDENDUM #3	10/08/2025
4	ADDENDUM #4	10/10/2025

CAD DWG FILE:
DRAWN BY: NHA / LBP
CHK'D BY: NHA / LBP

JOB NUMBER: **24901 & DGS CC-02-MC23-482**
ISSUE DATE: **09/05/2025**
SHEET TITLE:

LANDSCAPE PLAN

SHEET NUMBER:

L100

SHEET 11 OF 181

T:\2024\24901 Advanced Technology Center Renovation\CAD\Drawings\24901-MCC-ATC Renovation_CBES.rvt

PANEL FACADE SYSTEMS

- AP-1 ALUMINUM PANEL - WHITE
- AP-2 ALUMINUM PANEL - CHAMPAGNE
- AP-3 ALUMINUM PANEL - BLACK
- AP-4 ALUMINUM PANEL - FORMED - WHITE
- CP-1 CERAMIC PANEL - GRAY
- CP-2 CERAMIC PANEL - BLACK
- SP-1 SOLAR PANEL - BLACK

EXTERIOR ELEVATIONS GENERAL NOTES

1. INFILL ALL ABANDONED OPENINGS IN EXTERIOR MASONRY WALLS AS REQUIRED WITH LIKE MATERIALS.
2. POWERWASH EXISTING BRICK/MORTAR SURFACES TO BE EXPOSED, REPOINT DAMAGED MORTAR AS REQUIRED TO MATCH EXISTING.
3. POWERWASH EXISTING PRECAST FASCIA TO BE EXPOSED, RESEAL JOINTS AS REQUIRED TO MATCH EXISTING.
4. POWERWASH MISCELLANEOUS EXTERIOR SURFACES TO BE EXPOSED, PATCH AS REQUIRED AND PREPARE FOR NEW PAINT OR FINISH.
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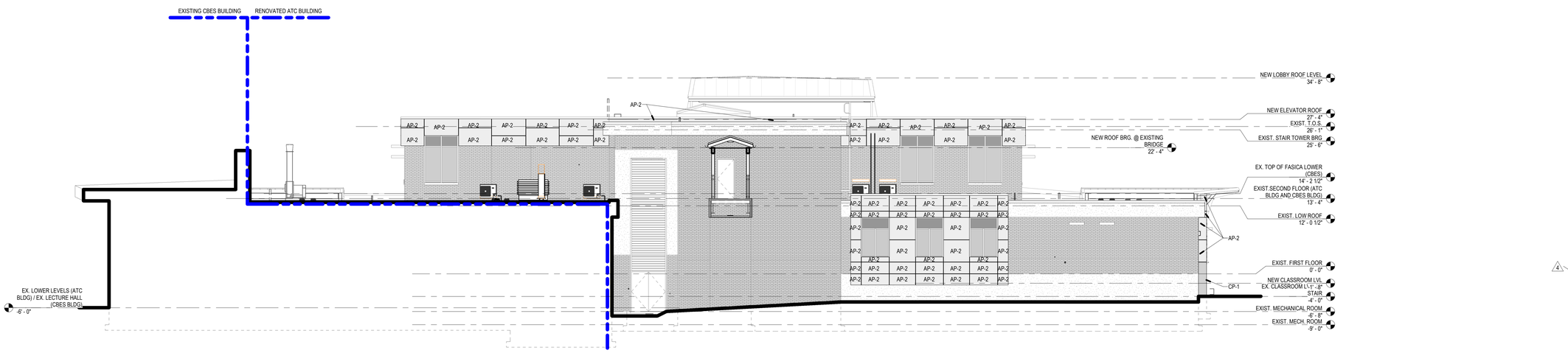
8. REFER TO DOOR SCHEDULE FOR EXISTING EXTERIOR DOORS TO REMAIN.
9. PARGE EXPOSED NEW MASONRY PIER FOUNDATIONS AS REQUIRED

2 A401A BUILDING ELEVATION - EAST
1/8" = 1'-0"



1 A401A BUILDING ELEVATION - NORTH
1/8" = 1'-0"

1/8" = 1'-0" SCALE 5 0 5 10 15 20 FEET

PROJECT TEAM

NOELKER AND HULL ASSOCIATES, INC.
ARCHITECTS
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FREDERICK, MD | 21701-5680
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Joppa, MD 21085
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Signature _____ Date _____
License # _____, Expiration Date ___/___/___

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ADVANCED TECHNOLOGY CENTER RENOVATION

PROJECT ADDRESS

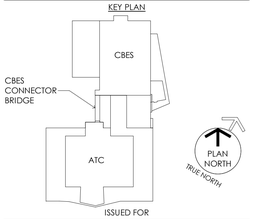
11400 ROBINWOOD DRIVE
HAGERSTOWN, MD 21742

PROJECT OWNER

HAGERSTOWN COMMUNITY COLLEGE
Maryland DEPARTMENT OF GENERAL SERVICES

SHEET INFORMATION

KEY PLAN



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4	ADDENDUM #4	10/10/2025

CAD DWG FILE:
DRAWN BY: NHA
CHK'D BY: NHA

JOB NUMBER: **24901 & DGS CC-02-MC23-482**
ISSUE DATE: **09/05/2025**
SHEET TITLE:

EXTERIOR ELEVATIONS
PANEL FACADE DESIGNATION

SHEET NUMBER:

A401A

SHEET 41 OF 181

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PANEL FACADE SYSTEMS

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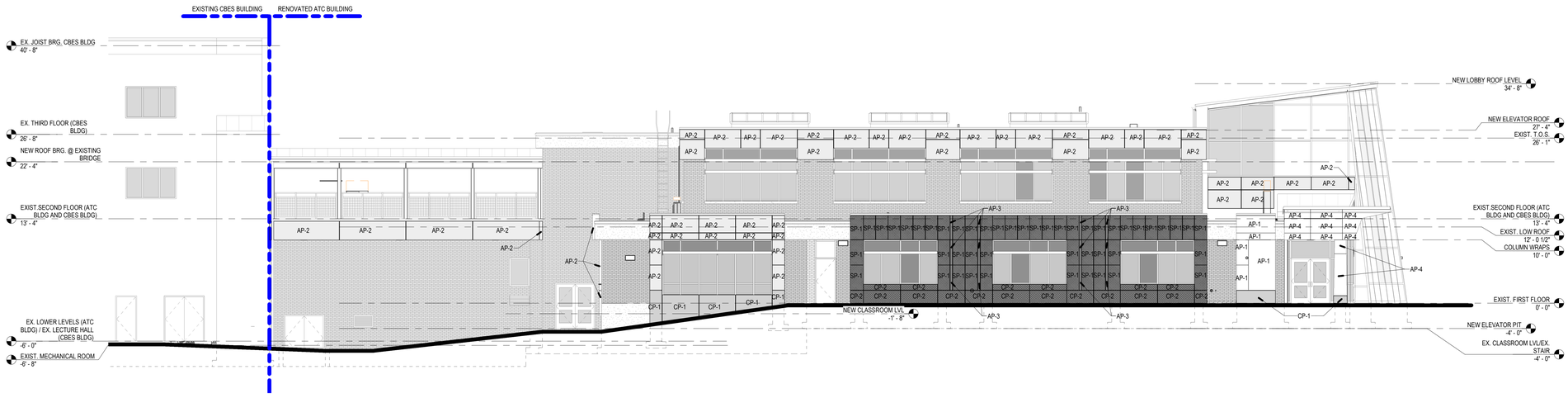
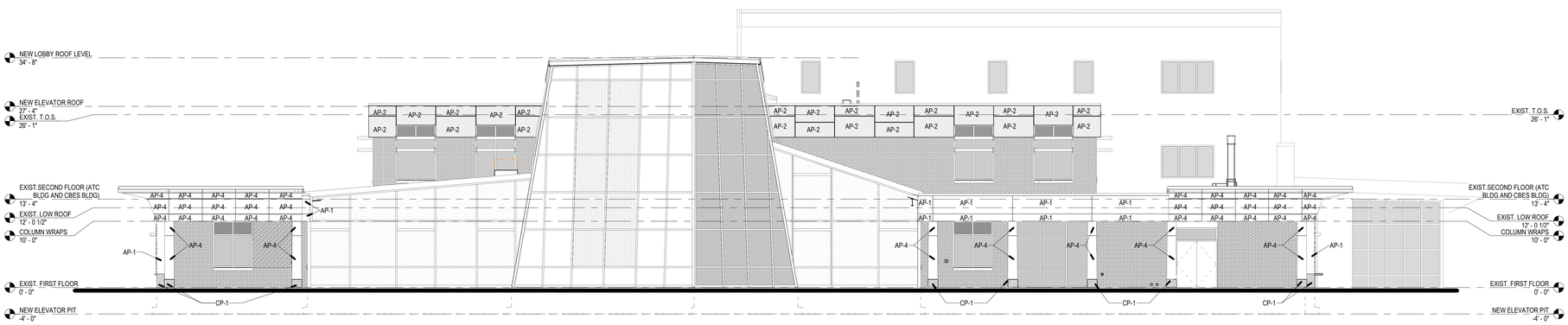


2 A402A BUILDING ELEVATION - WEST
1/8" = 1'-0"



1 A402A BUILDING ELEVATION - SOUTH
1/8" = 1'-0"

1/8" = 1'-0" SCALE 5 0 5 10 15 20 FEET

PROJECT TEAM

NOELKER AND HULL ASSOCIATES, INC. ARCHITECTS
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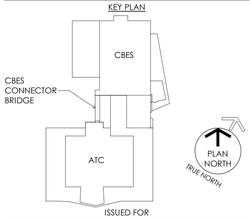
Maryland DEPARTMENT OF GENERAL SERVICES

SHEET INFORMATION

KEY PLAN



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CAD DWG FILE:
DRAWN BY: NHA
CHK'D BY: NHA

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4

SHEET TITLE:
EXTERIOR ELEVATIONS
PANEL FACADE DESIGNATION

SHEET NUMBER:
A402A

SHEET 42 OF 181

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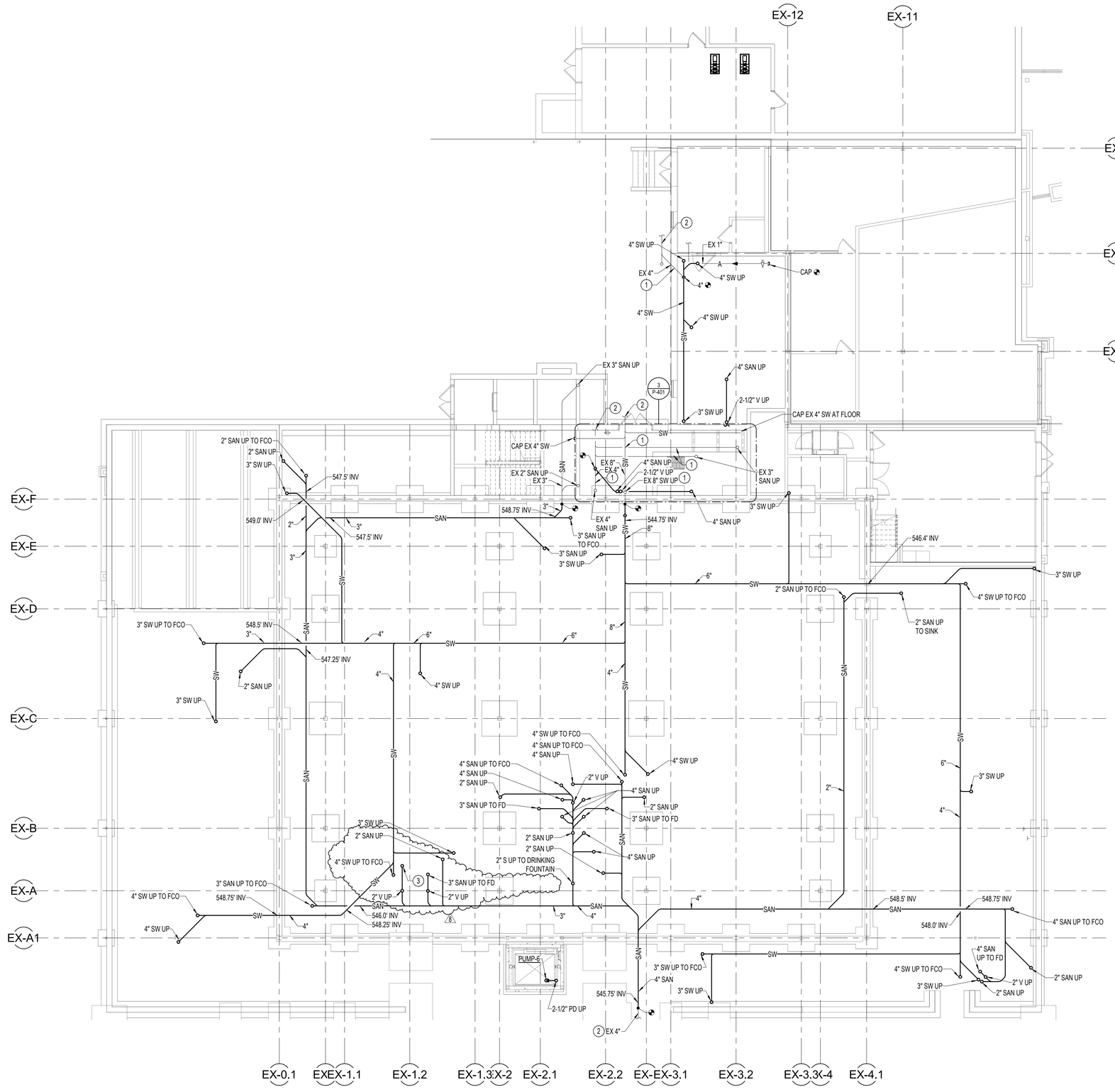

1 P-101 SUBSLAB - PLUMBING - NEW WORK PLAN
1/8" = 1'-0"

1/8" = 1'-0" 0 4 8 16 24 FT

DRAWING NOTES:
(APPLICABLE TO THIS DRAWING ONLY)

1. ALL ITEMS THAT REQUIRE ACCESS FOR OPERATING, CLEANING, SERVICING, MAINTENANCE, AND CALIBRATION, SHALL BE EASILY AND SAFELY ACCESSIBLE. EXAMPLES OF THESE ITEMS INCLUDE, BUT ARE NOT LIMITED TO: ALL TYPES OF VALVES, FILTERS, STRAINERS, TRANSMITTERS, AND CONTROL DEVICES. PRIOR TO COMMENCING INSTALLATION WORK, REFER CONFLICTS BETWEEN THIS REQUIREMENT AND CONTRACT DRAWINGS IN WRITING TO THE OWNER FOR RESOLUTION AND AWAIT WRITTEN DIRECTIONS BEFORE PROCEEDING.

2. CONTRACTOR SHALL FIELD VERIFY LOCATION OF ALL EXISTING SUBSLAB PIPNIG.

SPECIAL NOTES:
(APPLICABLE TO THIS DRAWING ONLY)

1. PIPING LOCATED BELOW MECH ROOM SLAB ON GRADE. SEE ENLARGED PLANS FOR PIPING IN THE LOWER MECHANICAL ROOM.
2. REFER TO CIVIL DRAWINGS FOR CONTINUATION.
3. 3" SAN UP TO MOP SINK

PROJECT TEAM

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STATE OF MARYLAND — CHRISTOPHER JACK RUSCHAK — 29040 — PROFESSIONAL ENGINEER

Professional Certification. I hereby certify that these documents were prepared or approved by me, and that I am a duly licensed professional engineer under the laws of the State of Maryland.
License # 0200470, Expiration Date 09/02/2025

PROJECT INFORMATION

PROJECT TITLE

THE ADVANCED TECHNOLOGY CENTER RENOVATION

PROJECT ADDRESS

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HAGERSTOWN, MD 21742

PROJECT OWNER

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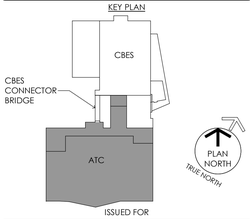

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5	PERMIT DOCUMENTS	07/16/2025
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8	ADDENDUM 4	10/10/2025

CAD DWG FILE:
DRAWN BY: NHA
CHK'D BY: NHA

JOB NUMBER: **24901**
ISSUE DATE: **09/05/2025**
SHEET TITLE:

SUBSLAB - PLUMBING - NEW WORK PLAN

SHEET NUMBER:

P-101

SHEET 101 OF 181

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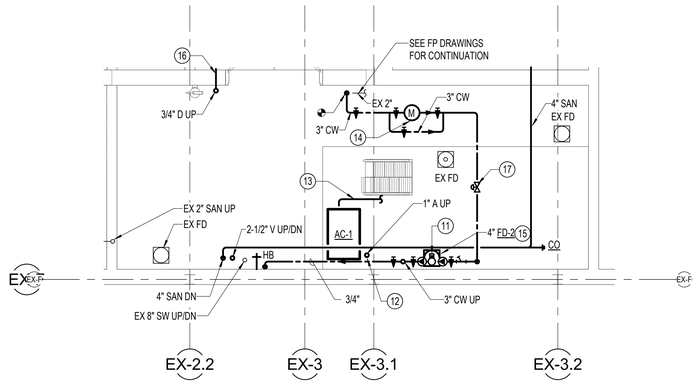
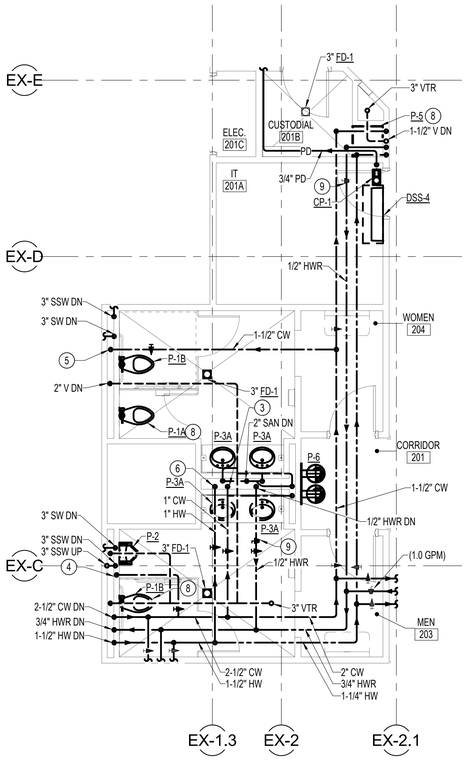
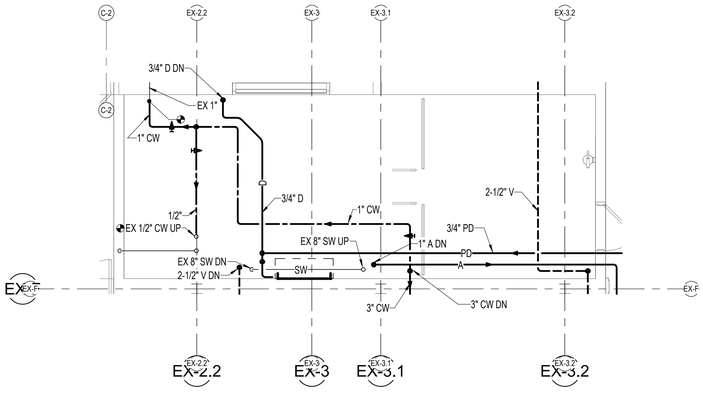


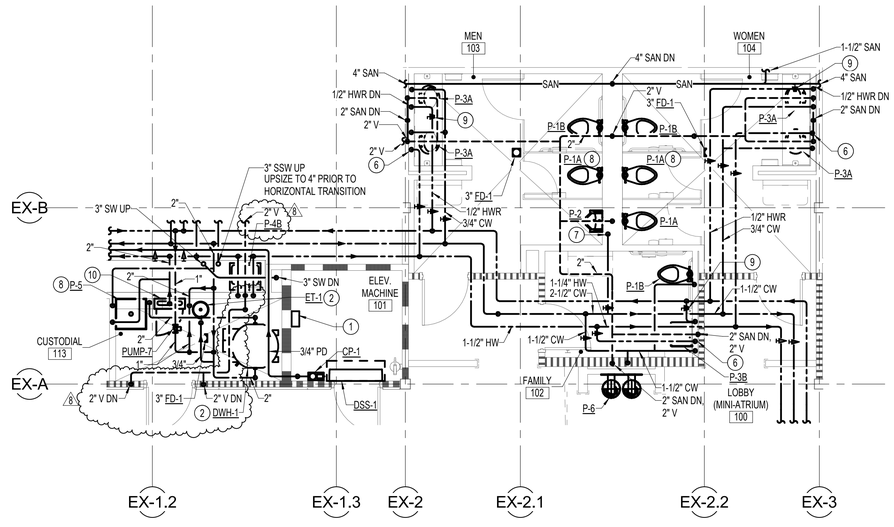
3 P-401 MECHANICAL ROOM LOWER - PLUMBING - NEW WORK ENLARGED PLAN
1/4" = 1'-0"



2 P-401 SECOND FLOOR RESTROOMS - PLUMBING - NEW WORK ENLARGED PLAN
1/4" = 1'-0"



4 P-401 MECHANICAL ROOM UPPER - PLUMBING - NEW WORK ENLARGED PLAN
1/4" = 1'-0"



1 P-401 FIRST FLOOR RESTROOMS - PLUMBING - NEW WORK ENLARGED PLAN
1/4" = 1'-0"

0 2 4 8 12 FT
1/4" = 1'-0"

DRAWING NOTES:
(APPLICABLE TO THIS DRAWING ONLY)

1. ALL ITEMS THAT REQUIRE ACCESS FOR OPERATING, CLEANING, SERVICING, MAINTENANCE, AND CALIBRATION, SHALL BE EASILY AND SAFELY ACCESSIBLE. EXAMPLES OF THESE ITEMS INCLUDE, BUT ARE NOT LIMITED TO: ALL TYPES OF VALVES, FILTERS, STRAINERS, TRANSMITTERS, AND CONTROL DEVICES. PRIOR TO COMMENCING INSTALLATION WORK, REFER CONFLICTS BETWEEN THIS REQUIREMENT AND CONTRACT DRAWINGS IN WRITING TO THE OWNER FOR RESOLUTION AND AWAIT WRITTEN DIRECTIONS BEFORE PROCEEDING.

SPECIAL NOTES:
(APPLICABLE TO THIS DRAWING ONLY)

1. ELEVATOR SUMP PUMP CONTROL PANEL. MOUNT 5'-0" AFF TO TOP OF UNIT.
2. MOUNT ON 4" HOUSKEEPING PAD.
3. 1" CW DN TO (4) LAVATORIES (1) DRINKING WATER FOUNTAIN
4. 1-1/2" CW DN TO (1) WATER CLOSET AND (1) URINAL
5. 1-1/2" CW DN TO (2) WATER CLOSETS
6. 3/4" HW DN TO SERVE ALL LAVATORIES ALONG WALL. TRANSITION TO 1/2" HWR DOWNSTREAM OF LAST FIXTURE.
7. 2" CW DN TO (5) WATER CLOSETS AND (1) URINAL.
8. PROVIDE TYPE B TRAP PRIMER VALVE FROM FIXTURE TO PRIME FLOOR DRAINS IN THIS SPACE.
9. BALANCE TO 0.5 GPM.
10. MIXING VALVE MV-1. MOUNT AT 5'-0" AFF TO TOP OF CABINET.
11. MOUNT BFP ON WALL AT 36" TO CENTER OF ASSEMBLY. PROVIDE BFP WITH AUTOMATIC WATER SHUTOFF VALVE SYSTEM PER SPECIFICATIONS.
12. PROVIDE SHUTOFF VALVE IN VERTICAL.
13. EXTEND 3/4" DRAIN FROM AIR COMPRESSOR TO NEAREST FLOOR DRAIN. INSTALL PER MANUFACTURER'S RECOMMENDATIONS. PROVIDE SUPPORTS AS REQUIRED.
14. PROVIDE DOMESTIC WATER SUB-METER PER SPECIFICATIONS. PROVIDE FULL SIZE BYPASS AS SHOWN. CONNECT SUB-METER TO EX CAMPUS BAS.
15. PROVIDE TRAP PRIMER CONNECTION TO FLOOR DRAIN FROM TPS-1.
16. TERMINATE CONDENSATE DRAIN 2'-0" ABOVE GRADE WITH RD-3.
17. BFP AUTOMATIC WATER SHUTOFF VALVE.

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Professional Certification. I hereby certify that these documents were prepared or approved by me, and that I am a duly licensed professional engineer under the laws of the State of Maryland.
License # 0200470, Expiration Date 09/02/2025

PROJECT INFORMATION

PROJECT TITLE

THE ADVANCED TECHNOLOGY CENTER RENOVATION

PROJECT ADDRESS

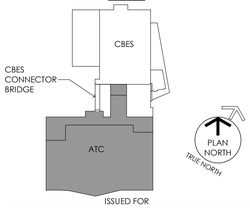
11400 ROBINWOOD DRIVE
HAGERSTOWN, MD 21742

PROJECT OWNER

HAGERSTOWN COMMUNITY COLLEGE
Maryland DEPARTMENT OF GENERAL SERVICES

SHEET INFORMATION

KEY PLAN



ISSUED FOR

	DESCRIPTION:	DATE:
1	DESIGN DEVELOPMENT SUBMISSION	9/20/2024
2	50% CONSTRUCTION DOCUMENTS	03/14/2025
3	95% CONSTRUCTION DOCUMENTS	05/02/2025
4	100% CONSTRUCTION DOCUMENTS	06/06/2025
5	PERMIT DOCUMENTS	07/16/2025
6	BID SUBMISSION	09/05/2025
8	ADDENDUM 4	10/10/2025

CAD DWG FILE:	
DRAWN BY:	NHA
CHK'D BY:	NHA

JOB NUMBER:	**24901**
ISSUE DATE:	**09/05/2025**

SHEET TITLE:

ENLARGED PLUMBING PLANS

SHEET NUMBER:

P-401

SHEET 105 OF 181

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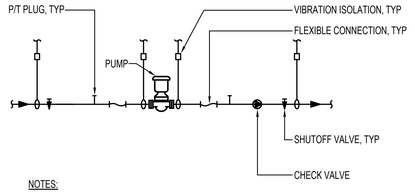
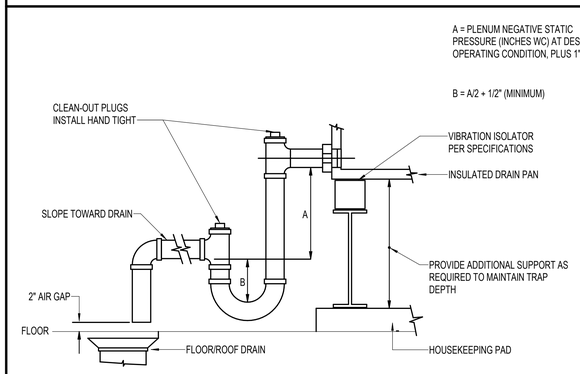


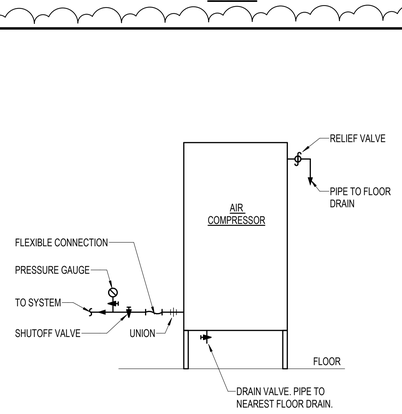
NOTES:

1. INSTALL RECIRCULATING PUMP PER THE MANUFACTURERS INSTRUCTIONS (MOTOR/ PUMP MOUNTED IN THE VERTICAL OR HORIZONTAL POSTION).

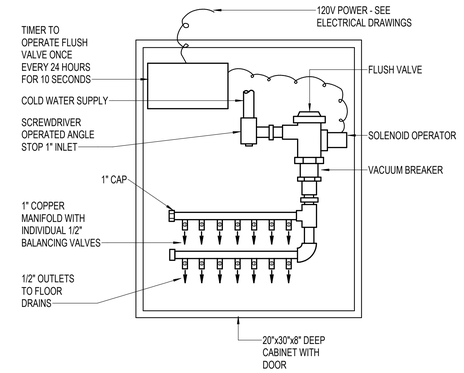
IN-LINE CIRCULATOR



DOAS COOLING COIL CONDENSATE DRAIN



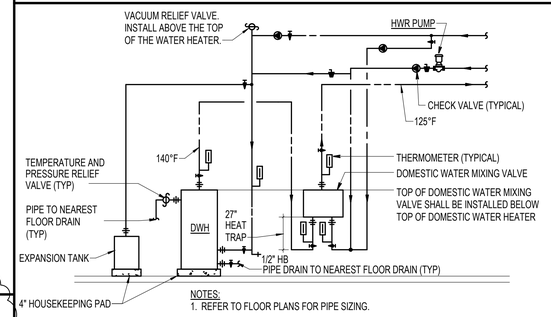
AIR COMPRESSOR



NOTES:

1. MAXIMUM 2 TRAPS PER 1/2" OUTLET.

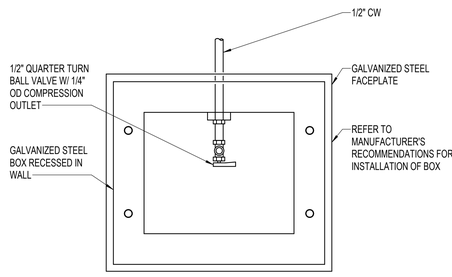
TYPE A TRAP PRIMING SYSTEM



NOTES:

1. REFER TO FLOOR PLANS FOR PIPE SIZING.

DOMESTIC WATER HEATER PIPING

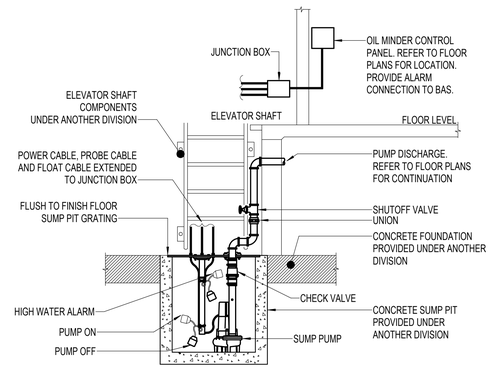


NOTES:

1. CONTRACTOR SHALL PROVIDE AN UP FEED OR DOWN FEED ICE MACHINE BOX AS INDICATED ON DRAWINGS.

2. PROVIDE SHOCK ABSORBER IN CW LINE SERVING ICE MAKER BOX

ICE MACHINE SUPPLY UNIT (P-8)



ELEVATOR PIT - SUBMERSIBLE SUMP PUMP

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Professional Certification. I hereby certify that these documents were prepared or approved by me, and that I am a duly licensed professional engineer under the laws of the State of Maryland.
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DRAWN BY:	NHA
CHK'D BY:	NHA

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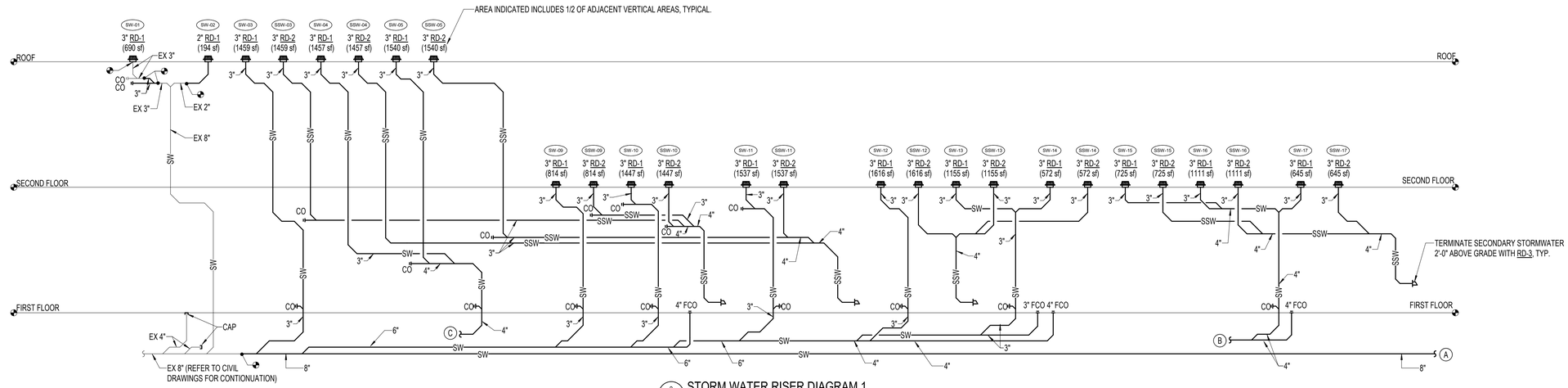
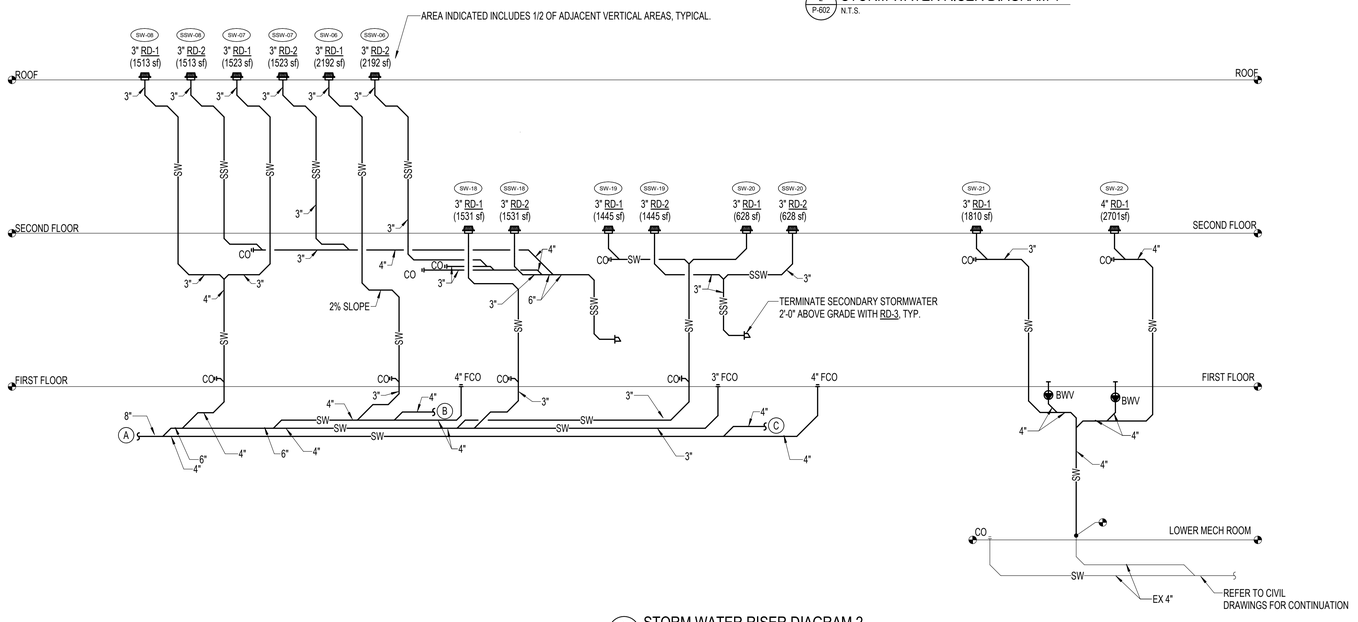
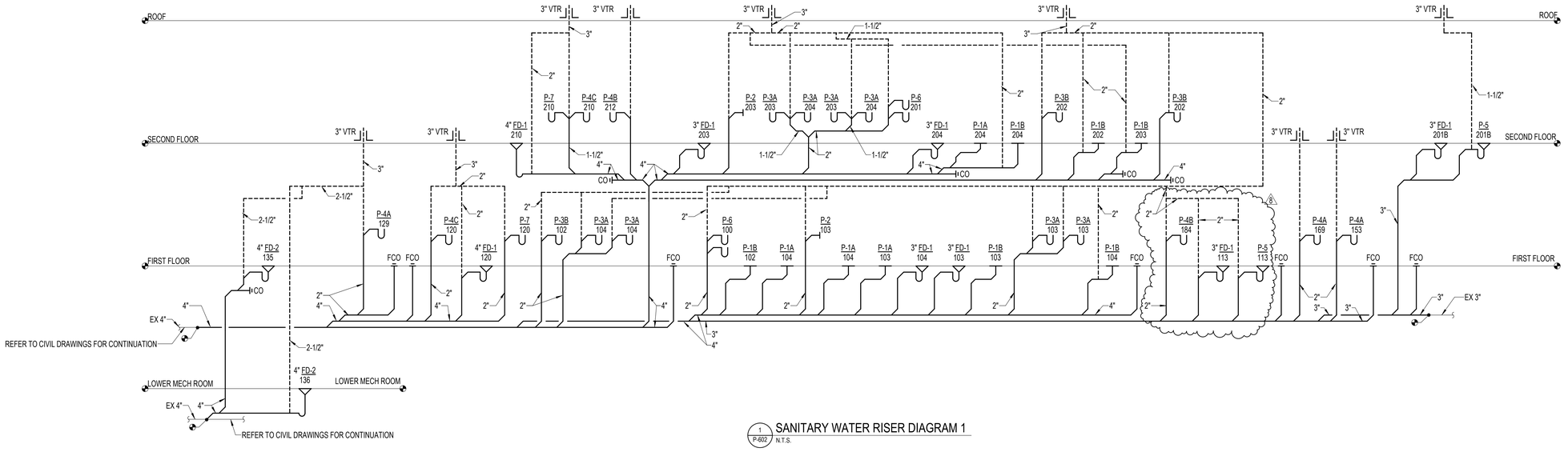


2 / P-602 STORM WATER RISER DIAGRAM 1
N.T.S.



1 / P-602 STORM WATER RISER DIAGRAM 2
N.T.S.



1 / P-602 SANITARY WATER RISER DIAGRAM 1
N.T.S.

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PLUMBING RISER DIAGRAMS

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