375 Essjay Road, Suite 200, Williamsville, New York 14221
P 716.688.0766 **F** 716.625.6825

ADDENDUM NO. 4

BUFFALO AND ERIE COUNTY BOTANICAL GARDENS ADDITION
Erie County DPW Project #2022-903-02
Wendel Project #605802

DATE

03-18-2025

CLIENT/PROJECT OWNER
Buffalo and Erie County Botanical Gardens Society
2655 South Park Ave
Buffalo, NY 14218

PROPERTY OWNER
County of Erie
c/o Department of Public Works
Edward A. Rath County Office Building
95 Franklin Street
Buffalo, NY 14202

ARCHITECT/ENGINEER
Wendel WD Architecture, Engineering, Surveying & Landscape Architecture, PC
375 Essjay Road
Suite 200
Williamsville, NY 14221
Phone: 716-688-0766
Fax: 716-625-6825

This Addendum is being issued to clarify the bid documents and shall supersede and supplement all portions of previously issued bid documents with which it conflicts. It shall be made an integral part of the construction documents.

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Project **Buffalo and Erie County Botanical Gardens Addition**
Addendum No. **4**
DPW Project # **2022-903-02**
Wendel Project No. **605802**
Date **03.18.2025**

RTICLE- **1**
DRAWING NO.
SPEC SECTION **00 10 00; 00 20 10; 00 20 20; 00 20 30; 00 20 50; 00 20 60; 00 60 00;**

Turner Bid Addendum No.4

ARTICLE - **2**
DRAWING NO.
SPEC SECTION

Pre-Bid RFI Log Addendum #4

ARTICLE - **3**
DRAWING NO.
SPEC SECTION **TOC**

Replace: Project Manual Table of Contents (TOC) in its entirety, with this issuance

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ARTICLE - **4**
DRAWING NO.
SPEC SECTION **03 54 00**

Add: Specification 03 54 00 Cast Underlayment, in lieu of 03 54 13 being added

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ARTICLE - **5**
DRAWING NO.
SPEC SECTION **23 09 23**

Replace: Specification 23 09 23 with this issuance

ARTICLE - **6**
DRAWING NO.
SPEC SECTION **G000**

Replace: G000 with this issuance

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wendel

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Project **Buffalo and Erie County Botanical Gardens Addition**
Addendum No. **4**
DPW Project # **2022-903-02**
Wendel Project No. **605802**
Date **03.18.2025**

ARTICLE - **7**
DRAWING NO. **C101**
SPEC SECTION

Replace: C101 with this issuance

ARTICLE - **8**
DRAWING NO. **C102**
SPEC SECTION

Replace: C102 with this issuance

ARTICLE - **9**
DRAWING NO. **C200**
SPEC SECTION

Replace: C200 with this issuance

ARTICLE - **10**
DRAWING NO. **C201**
SPEC SECTION

Replace: C201 with this issuance

ARTICLE - **11**
DRAWING NO. **C300**
SPEC SECTION

Replace: C300 with this issuance

ARTICLE - **12**
DRAWING NO.
SPEC SECTION

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Project **Buffalo and Erie County Botanical Gardens Addition**
Wendel Project No. **605802**
Addendum No. **4**
DPW Project # **2022-903-02**
Date **03.18.2025**

ARTICLE - **13**
DRAWING NO. **L401**
SPEC SECTION

Replace: L401 with this issuance

ARTICLE - **14**
DRAWING NO. **S100**
SPEC SECTION

Replace: S100 with this issuance

ARTICLE - **15**
DRAWING NO. **S101 (GR)**
SPEC SECTION

Replace: S101 (GR) with this issuance

ARTICLE - **16**
DRAWING NO. **S103**
SPEC SECTION

Replace: S103 with this issuance

ARTICLE - **17**
DRAWING NO. **S200**
SPEC SECTION

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Project	**Buffalo and Erie County Botanical Gardens Addition**	Addendum No.	**4**
		DPW Project #	**2022-903-02**
Wendel Project No.	**605802**	Date	**03.18.2025**

Replace: S200 with this issuance

ARTICLE - **18** DRAWING NO. **A102**

SPEC SECTION

Replace: A102 with this issuance

ARTICLE - **19** DRAWING NO. **A150**

SPEC SECTION

Replace: A150 with this issuance

ARTICLE - **20** DRAWING NO. **A251**

SPEC SECTION

Replace: A251 with this issuance

ARTICLE - **21** DRAWING NO. **A301**

SPEC SECTION

Replace: A301 with this issuance

ARTICLE - **22** DRAWING NO. **A401**

SPEC SECTION

Replace: A401 with this issuance

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Project **Buffalo and Erie County Botanical Gardens Addition**
Addendum No. **4**
DPW Project # **2022-903-02**
Wendel Project No. **605802**
Date **03.18.2025**

ARTICLE - **23** DRAWING NO. **A402**
SPEC SECTION

Replace: A402 with this issuance

ARTICLE - **24** DRAWING NO. **A450**
SPEC SECTION

Replace: A450 with this issuance

ARTICLE - **25** DRAWING NO. **A481**
SPEC SECTION

Replace: A481 with this issuance

ARTICLE - **26** DRAWING NO. **A601**
SPEC SECTION

Replace: A601 with this issuance

ARTICLE - **27** DRAWING NO. **A803**
SPEC SECTION

Replace: A803 with this issuance

ARTICLE - **28** DRAWING NO. **A950**
SPEC SECTION

Replace: A950 with this issuance

375 Essjay Road, Suite 200, Williamsville, New York 14221
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Project **Buffalo and Erie County Botanical Gardens Addition**
Addendum No. **4**
DPW Project # **2022-903-02**
Wendel Project No. **605802**
Date **03.18.2025**

ARTICLE - **29** DRAWING NO. **A951**
SPEC SECTION

Replace: A951 with this issuance

ARTICLE - **30** DRAWING NO. **A952**
SPEC SECTION

Replace: A952 with this issuance

ARTICLE - **31** DRAWING NO. **E105**
SPEC SECTION

Replace: E105 with this issuance

ARTICLE - **32** DRAWING NO. **E402**
SPEC SECTION

Replace: E402 with this issuance

ARTICLE - DRAWING NO.
SPEC SECTION

BID ADDENDUM NO. 4

To

BUFFALO AND ERIE COUNTY BOTANICAL GARDENS ADDITION

All Contractors bidding on the named project shall be governed by the following changes in the Specifications and Plans which herewith shall become part of the Contract Documents.

SPECIFICATIONS

Sections SC1-SC10, G1-G10, P1-P10, M1-M10, E1-E10, W1-W10 - Prime Contractor Bid Proposals

DELETE: The entity to whom the Bid Proposal is being submitted.

REPLACE: "TO: **Erin Grajek**, President / CEO
Buffalo and Erie County Botanical Gardens
2655 South Park Avenue Buffalo, NY 14218

AND

William E. Geary, Commissioner of Public Works
Erie County Department of Public Works
Rath Building, 95 Franklin Street, Suite 1400, Buffalo, NY 14202"

Section 00 10 00 – Special Provisions, Section 2.0, 2.1

DELETE: "OWNER:
Buffalo and Erie County Botanical Gardens
Board of Directors
2655 South Park Avenue
Buffalo, NY 14218"

REPLACE: "OWNER:
Buffalo and Erie County Botanical Gardens
2655 South Park Avenue
Buffalo, NY 14218

AND

The County of Erie
C/O Department of Public Works
Edward A. Rath County Offices Building
95 Franklin Street
Buffalo, NY"

Section 00 10 00 – Special Provisions, Section 7.8, Paragraph 2

DELETE: "Cooling: The General Contractor will be responsible for designing, providing, maintaining, and removing a full temporary cooling system during the Interior Grow Range Renovations (2025-2026) & New Building Addition construction (2025 – 2026). The General Contractor shall provide tempered/regulated air and shall include filter changes as needed. Cooling systems shall be designed in accordance with the Cross Laminated Timber and Glue Laminated Beam manufacturer requirements. Temporary cooling must be available for the buildings continuously throughout the project duration. The temporary cooling system must be capable of sustaining temperatures between 55-65 degrees Fahrenheit for both the Interior Grow Range Renovations and New Building Addition."

REPLACE: "Cooling: The General Contractor will be responsible for designing, providing, maintaining, and removing a full temporary cooling system during the New Building Addition construction (2025 – 2026). Temporary cooling system must be available for the new building Addition starting on June 1st, 2026, and ending on September 30th, 2026. The General Contractor shall provide tempered/regulated air and shall include filter changes as needed. Cooling systems shall be designed in accordance with the Cross Laminated Timber and Glue Laminated Beam manufacturer requirements. The temporary cooling system must be capable of sustaining temperatures between **65-75** degrees Fahrenheit for the New Building Addition, while also maintaining a 30% - 50% relative humidity."

Section 00 10 00 – Special Provisions, Section 7.8, Paragraph 3

DELETE: "The temporary dehumidification equipment shall be in place for the new building Addition once it is weather tight."

REPLACE: "The temporary dehumidification equipment shall be in place for the new building Addition once it is weather tight and the equipment shall remain until September 30th, 2026."

Section 00 10 00 – Special Provisions, Section 7.8, Paragraph 5

DELETE: "October 15th, 2025, through March 31st, 2025"

REPLACE: "October 15th, 2025, through March 31st, **2026**"

Section 00 10 00 – Addendum #2 Exhibit E – Specification Responsibility Matrix

DELETE: Section 03 54 13 Gypsum Concrete Underlayment.

ADD: Section 03 54 00 Cast Underlayment. Primary Responsibility will be the BP-102 General Contractor.

Section 00 20 10 – Addendum #1 BP-101 Site Work Contractor SOW, SITEWORK, EXCAVATION AND FILL, paragraph o

CLARIFICATION: The Site Contractor shall provide the mechanical screen and structural steel supports that surround the exterior ACCU's as shown in drawing A202, detail 2 on S101 (GR), and detail 19 on S400 (GR). This includes but does not limit to providing all clip angles, steel framing, structural steel supports, hollow structural sections, extruded aluminum horizontal screen, vertical tee, steel angles, base plates, grout, concrete footings, reinforcing, etc.

Section 00 20 10 – Addendum #1 BP-101 Site Work Contractor SOW, SITE UTILITIES, paragraph g

CLARIFICATION: National Fuel is responsible for the gas line relocation as shown in note 9 on drawing C102 and note 23 on C202. This includes removing the existing and installing the new. The National Fuel gas line work shall be carried in the Site Contractors bid as an allowance per specification 01 21 00 Allowances. The Site Contractor shall be responsible for paying and coordinating with National Fuel for their gas line relocation work.

Section 00 20 10 – Addendum #1 BP-101 Site Work Contractor SOW, SITE UTILITIES, paragraph m

CLARIFICATION: The Site Contractor shall provide all excavation, trenching, compaction, subbase, backfill, grading, and concrete bases/foundations associated with the exterior mechanical Air-Cooled Condensing Units (ACCU's) and underground refrigerant piping. The Site Contractor will provide trenching & backfilling from the Grow Range to the exterior ACCU's for the Mechanical Contractor to install their underground refrigerant lines. The extent of the underground refrigerant piping is shown on drawing M103.

Section 00 20 20 – Addendum #1 BP-102 General Contractor SOW, GENERAL, paragraph h

CLARIFICATION: Per specification 01 31 00 section 1.6, the Architect will furnish a set of digital files in the form of CAD to the General Contractor after they complete the "Request Form For Electronic Files". The General Contractor will update those digital files with approved shop drawings/submittals and then furnish the updated digital files to the Mechanical Contractor in either CAD or BIM format so that they can conduct clash detection.

Section 00 20 20 – Addendum #1 BP-102 General Contractor SOW, STRUCTURAL STEEL AND METALS

ADD: "l) The General Contractor shall provide all pre-finished aluminum bent column covers on the exterior of the new building Addition. This includes but does not limit to riveting the column covers to the CFMF angle at sides per detail 2 on drawing A251 and sealant over single flange backer per detail 3 on drawing A251.

Section 00 20 30 – Addendum #1 BP-103 Plumbing Contractor SOW, GENERAL, paragraph j

CLARIFICATION: Per specification 01 31 00 section 1.6, the Architect will furnish a set of digital files in the form of CAD to the Plumbing Contractor after they complete the "Request Form For Electronic Files". The Plumbing Contractor will update those digital files with approved shop drawings/submittals and then furnish the updated digital files to the Mechanical Contractor in either CAD or BIM format so that they can conduct clash detection.

Section 00 20 50 – Addendum #1 BP-105 Electrical Contractor SOW, GENERAL, paragraph j

CLARIFICATION: Per specification 01 31 00 section 1.6, the Architect will furnish a set of digital files in the form of CAD to the Electrical Contractor after they complete the "Request Form For Electronic Files". The Electrical Contractor will update those digital files with approved shop drawings/submittals and then furnish the updated digital files to the Mechanical Contractor in either CAD or BIM format so that they can conduct clash detection.

Section 00 20 50 – Addendum #1 BP-105 Electrical Contractor SOW, ELECTRICAL, paragraph ll

ADD: "ll. The Electrical Contractor shall provide the mini power-zone (MZ-P1) and pedestal per detail 3 on drawing E101. This includes but is not limited to all excavation, backfill, mini power-zone (MZ-P1), welded steel c-channel frame, lockable weatherproof service receptacle, copper clad steel ground rod, cadweld, bolts, conduit, and concrete foundations/footing."

Section 00 20 60 – Addendum #1 BP-106 Window Contractor SOW, DOORS, FRAMES, AND HARDWARE, paragraph a

DELETE: "The Window Contractor shall provide all exterior and interior aluminum doors, frames, and hardware in the existing Grow Range and New Building Addition including door numbers 001A, 001B, 001C, 001D, 007, 009, 010, 110, 101B, 101C, 101D, 102A, 102B, 108B on drawing A920. Provide all glazing bars, mutins, glass, transoms, and door lites, associated with the doors of this scope. Set door threshold in bed of sealant."

REPLACE: "The Window Contractor shall provide all exterior and interior aluminum doors, frames, and hardware in the existing Grow Range and New Building Addition including door numbers 001A, 001B, 001C, 001D, 007, 009, 010, 101B, 101C, 101D, 102A, 102B, 108B on drawing A920. Provide all glazing bars, mutins, glass, transoms, and door lites, associated with the doors of this scope. Set door threshold in bed of sealant."

Section 00 60 00 – AIA Documents: A132, A132 Exhibit A, A232, A312 (Payment & Performance Bond)

DELETE: The Owner language on page 1 of all AIA documents in specification 00 60 00.

REPLACE: "OWNER:

Buffalo and Erie County Botanical Gardens
2655 South Park Avenue
Buffalo, NY 14218

AND

The County of Erie
C/O Department of Public Works
Edward A. Rath County Offices Building
95 Franklin Street
Buffalo, NY"

Pre-Bid RFI Log

Pre-Bid RFI #	Title	RFI	Response	Addendum Issued
1	Apprenticeship Requirements	It appears that the project contains a apprenticeship stipulation, how are we able to bid if we are a non union company.	The County requirement on all projects is 10% apprenticeship through employees that are certified apprenticeships through NY State. How a contractor acheives that is through training programs within NYS and EEO can assist with providing direction on which programs. That said, the contractor also has the option to check inapplicable and provide reasoning why whithin the bid as shown on the NEW YORK STATE CERTIFIED APPRENTICESHIP TRAINING PROGRAM CERTIFICATION form within the bid proposal	Addendum #2
2	Fire Alarm	What company is the Fire Alarm Vendor?	Seimens	Addendum #2
3	Field Supervision	Per section 001000 3.3 Each Prime Contractor is to provide a breakout for a full-time Field Supervisor. The value of the payment application line item shall be the cost/salary of the Full-time Supervisor for the duration of the project. Please confirm that a full-time field supervisor is required, and if they can be working or non-working based on the package.	Refer to specification 001000 section 6.2 for field supervisor requirements.	Addendum #2
4	Gypsum Underlayment	Section 035413 Gypsum Underlayment was removed via Addendum 1. S101 still calls out a 3" gypcrete topping at S1 CLT deck. Is this work going to be performed by others?	Specification 03 54 13 Gypsum Concrete Underlayment will be added in addendum #3 and will be included in the BP-102 General Contractor Scope of Work. (Repeated in RFI #21)	Addendum #2
5	Contractors Own Workforce	Per the bid proposal, Contractors Own Workforce, please confirm that the only items that contribute to the 25% requirement is actual "work in place" and not management, supervision, general conditions, etc.	General Conditions, supervision, clerical **CAN** contribute to the minimum 25% requirement in addition to "work in place".	Addendum #2
6	Mechanical Screen	On A202, a mechanical screen is indicated, what package is responsible for this? Please provide specification	Per Addendum #1 specification 002010-7 section "Sitework, Excavation and Fill", item "o", the BP-101 Site Contractor shall provide the mechanical screen surrounding the exterior ACCU's. See specifications sections 08 90 00 and 08 92 00	Addendum #2
7	Spec. 072700	Per section 072700 an accredited ABAA contractor is required; can this be waived	No, this requirement can not be waived	Addendum #2
8	Spec. 074243	Section 074243 only lists one product as the basis of design. Traditionally, in public bids at least 3 products are listed. Please provide at least two other products that would be considered an equal.	A basis of design or approved equal fulfills the requirements for this project. No additional products will be added to the spec.	Addendum #2
9	Spec. 078123	Section 078123 only lists one product as the basis of design for the fire protection material and top coat. Traditionally in public bids at least 3 products are listed. Please provide at least two other products that would be considered an equal	A basis of design or approved equal fulfills the requirements for this project. No additional products will be added to the spec.	Addendum #2
10	Spec. 083613	Section 083613 only lists one product as the basis of design. Traditionally, in public bids at least 3 products are listed. Please provide at least two other products that would be considered an equal.	A basis of design or approved equal fulfills the requirements for this project. No additional products will be added to the spec.	Addendum #2
11	Spec. 086300	Section 086300 only lists one product as the basis of design. Traditionally, in public bids at least 3 products are listed. Please provide at least two other products that would be considered an equal.	A basis of design or approved equal fulfills the requirements for this project. No additional products will be added to the spec.	Addendum #2
12	Spec. 102239	Section 102239 only lists one product as the basis of design. Traditionally, in public bids at least 3 products are listed. Please provide at least two other products that would be considered an equal	A basis of design or approved equal fulfills the requirements for this project. No additional products will be added to the spec.	Addendum #2
13	Spec. 122400	Section 122400 only lists one product as the basis of design. Traditionally, in public bids at least 3 products are listed. Please provide at least two other products that would be considered an equal	A basis of design or approved equal fulfills the requirements for this project. No additional products will be added to the spec.	Addendum #2

Pre-Bid RFI Log

14	Spec. 142400	Section 142400 only lists one product as the basis of design. Traditionally, in public bids at least 3 products are listed. Please provide at least two other products that would be considered an equal.	A basis of design or approved equal fulfills the requirements for this project. No additional products will be added to the spec.	Addendum #2
15	Spec. 081613	Is section 081613 Fiberglass Doors part of package 106?	Refer to Addendum #1 Exhibit E Specification Responsibility Matrix, Specification 081613 is the primary responsibility of the BP-102 General Contractor. Refer to Addendum #1 specification 002020-12 section "Doors/Frames/Hardware", Item "a" for more information.	Addendum #2
16	Exhibit G Testing	Please confirm that all moisture testing required via Exhibit G will be performed by the owner	All moisture testing required via Exhibit G will be performed by the Owner's Special Inspection Testing Agency. The protection and testing measures included in Exhibit G shall be coordinated with the Cross Laminated Timber and Glue Laminated Construction Manufacturer. The Manufacturer requirements will supercede the Exhibit G requirements.	Addendum #2
17	Contractors Own Workforce	I wanted to reach out regarding the Erie County requirement for prime contractors to self-perform at least 25% of the work. Meeting the 25% self-performance requirement may be challenging for many Prime Contractors. Could you provide some clarification on this requirement? Specifically, is there any consideration for the general contracting portion of the bid to count toward this percentage? Any information you can share would be greatly appreciated.	Any and all work executed by the prime contractor will count toward the 25% requirements. This includes but is not limited to supervision, general conditions, clerical, any on on-site scoped work related to the project, etc. by employees working under the prime contractor.	Addendum #2
18	P2 Greenhouse	Are there any benches being installed in Greenhouse P2?	No benches for P2 Greenhouse	Addendum #2
19	Finish Schedule	CONC-1 is polished concrete called out on the Finish Schedule on Drawing A952. The Finish Schedule states to reference architectural specs, however there is no spec for polished concrete. Can you please provide?	Spec 03 35 11 for polished concrete will be added.	Addendum #2
20	Rm 105 Event Servery	Drawing A201: Rm 105 Event Servery, is the Prep Surface NIC like the Dirty Carts and Rack? If it is part of the contract, can you please provide a spec or additional details for what is desired?	The prepsurface note is deleted in addendum #2. The three basin sink is part of the contract. Refer to plumbing drawings.	Addendum #2
21	Exhibit E	Addendum #1: Specification 03 5413 Gypsum Concrete Underlayment was crossed off the TOC, however it was then added to the Exhibit E Specification Responsibility Matrix to be included in BP-102 scope of work. Please advise if this work is to be done by BP-102 or not.	Specification 03 54 13 Gypsum Concrete Underlayment will be added in addendum #2 and will be included in the BP-102 General Contractor Scope of Work.	Addendum #2
22	Masonry Specification	There are no specifications for the split face or ground face block on the Botanical Gardens project. Where could I find out what you are looking for? The color of the masonry units affects the price of the units. Please let me know where I can submit samples to.	Refer to Specification section 04 22 00. Basis of Design CMU block in Conservatory Vestibule 101 will be 8" Trenwyth in standard color. Exposed block in Conservatory Vestibule 101 shall be split face block. Exposed block at exterior of conservatory Vestibule 101 shall be ground face block. Please provide standard color options to architect for selection.	Addendum #3
23	Temporary Stair Tower	Section 00 1000, 7.19, 1. The temporary stair towers call for 36" wide. Is this dimension from outside to outside wall or inside to inside wall? If it is inside to inside wall, these are special order and more expensive. The typical stair tower has a dimension of 25" from inside to inside.	The temporary stair tower's treads must have a 36" width from outside to outside wall. The intent is to not special order a stair tower.	Addendum #2
24	OCSD - 4	On bid day you are requesting that OCSD-4 M/WBE & SDVOB Utilization Report be filled out and submitted. Is there anyway to have this form be submitted within 24 - 48 hours after bid day? It will be very difficult to accurately fill this out on bid day, but given the extra time, the form would be filled out correctly.	Refer to Addendum #2 clarification on specification 00 30 00 section 1.1, A, 14 (page 3).	Addendum #2

Pre-Bid RFI Log

25	BIM Coordination	Per section 002020 BP-102 2-H all contractors are to provide coordination drawings of the new and existing buildings in a BIM format to the MC. Please clarify the exact BIM format and level of detail required, is scanning of the existing structures required? If so, what contract is responsible?	Refer to Addendum #2 Scope of Work clarifications.	Addendum #2
26	Spec. 042613	Per 042613 and note E17 on the elevation drawings, the face brick is to match existing. Please provide the basis of design, manufacture, size, color, and finish of face brick to match existing.	Spec 04 26 13 for face brick is provided in Addendum #3.	Addendum #3
27	Pre cast coping and split face CMU	Per notes E11 & E12 pre cast coping and split face CMU is to match existing conservatory stone base color. Please provide the basis of design, manufacture, size, color, and finish of precast coping and split face CMU to match the existing	Refer to Specification section 04 22 00. Basis of Design CMU block in Conservatory Vestibule 101 will be 8" Trenwyth in standard color. Exposed block in Conservatory Vestibule 101 shall be split face block. Exposed block at exterior of conservatory Vestibule 101 shall be ground face block. Please provide standard color options to architect for selection.	Addendum #3
28	Footing Schedule	Ref. Drawing S100 "Footing Schedule": Please confirm that footing type F4.5 should be 4'-6" sq. to match the plan.	Yes that has been updated on the drawings in Addendum #4	Addendum #4
29	Control System	Would a Niagara and/or Honeywell control system be acceptable as a BAS manufacturer for this project?	Substitution request can not be approved or denied without product submittal data as documentation	Addendum #4
30	BAS System	Is there an existing BAS system that would need to be incorporated or extended into the new and renovated areas? If so, what system is it currently?	It's a competitive bid. The new controls need to be integrated with the existing front end.	Addendum #2
31	Builder's Risk	Section 00 2020 (page 17): States that Builder's Risk is by Owner, but AIA A132 Exhibit A, Section A.3.3.3.5. states that the contractor shall provide the Builder's Risk policy. Please confirm the Owner is providing.	The Owner is providing the Builder's Risk Policy.	Addendum #3
32	Column Schedule	Drawing S200 Column Schedule: Column C-1 is 6.75x6.875. This is the only column of this size. Can you confirm this is correct, or is it a typo?	This is a typo C-1 and B-1 should be 10.5x11 to match other columns on those grids	Addendum #4
33	Dumpster Coordination	Specification 00 1000, 7.3, 5: It states that you would like a separate dumpster for each type of material being recycled. One of the dumpster service providers has the ability to sort recyclables off site, lessening the amount of dumpsters onsite. This has been approved for LEED certified projects before. Would this be acceptable for this project?	Comingling dumpsters with multiple waste streams can be recycled and sorted offsite ONLY IF the offsite waste facility weighs each material stream separately after sorting. As stated in 00 10 00, 7.3, 3: Visual weight estimates will not be accepted. The offsite recycling facility must weigh each of the different waste streams from the comingling dumpster separately and provide weight documentation for each waste stream to the Owner, CM or A/E LEED Coordinator.	Addendum #2
34	Local Labor Requirement	At the pre-bid bid it was mentioned that this project is subject to local labor requirements from an 8-county surrounding area. Would a waiver on this requirement be considered to specialty contractors such as those performing work on the greenhouse?	Please refer to specification 00 30 00 section 1.3, C: Should a bidder conclude that they would be unable to satisfy the requirements of Executive Order #18, the bidder shall submit a properly executed Executive Order #18 Erie County Local and Disadvantaged Worker Compliance Certification Waiver Request as shown in Appendix E.	Addendum #3
35	P1 Slab on Grade	Ref. 012300-3.1-A-2 and BP-102 Scope of Work: For alternate #1 should the new 5" slab on grade in Greenhouse P1 be eliminated from the scope?	Yes, the slab in P1 is identified as part of Deduct Alternate 1. See update in addendum 4.	Addendum #4
36	Retaining Wall and Seat Wall	Ref. Detail 10/S300, 8/A302 and Note 33 on C201: Does section 10/S300 apply to the retaining wall shown in 8/A302 and referenced in Note 33 on C201? Is this retaining wall part of BP-201?	The Concrete Seatwalls as shown in note 22 on drawing C201 will be provided by the BP-101 Site Contractor. The Concrete Retaining Wall as shown in note 33 on drawing C201 will be provided by the BP-102 General Contractor. Clarification on C201 Keynote 33, issued as part of Addendum #3	Addendum #3
37	Gift Shop Flooring	Ref. Drawing A-950 and A-952: The floor finish in the Gift Shop 007 is listed as CONC. Should this be CONC-1 or is there another finish type for CONC?	Please see sheet A-950 reissue in Addendum 2: Gift Shop 007 floor finish is revised to 'CONC-1'	Addendum #3

Pre-Bid RFI Log

38	Spec. 03 30 00	Ref. Section 033000: Please clarify if the following items listed in 033000 are required on this project. 2.1-G Non Slip Aggregate Finish, 2.1-H Liquid Densifier/Sealer, 2.1-I Penetrating Anti-Spalling Sealer, 2.1J Floor Hardener, 2.1K Floor Hardener, 2.1M Fibers.	If it is included in the spec, it is required	Addendum #3
39	Underpinning	Ref. Detail 5/S002: Is any underpinning required on this project?	Yes. Refer to specification 00 20 10 BP-101 Site Work Contractor SOW "SITEWORK, EXCAVATION AND FILL" item "c" for scoping responsibility.	Addendum #3
40	Reinforcing	Ref. Drawing S101(GR): Is there any reinforcing required in the new 5” slab on grade in the P1 and P2 greenhouses?	Yes. 6x6-W2.0xW2.0	Addendum #4
41	Air Handeling Units	Ref. Drawing M103 and M105: Are concrete pads required below the AHUs? If yes, what are the dimensions of the pads?	Air handlers are to be on rails.	Addendum #3
42	ACCU Foundations	Ref. 1/M102 and C201: Are concrete pads/foundations required below the ACCUs at P1? If yes, what are the dimensions of the pads/foundations?	ACCU's are to be mounted to rails refer to wind rated equipment support rails detail on M201.	Addendum #3
43	Greenhouse P1	In section 002020 Greenhouse Specialties item b the term allowance is used. Is an allowance to be used toward this portion of the greenhouse restoration?	There is no allowance for the greenhouse renovation. Refer to the addendum #1 specification 00 20 20 section "P1 Greenhouse Specialties" item "b".	Addendum #3
44	P1 Abatement	Per note 14 on the HM Drawings, we are to remove exterior metal glazing caps/glazing at the P1/P2 greenhouses, and per note 8 at house 4 gable end greenhouse. This is to take place at glass modification or replacement. For bidding purposes, can a replacement quantity be provided for cap replacement and glass replacement if damaged during abatement operations?	Refer to the Addendum #3 added allowance scope in specification 00 20 20 BP-102 General Contractor SOW for unavoidably damaged items during glazing/greenhouse abatement. Please carry an $5,000 allowance.	Addendum #3
45	P1 & P2 Fin Tube Piping Scope of Work	In section 002020 Greenhouse Specialties item h, it is indicated that fin tube piping & heating are at greenhouse P1 only. Per GH100 scope for P2 Greenhouse note 5, new fin tube is indicated. Please confirm the location of the fin tube at the greenhouses that is part of contract 102	The BP-102 General Contractor will be responsible to provide all new fin tube piping in the P1 Greenhouse. The BP-104 Mechanical Contractor will be responsible to provide all new fin tube piping in the P2 Greenhouse.	Addendum #3
46	Flooring	CPT4 is specified to be tile pieces, however the product only comes in sheets. Can you please advise if sheets are acceptable or if you want to change CPT4 for another product?	Sheets are acceptable. CPT-4 information on sheet A952 will be revised in Addendum 3	Addendum #3
47	Approved Manufacturer	Please advise if Trane can be listed as an approved manufacturer under Specification Section 237313.16-2.2.A.	Trane is an acceptable air handler manufacture. The dimensionality of the air handlers need to be consistent with the basis of design because of the strict size constraints of the mechanical rooms. If dimensionality of the air handler changes redesign of the spaces will fall on the contractor.	Addendum #3
48	Building Automation System	Should the existing Siemens Desigo Building Automation System at Botanical Gardens be extended for this project and tied into the Central Erie County Building Campus Siemens Desigo Network?	It's a competitive bid. The new controls need to be integrated with the existing front end.	Addendum #3
49	Fire Alarm System	Should the existing Siemens Desigo Fire Alarm System at Botanical Gardens be extended for this project and tied into the Central Erie County Building Campus Siemens Desigo Network?	It's a competitive bid. The new system can operate as it's own stand alone system	Addendum #3
50	Approved Manufacturer	Can Thermal Corporation be added to the list of acceptable manufacturers for Indoor, Semi-Custom Air-Handling Units called out in spec section 237313.16, part 2.2.A.?	Substitution request can not be approved or denied without product submittal data as documentation	Addendum #4
51	Concrete Patching	Drawing AD101, General Demo Note #17 Drawing A950, P21 & P36 The above mentioned notes state to clean/patch/repair the existing spalled concrete floor. During the walk through it was hard to get a sense of how much repair is required. Is there anyway to have an allowance for the BP #102 General Trades Contractors to include in their pricing so that everyone is apples to apples with one another?	Refer to the Addendum #3 added allowance scope in specification 00 20 20 BP-102 General Contractor SOW for concrete spalling repair.	Addendum #3

Pre-Bid RFI Log

52	Division 5 Manufacturers	O'Keeffe's Inc. respectfully asks for your approval to be included in your Division 5 – Metal Ladders/Fabrication specifications on Buffalo Erie County Botanical Gardens Addition project.	Substitution request has been received and this approval is accepted.	Addendum #4
53	Reinforced Turf	Can you confirm that the area of Reinforced Turf will be finished graded and sodded instead of seeded? Refer to L-501/4.	See revised drawing L401, stabilized turf areas within the courtyard are to finish graded and sodded	Addendum #4
54	Owner Plantings	Please confirm that all plantings are not to be in this contract per L400 drawing.	The following plantings listed on drawing L400 will be provided by the Owner: deciduous canopy tree, coniferous tree, deciduous understory/ornamental tree, container shrubs, container grasses, and perennial/groundcover drifts. Refer to Addendum #1 specification 00 20 10-6 BP-101 Site Work Contractor SOW "SITEWORK, EXCAVATION AND FILL" paragraphs "g", "h", and "I" for how the plant beds, soil profiles, and disturbed areas will be turned over to the Owner for their planting installations.	Addendum #3
55	VCT-3	Keynote P22/A951 called out for VCT to Carpet Transition. Also, Keynote P29/A951 Called out for VCT to ETR Conc Floor. Also, VCT-3 is not used in Whole project. Please advise if VCT-3 needs to be estimated at room 120 door entry and transition adjacent to the elevator.	Please see updated finish tag added for Corridor 119 leading to Room 120. VCT-3 is not used. These items will be updated in Addendum 4.	Addendum #4
56	VCT-3	Finish Key Note P29 called out for VCT to Existing to Remain Conc Floor Transition Strip. Although Finish Tag shows Existing to remain Flooring @Staff Room 027/ Security 028/Retail Storage 031/Event Storage 032. Also, VCT-3 not used in whole project. Please advise if VCT-3 needs to be estimated.	Keynote P29 has been removed in four locations where the existing to remain exposed concrete floor is in the corridor and the adjacent room. VCT-3 is not used. These items will be updated in Addendum 4.	Addendum #4
57	Exposed Tile Edges	TS-1 Schluter Reno is marked on elevation 1/A601 at tile exposed edge. which is as per Finish Schedule is Floor Transition. For now, TS-1 (Schluter, Schiene) is estimated as per Section 093000 for exposed tile edges. Please advise.	TS-3 has been added for the tile edge application. A601 elevations have been revised. These items will be updated in Addendum 4.	Addendum #4
58	Fiberglass Doors	What contract is responsible for section 081613 Fiberglass Doors? This is listed on the table of contents but not included on the responsibility matrix.	Refer to Addendum #1 Exhibit E Specification Responsibility Matrix, Specification 081613 is the primary responsibility of the BP-102 General Contractor. Refer to Addendum #1 specification 002020-12 BP-101 General Contractor SOW section "Doors/Frames/Hardware", Item "a" for more information.	Addendum #4
59	Reception Desk	SSM-3, the solid surface which clads the Reception Desk is not listed on the finishes plan. Could you please advise?	SSM-1 should be used in all locations on the reception desk. These items will be updated in Addendum 4.	Addendum #4
60	Below Grade Rigid Insulation	Ref. Drawing A100, A450, A451 and 072100: A100 and 072100 call for 2" rigid insulation. The details on A450 and A451 call for 2.5" below grade insulation. Please confirm which is correct.	The details show what is required in each location. Foundation insulation requires an R-10, 2 ½" of EPS and below grade walls require R-7.5, 2" of EPS.	Addendum #4
61	Column Covers	Section 057500 references factory fabricated column covers. The only reference on the drawings to column covers occurs on 1 A402 which calls out 2&3 ON A 251. If column covers are to be applied at these locations, it seems they need to be custom. Also, column covers are not indicated on details 2&3 of A251. Please clarify the design intent of the column covers	Refer to the Addendum #4 scope added to specification 00 20 20 BP-102 General Contractor SOW, section "STRUCTURAL STEEL AND METALS", paragraph "I". No custom covers are required. Drawings have been updated to clarify use of factory fabricated column covers. Spec has been updated to identify Americlad Aluminum Composite Column Cover. Basis of Design is type AC-20C (Hairline Joint) rectangular in bronze color. Submit standard color chart to architect for selection.	Addendum #4
62	Column Cover Scope	Is note E02 on drawing A301 intended to be the factory fabricated column covers? Is the bronze color supposed to match the window mullions? If so can this be included with package 106?	Refer to the Addendum #4 scope added to specification 00 20 20 BP-102 General Contractor SOW, section "STRUCTURAL STEEL AND METALS", paragraph "I". Yes, E02 should be factory fabricated alum column covers to match the alum storefront mullions.	Addendum #4

Pre-Bid RFI Log

63	Temporary Heat	Per special provisions 7.8 item 5 temporary heat will be provided October 15, 2025- March 31, 2025. Should it be March 31, 2026?	Refer to the Addendum #4 revised scope in specification 00 10 00 Special Provisions, section 7.8, Paragraph 5.	Addendum #4
64	Temporary De-Humidification	41. Does the temporary dehumidification system only need to be operational once the new addition is weather tight, though completion of interior architectural finishes? Can temporary de-humidification be discontinued at an earlier date?	Refer to the Addendum #4 revised scope in specification 00 10 00 Special Provisions, section 7.8, Paragraph 3.	Addendum #4
65	Temporary Cooling System	42. Can the maximum temporary range of the temporary cooling system be increased to 65-72 degrees?	Refer to the Addendum #4 revised scope in specification 00 10 00 Special Provisions, section 7.8, Paragraph 2.	Addendum #4
66	Temporary Cooling in Grow Range	43. Can the requirement for temporary cooling at the interior grow range renovation be removed due to the fact there are no mass timber (CLT/Glu-Lam) elements in this area?	Refer to the Addendum #4 revised scope in specification 00 10 00 Special Provisions, section 7.8, Paragraph 2.	Addendum #4
67	Polished Concrete	The finish schedule states to reference the specs for more details but I do not see mention of polished concrete within the specs. Could you please provide more details on this scope of work?	Polished concrete specification section 03 35 11 was added in Addendum 3.	Addendum #4
68	AISC Certification	Division 5 - Metals: Specification section 05 51 00 "Metal Stairs" and 05 52 13 "Pipe and Tube Railings" require AISC 201 Fabricator Certifications. Currently the local and surrounding areas contain only a few vendors with said certification. In order to expand the market and allow for multiple competitive bids in lieu of limiting it, eliminating the AISC certification requirement will allow local (including minority, women owned and SDVOB) vendors to participate and to expand into the market that may not have such a certification, but do provide 5-10+ of expertise and experience in their field. Please confirm the AISC certification can be eliminated from the above referenced specifications.	Please utilize scope as outlined in the bid documents.	Addendum #4
69	National Fuel	Per the Sitework Contract scope of work/Site Utilities/Letter G states to provide all new gas piping needed for the relocation as shown in the contract documents. When comparing the plan set, drawing C102/Note #9 states that all removal of existing gas service by national fuel and on drawing C202/Note #23 states the relocation of gas service is by national fuel. Please clarify intent/confirm that National fuel is indeed responsible for this scope of work.	Refer to the Addendum #4 scope clarification for specification 00 20 10 Site Work Contractor SOW, SITE UTILITIES, Paragraph g.	Addendum #4
70	Temporary Cooling	Spec Section 00 1000, Section 7.8, 2. Temporary Cooling The spec calls for the summertime temperature to be between 55 - 65 degrees. This is very cold and seems like it might be a typo. Can you confirm the temperature that will be required for the cooling during the summertime?	Refer to the Addendum #4 revised scope in specification 00 10 00 Special Provisions, section 7.8, Paragraph 2.	Addendum #4
71	Door Hardware	Door hardware set shows doors 009, 010, and 101C as getting auto operators, but not listed in door Hardware sets? Please advise.	For door 009, price same components as hardware set #31 (Door 001C). For door 010, price same components as hardware set # 32 (Door 001D) . For Door 101C, price same components as hardware set #37 (Door 101D). Hardware sets will be updated and distributed as future bulletin.	Addendum #4
72	Substitute Operator	Can the Assa Abloy sw200i operator be considered a substitute to the specified operators	Substitutions may be submitted during the bid period. Refer to Specification section 016000 and submit appropriate information to Turner.	Addendum #4

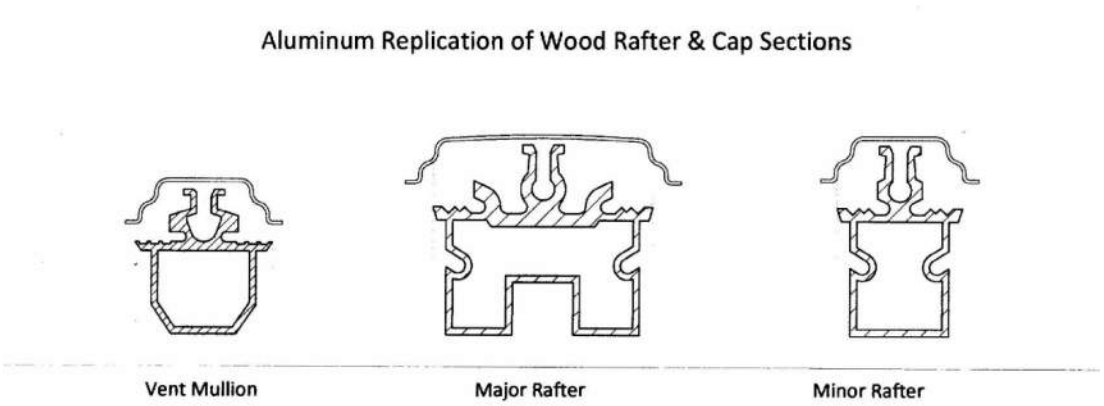
Pre-Bid RFI Log

73	Temproary Heating & Cooling	We understand the temperature specifications for the space to be 55F - 65F and humidities between 30% - 50% RH, which are good conditions to install the woodwork in. Targeting 55F inside the space when we are heating is practical and works out well for a construction space; there's also the target of 65F in the space when cooling. As much as 65F is a good temperature for the timber-related activities, the same is true about higher temperatures that may not require as much energy/equipment to be maintained in the space. Is there a possibility to raise the upper bound of temperatures on the specifications and have the range be 55F - 75F, still with 30% - 50% RH? Moisture will be pulled out of the wood through a vapor pressure differential; by raising the temperature and maintaining the RH levels, we allow for that differential to happen without the need of additional energy and equipment to cool	Refer to the Addendum #4 revised scope in specification 00 10 00 Special Provisions, section 7.8, Paragraph 2.	Addendum #4
74	Door Scope	BP-102 Scope of work indicates that the general trades contractor will provide all interior and exterior hollow metal doors, frames and hardware. Package 106 scope of work list door 110 as part of its work. Door 110 is hollow metal with a hollow metal frame. Please clarify which package is responsible for door 110.	Refer to the Addendum #4 revised scope in specification 00 20 60 BP-106 Window Contractor SOW, DOORS, FRAMES, AND HARDWARE, paragraph a. BP-102 General Contractor shall be responsible for door 110 and all associated frames and hardware.	Addendum #4
75	NYS Greenhouse Building Codes	Does the current structure meet all New York State building codes for snow load and wind loads?	Please utilize scope as outlined in the bid documents.	Addendum #4
76	NYS Greenhouse Building Codes	Does the replacement of individual glass panels require the structure to be brought up to current code standards?	There is a very small percentage of roof glazing being replaced. Please utilize scope as outlined in the bid documents.	Addendum #4
77	Greenhouse Manufacturer	Is the original greenhouse manufacturer still in business, and are replacement parts for the glass capture system available?	No, Lord & Burnham Company was closed in 1988. A residential greenhouse company acquired the name in 2018.	Addendum #4
78	Greenhouse Photos	Are there any available up-close external photographs of the glass and capture system?	See last page with jpg "Rafter sections". The rafters are aluminum.	Addendum #4
79	Greenhouse Subframe	Is the subframe composed of steel or aluminum?	It is an aluminum structure.	Addendum #4
80	Greenhouse Glazing System	Is the current glazing system utilizing annealed single-pane glass in both the walls and roof?	Yes, traditional 1/8" "Bar & Cap" lapped glass glazing. See last page with jpg "L&B Bar cap section"	Addendum #4
81	Greenhouse Drawings	Is there an existing drawing that details the glass sizes?	Roof glass and sidewall is 24" wide, gable end glass is 20" wide.	Addendum #4
82	Mechanical Excavation	In Mechanical Contract scope of work Addendum #1/Exclusions/Letter I, states that the sitework contractor is responsible for the excavation, trenching, & backfill for underground mechanical piping. Please clarify intent & locations.	Refer to the Addendum #4 revised scope for specification 00 20 10 Site Work Contractor SOW, SITE UTILITIES, Paragraph m.	Addendum #4
82	Mechanical Excavation	In Mechanical Contract scope of work Addendum #1/Exclusions/Letter I, states that the sitework contractor is responsible for the excavation, trenching, & backfill for underground mechanical piping. Please clarify intent & locations.	Refer to the Addendum #4 revised scope for specification 00 20 10 BP-101 Site Work Contractor SOW, SITE UTILITIES, Paragraph m.	Addendum #4
83	Mechanical Screen	With regards to the Mechanical Screen that is in the Sitework package. Is the Sitework contractor also responsible for the structural steel supports that the Mechanical Screen attach to or only furnish and install of the screen itself?	Refer to the Addendum #4 scope clarification for specification 00 20 10 BP-101 Site Work Contractor SOW, SITEWORK, EXCAVATION AND FILL, Paragraph o.	Addendum #4
84	Spec 08 70 00	Per addendum 2 responsibility matrix section, Section 08 70 00 Hardware is listed as a primary responsibility of both the General Trades and Window contracts. Per the scope of work window contractor is only responsible for the hardware at the doors assigned to them. Please confirm the general trades contract is to include all other hardware on the doors NOT assigned to the window contractor.	Correct, The BP-102 General Contractor is responsible for all other hardware on the doors NOT assigned to the BP-106 Window Contractor.	Addendum #4

Pre-Bid RFI Log

85	Spec 03 30 00	Ref. Addendum #3, RFI #38 Answer: Please indicate specifically where on this project the following items are required? 033000-2.1-G Non-Slip Aggregate Finish, 033000-2.1-H Liquid Densifier/Sealer, 033000-2.1-I Penetrating Anti-Spalling Sealer, 033000-2.1J Floor Hardener, 033000-2.1K Floor Hardener, 033000-2.1M Fibers.	Wendel can specify the Non-slip Aggregate finish. Assume, at minimum it is in mechanical areas and the Equipment Pad next to P1. See attached SSK-1. Anti-spalling sealer to be on equipment pad noted above. Liquid Densifier sealer on Ground Floor and equipment pad. The hardener may be used in lieu of the densifier. Fibers are an option for the outdoor pad. But for bidding assume WWM.	Addendum #4
86	ACCU Equipment Pads	Ref. Addendum #3, RFI #42 Answer: Detail 8 on M201 shows wind rated equipment support rails anchored to the roof structure. Detail 3/M201 shows an outdoor condensing unit mounted to rails and references Detail 1/M201. M201 shows a 4" equipment pad poured on a concrete slab. Please provide site specific details with dimensions for the support of the outdoor ACCUs at the P1 Greenhouse. Specifically, is there a concrete pad required under the wind rated equipment support rail?	Refer to the Addendum #4 revised scope for specification 00 20 10 Site Work Contractor SOW, SITE UTILITIES, Paragraph m. Please see SSK-1 sketch at the end of the RFI Log for reference.	Addendum #4
87	Finish Schedule	Drawing A950: Rooms 018 - 022 This drawing notes PT-7 or Alternate WC-1. The Finish Schedule on A952 notes WC-1 is "Alternate accent at ground floor circ". How would you like this priced since there is not a space for this pricing on the bid form?	Alternate WC-1 is removed from the scope. This is updated on the floor plan and in the finish legend in Addendum 4.	Addendum #4
88	Masonry Colors	Addendum #3 states the colors of the architectural masonry should be submitted to the architect. To whom should I send them to at Wendel?	For bidding purposes, please use the most costly standard CMU color. All color charts may be submitted to Wendel ATTN: Ann Casey, Proj #605802, Suite 500, 237 Main Street Buffalo, 14203	Addendum #4
89	Timber Species	Per S000, Per "Engineered Wood Products" note #05/S000 all mass timber elements are noted to be southern yellow pine UON. However, on the legend sections of sheets, S101 & S103 glulam beams are listed as "24F-V4 DFN" i.e. Douglas fir. Please confirm the required species for glulam and CLT materials.	The species given in the legend supersede the general notes.	Addendum #4
90	Structural Framing Plans	Per S101 & 103 ; On the structural framing plans, glulam beams are shown with depths sized in 1 3/8" increments i.e. southern yellow pine, and in 1 1/2" increments i.e. Douglas fir. Please confirm if standard lay-up depths can be assumed. Note that standardized depths are recommended for cost efficiency	Yes, standard lay-up depths can be assumed., and should be the nearest standard depth that is not less than that shown on the dwgs	Addendum #4
91	Structural Framing Plans	Per S101 & 103 ; On the structural framing plans, glulam beams are shown with sized non-standard widths. E.g. There are 5" and 5 1/2" wide glulam beams shown, neither of which conform to the closest APA standard nominal or actual widths i.e. 6" or 5 1/8". Please confirm if standard APA glulam member widths can be assumed. Note that standardized widths are recommended for cost efficiency.	Yes, standard APA glulam member widths can be assumed, should be the nearest standard width that is not less than that shown on the dwgs	Addendum #4
92	Septic Field	Per C102 – Site Preparation Plan/Note #11 states to remove the existing septic field. Would there be an existing septic tank that needs to be removed as well? If so, please provide location.	Based on the previous field investigation report provided by the owner, no existing tank was identified. However, there may be remnants of the septic field remaining which can be disposed of if encountered.	Addendum #4
93	Vapor Retarder	Please provide a spec for vapor retarder at framed walls.	Please see Project Manual spec section 072600 - Vapor Retarders, Part 2 Products.	Addendum #4
94	Fräsch	I am submitting fräsch for consideration as a comparable product to the specified products, 098430 P2.1A. Please advise if this is acceptable.	Substitution request and product information received. This substitution is rejected due to limitation in product length resulting in extra seaming, labor, and connection points to the wall.	Addendum #4
95	Termally Isolated Z-Girts	Our partners are looking at this project and would like to submit Slotted-Z as an alternative comparable product to specification 074243, 2.3, B, 6. Please advise if this is acceptable.	Substitution request and product information received. This substitution is accepted.	Addendum #4

RFI 78 (Rafter sections)



RFI 80 (L&B Bar cap section)

L & B Aluminum Barcaps

ELIMINATE THE HIGH COST OF LABOR TO REGLAZE, PAINT ROOF BARS, REPUTTY AND PUSH UP SLIPPED GLASS

SAVE YOU UP TO 25% ON HEATING COSTS

- **Stop Leaky Roofs**
- **Prevent Slipped Glass and Cut Down Glass Breakage**
- **Capped Bars Never Need Painting, One of Your Biggest Savings**

FREE Barcap Selector Kit Write today for your free BARCAP SELECTOR KIT containing six Barcap samples and instructions for determining the exact size Barcaps needed for your greenhouse. A post card puts your Kit in the mail.

Barcaps form a continuous unbroken shield over the glazing bar and glass seam, for complete glazing protection — not like clips or short-cap imitations that give partial or no protection at all.

L & B Aluminum Barcaps give you permanent, profit-saving greenhouse protection — no more costly heat loss, no more slipped glass, no more leaks, no more painting of capped bars — in short, no more excessive maintenance costs.

Don't let another winter pass without investigating the money-saving benefits of permanent L & B Barcap protection.

FOR IRON FRAME GREENHOUSES

Description	Barcap Number & Size	Price Ea.
Roof Barcap	155-18"	$.14
Roof Barcap	155-20"	.16
Roof Barcap	155-24"	.18
Roof Barcap	155-26"	.21
Rafter Barcap for 1⅛" wide tongue	157-18"S	.29
Rafter Barcap for 1⅛" wide tongue	157-20"S	.31
Rafter Barcap for 1⅛" wide tongue	157-24"S	.34
Rafter Barcap for 1⅛" wide tongue	157-26"S	.36
Roof Vent Sash Barcap (on Muntin)	155B-29V (for 24" glass)	.39
Roof Vent Sash Barcap (on Stile)	155B-29VE (for 24" glass)	.36

155 Series

155B Series

FOR SEMI-IRON, PIPE FRAME & SASH BAR HOUSES

Roof Barcap	156-18"	$.15
Roof Barcap	156-20"	.17
Roof Barcap	156-24"	.19
Roof Barcap	156-26"	.22
Roof Vent Sash Barcap (on Muntin)	156B-29V (for 24" glass)	.40
Roof Vent Sash Barcap (on Stile)	156B-29VE (for 24" glass)	.37

156 Series

156B Series

COMPOUND — SEE PRICES ON PAGE 22

BARCAP PRICES do not include compound. See Quantity Requirements below. Order Compound from page 22. See page 23 for Glass, Scaffold Brackets and Glazing Accessories. Our New All-aluminum Scaffold is listed on page 25.

PRICES ON OTHER BARCAPS FURNISHED ON REQUEST

COMPOUND QUANTITIES REQUIRED

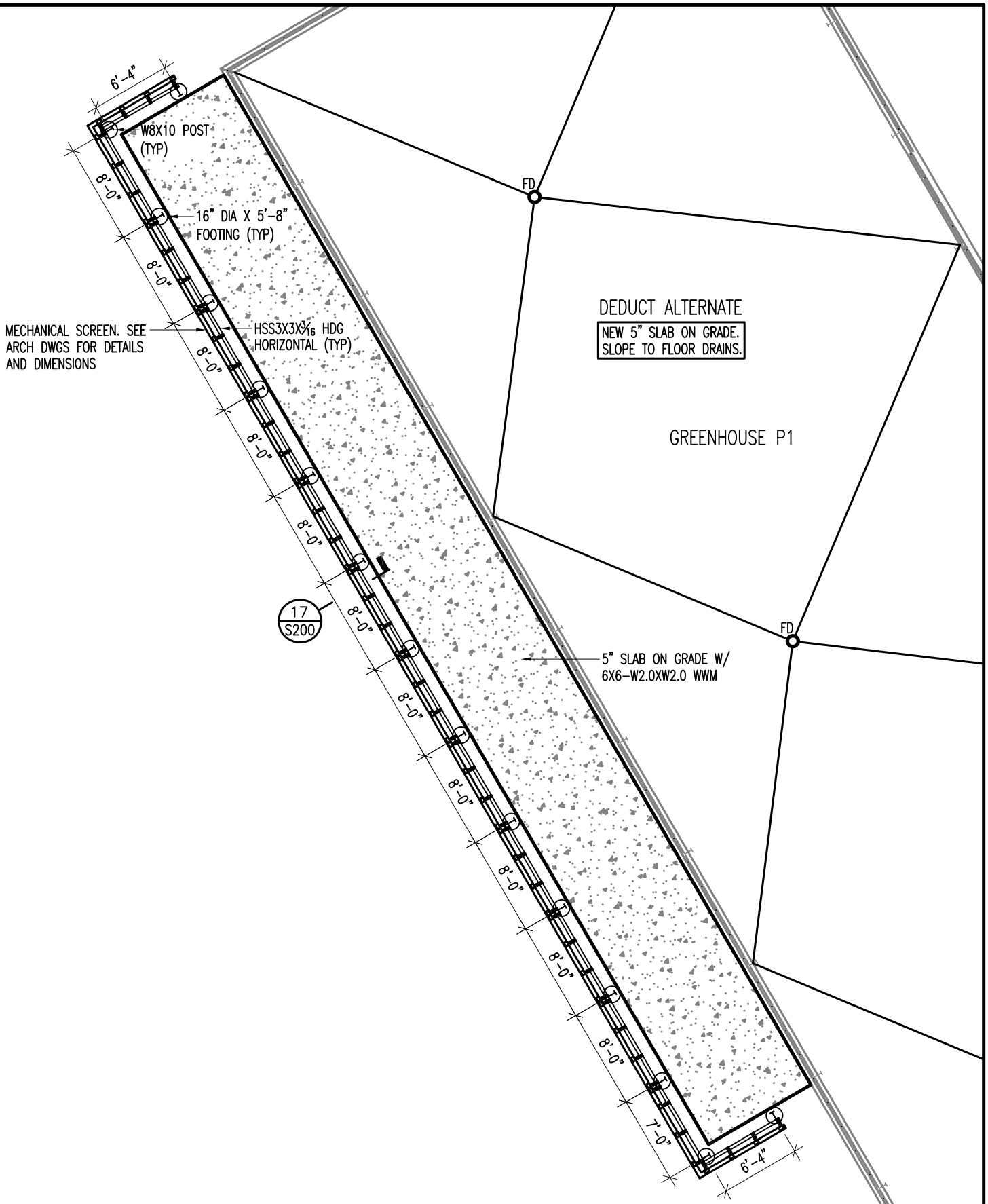
For Barcap Series 155 and 155B and Barcap Series 156 and 156B figure 1 gallon of #303 compound for every 130 ft. of cap.

CAPPING METHOD

CONDITION OF GLAZING — Putty bed under glass must be in fair to good condition. Glass laps should be brought in line, old glazing nails removed and dirt cleaned from lap corners.

APPLICATION — Bar tongue painted 2 coats L & B white. Single bead #303 compound gunned along each side of tongue. Area under cap need not be filled with compound.

26



PROJECT 23120

BUFFALO AND ERIE COUNTY BOTANICAL GARDENS
ADDITION

TITLE:	P1 EQUIPMENT PAD
REF:	S101(GR)
SCALE:	NTS
DATE:	03.18.25
DRAWN BY:	LOH

RSE

RSE ASSOCIATES, INC.
63 PLEASANT STREET, SUITE 200
WATERTOWN, MA 02472
T| 617.926.9300 F| 617.926.9301

SHEET #: 1 OF 1

SSK-1

ERIE COUNTY DEPARTMENT OF PUBLIC WORKS
OFFICE OF THE COMMISSIONER
Buffalo and Erie County Botanical Gardens Addition; EC DPW #2022-903-02

PROJECT MANUAL: TABLE OF CONTENTS

ERIE COUNTY DEPARTMENT OF PUBLIC WORKS
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PROJECT MANUAL: TABLE OF CONTENTS

ERIE COUNTY DEPARTMENT OF PUBLIC WORKS
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PROJECT MANUAL: TABLE OF CONTENTS

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PROJECT MANUAL: TABLE OF CONTENTS

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PROJECT MANUAL: TABLE OF CONTENTS

ERIE COUNTY DEPARTMENT OF PUBLIC WORKS
OFFICE OF THE COMMISSIONER
Buffalo and Erie County Botanical Gardens Addition; EC DPW #2022-903-02

PROJECT MANUAL: TABLE OF CONTENTS

ERIE COUNTY DEPARTMENT OF PUBLIC WORKS
OFFICE OF THE COMMISSIONER
Buffalo and Erie County Botanical Gardens Addition; EC DPW #2022-903-02

PROJECT MANUAL: TABLE OF CONTENTS

ERIE COUNTY DEPARTMENT OF PUBLIC WORKS
OFFICE OF THE COMMISSIONER
Buffalo and Erie County Botanical Gardens Addition; EC DPW #2022-903-02

PROJECT MANUAL: TABLE OF CONTENTS

SECTION 035400 - CAST UNDERLAYMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Liquid-applied self-leveling floor underlayment.
   1. Use gypsum-based type at as indicated on drawings.

1.2 RELATED REQUIREMENTS

A. Division 01, Sustainable Design Requirements Section 018113.13 for credits MR 4, MR 5, IEQ 4.1.
   1. The above listed LEED credits are related to this section. Other LEED credits may apply and shall be reviewed for their potentila applicablility and conformed with as though listed.

B. Division 09 Sections for patching and leveling compounds applied with floor coverings.

1.3 REFERENCE STANDARDS

A. ASTM C1602/C1602M - Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete.

B. ASTM C472 - Standard Test Methods for Physical Testing of Gypsum, Gypsum Plasters, and Gypsum Concrete.

C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

1.4 SUBMITTALS

A. Product Data: Provide manufacturer's data sheets documenting physical characteristics and product limitations of underlayment materials. Include information on surface preparation, environmental limitations, and installation instructions.

B. Certificate: Certify that products meet or exceed specified requirements.

C. Manufacturer's Instructions.

D. Shop Drawings: Include plans indicating substrates, locations, and average depths of underlayment based on survey of substrate conditions.

1.5 QUALITY ASSURANCE

A. Applicator Qualifications: Company specializing in performing the work of this section, and approved by manufacturer.

1.6 PREINSTALLATION MEETINGS

A. Conduct Preinstallation Conference at Project Site..

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Keep dry and protect from direct sun exposure, freezing, and ambient temperature greater than 105 degrees F.

1.8 FIELD CONDITIONS

A. Do not install underlayment until floor penetrations and peripheral work are complete.

B. Environmental Limitations: Comply with manufacturer's written instructions for substrate temperature, ventilation, ambient temperature and humidity, and other conditions affecting underlayment performance.
   1. Place underlayments only when ambient temperature and temperature of substrates are between 50 and 80 deg. F. Maintain ambient temperatures 24 hours before, during and 72 hours after installation of underlayment.

C. During the curing process, ventilate spaces to remove excess moisture.

1.9 COORDINATION

A. Coordinate application of underlayment within requirements of floor-covering products and adhesives, specified in Division 09 Sections, to ensure compatibility of products.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Gypsum Underlayment:
   1. Maxxon Corporation; Gyp-Crete 2000/3.2K: www.maxxon.com/#sle.
   2. Substitutions: See Section 016000 - Product Requirements.

2.2 MATERIALS

A. Cast Underlayment General:
   1. Comply with applicable code for combustibility or flame spread requirements.

B. Gypsum-Based Underlayment: Gypsum based mix, that when mixed with water in accordance with manufacturer's directions will produce self-leveling underlayment with the following properties:
   1. Compressive Strength: Minimum 2500 pounds per square inch, tested per ASTM C472.
   2. Density: Maximum 115 pounds per cubic foot.

3. Final Set Time: 1 to 2 hours, maximum.
4. Thickness: 3/4 inch to maximum 3-1/2 inch.
5. Surface Burning Characteristics: Flame spread/Smoke developed index of 0/0 in accordance with ASTM E84.

C. Aggregate: Dry, well graded, washed silica aggregate, approximately 1/8 inch in size or coarse sand and acceptable to underlayment manufacturer.
1. Provide aggregate when recommended in writing by underlayment manufacturer for underlayment thickness.

D. Reinforcement: Galvanized metal lath complying with recommendations of underlayment manufacturer for specific project circumstances.

E. Water: ASTM C1602/C1602M; clean, potable, and not detrimental to underlayment mix materials.

F. Primer: Manufacturer's recommended type for substrate conditions.

G. Joint and Crack Filler: Latex based filler, as recommended by manufacturer.

H. Corrosion-Resistant Coating: Recommended in writing by underlayment manufacturer for metal substrates.

I. Surface Sealer: Designed to reduce porosity as recommended by manufacturer for type of floor covering to be applied to underlayment.

J. Sound Control Mat: Sheet material, perimeter isolation strip, and tape; as recommended by the underlayment manufacturer. Maxxon Acousti-mat; Acousti-mat 3/4, www.maxxon.com. Substituions: See Section 016000- Product Requirements.

2.3 MIXING

A. Site mix materials in accordance with manufacturer's instructions.

B. Add aggregate for areas where thickness will exceed 1/2 inch. Mix underlayment and water for at least two minutes before adding aggregate, and continue mixing to assure that aggregate has been thoroughly coated.

C. Mix to self-leveling consistency without over-watering.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that substrate surfaces are clean, dry, unfrozen, do not contain petroleum byproducts, or other compounds detrimental to underlayment material bond to substrate. Examine substrates, with Installer present, for conditions affecting performance of the Work

B. Proceed with application only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. General: Prepare and clean substrate according to manufacturer's written instructions. Mechanically remove, laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants that might impair underlayment bond.
   1. Treat nonmoving substrate cracks according to manufacturer's written instructions to prevent cracks from telegraphing (reflecting) through underlayment.
   2. Remove substrate surface irregularities. Fill substrate voids to prevent underlayment from leaking. Finish smooth.
   3. Vacuum clean surfaces.
   4. Prime substrate in accordance with manufacturer's instructions. Allow to dry.

B. Wood Substrates: Mechanically fasten loose boards and panels to eliminate substrate movement and squeaks. Sand to remove coatings that might impair underlayment bond and remove sanding dust.
   1. Install underlayment reinforcement as recommended by manufacturer.

C. Adhesion Tests: After substrate preparation, test substrate for adhesion with underlayment according to manufacturer's written instructions.

D. Vacuum clean surfaces.

E. Prime substrate in accordance with manufacturer's instructions. Allow to dry.

F. Install sound control mat in accordance with manufacturer's instructions.

3.3 APPLICATION

A. Mix and Install underlayment in accordance with manufacturer's instructions.
   1. Close areas to traffic during underlayment application and for time period after application recommended in writing by manufacturer.
   2. Coordinate application of components to provide optimum adhesion to substrate and between coats.
   3. At substrate expansion, isolation, and other moving joints, allow joint of same width to continue through underlayment.

B. Pump or pour material onto substrate. Do not retemper or add water.
   1. Pump, move, and screed while the material is still highly flowable.
   2. Be careful not to create cold joints.
   3. Wear spiked shoes while working in the wet material to avoid leaving marks.

C. Apply primer over prepared substrate at manufacturer's recommended spreading rate.

D. Place to indicated thickness, apply to produce uniform, level surface, with top surface level to 1/8 inch in 10 ft.

E. For final thickness over 1-1/2 inches, place underlayment in layers. Allow initial layer to harden to the point where the material has lost its evaporative moisture. Immediately prime and begin application of the subsequent layer within 24 hours.

F. Where additional aggregate has been used in the mix, add a top layer of neat mix (without aggregate), if needed to level and smooth the surface.

G. If a fine, feathered edge is desired, steel trowel the edge after initial set, but before it is completely hard.

H. CURING
   1. Once underlayment starts to set, prohibit foot traffic until final set has been reached.
   2. Air cure in accordance with manufacturer's instructions.

I. Do not install floor coverings over underlayment until after time period recommended in writing by underlayment manufacturer.

J. Apply surface sealer at rate recommended by manufacturer.

K. Remove and replace underlayment areas that evidence lack of bond with substrate, including areas that emit a "hollow" sound when tapped.

3.4 PROTECTION

A. Protect against direct sunlight, heat, and wind; prevent rapid drying to avoid shrinkage and cracking.

B. Do not permit traffic from concentrated and/or rolling loads over unprotected floor underlayment surfaces.

END OF SECTION 035400

SECTION 23 0923 – DIRECT DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the Building Management System (BMS) control equipment for HVAC systems and components, including open protocol control components for terminal heating and cooling units, as well as metering, lighting control, and building alarm systems. Depending on the scope of the project, the complete specification may have numerous sections that interface to this section, including several from Divisions 26.

B. Commonly included related Sections include the following:

1. Section 230519 "Meters and Gages for HVAC Piping" for measuring equipment that relates to this Section.
2. Section 230593 “Testing, Adjusting, and Balancing for HVAC Equipment” for requirements that relate to this section.
3. Section 230993 "Sequence of Operations for HVAC Controls" for requirements that relate to this Section.

1.3 REFERENCED CODES AND STANDARDS

A. Provide BAS components and ancillary equipment, which are UL-916 listed and labeled.

B. All equipment, wiring, and piping used in conditioned air streams, spaces or return air plenums shall comply with NFPA 90A Flame/Smoke/Fuel contribution rating of 25/50/0 and all applicable building codes or requirements.

C. All wiring shall conform to the National Electrical Code.

D. All smoke dampers shall be rated in accordance with UL 555S.

E. Comply with FCC rules, Part 15 regarding Class A radiation for computing devices and low power communication equipment operating in commercial environments.

F. Comply with FCC, Part 68 rules for telephone modems and data sets.

G. Comply with ASHRAE 135-2004 for BACnet systems.

1.4 ABBREVIATIONS AND DEFINITIONS

A. Abbreviations and definitions listed within this section shall also apply to specification section 230993 “Sequence of Operation”

B. Abbreviations:

AAC	Advanced application controller
ADJ	Adjustable
AI	Analog Input
AO	Analog Output
ASC	Application specific controller
ASD	Application specific device
AUTO	Automatic
AUX	Auxiliary
AV	Analog Value
BACnet	Building Automation Controls Network
BC	Building controller
BMS	Building Management System,
BI	Binary Input (DI: Digital Input),
BO	Binary Output (DO: Digital Output)
BV	Binary Value
C	Common
CAC	Custom application controller
DA	Discharge air
DCU	Distributed control unit
DDC	Direct Digital Control
DR	Demand response
FTP	File transfer protocol
EA	Exhaust air
GUI	Graphical User Interface
HOA	Hand-off-auto
I/O	Input/output
IP	Internet protocol
LAN	Local area network
LCM	Local control module

LON	Local Operating Network
LPES	LON portable operator's
MAX	Maximum
MIN	Minimum
MPC	Multi-purpose controller
MS/TP	Master slave / Token passing
NC	Normally closed
NO	Normally open
NSC	Network server controller
OA	Outside air
OBIX	Open building information exchange
OWS	Operator workstation
PC	Personal computer
PEM	Packaged equipment module
PEMS	Power and energy management software
PICS	Protocol Implementation Conformance Statement
PID	Proportional plus integral plus derivative
POT	Portable operator's terminal
PPC	Programmable process controller
RA	Return air
RC	Room controller
RH	Relative humidity
RTD	Resistance temperature detector
SA	Supply air
SDCU	Standalone digital control unit
SLC	Supervisory logic controller
SNVT	Standard network variable type
SP	Static pressure
TCP	Transmission control protocol
TEMP	Temperature
UEC	Unitary equipment controller
VAVDDC	Variable air volume direct digital controller
W/	With

W/O	Without
XML	eXtensible markup language

C. Definitions:

Advanced Application Controller	A fully programmable control module. This control module may be capable of some of the advanced features found in Building Controllers (storing trends, initiating read and write requests, etc.) but it does not serve as a master controller. Advanced Application Controllers may reside on either the Ethernet/IP backbone or on a subnet.
Analog Input	A continuously varying voltage or amperage signal that is varied by a sensor in relation to a sensed variable. This signal is processed in the controller after an analog-to-digital converter on the controller that converts the analog signal to a digital value.
Analog Output	A continuously varying voltage or amperage signal that is generated from the controller after digital-to-analog conversion. The voltage or amperage signal will be used, for instance, to drive a modulating actuator or reset a hardwired set point on a packaged device. 6. Analog Value (AV): A network-visible analog point whose value is determined by a controller computation.
Analog Value	A network-visible analog point whose value is determined by a controller computation.
Application Specific Controller	A pre-programmed control module which is intended for use in a specific application. ASCs may be configurable, in that the user can choose between various pre-programmed options, but it does not support full custom programming. ASCs are often used on terminal equipment such as VAV boxes or fan coil units. In many vendors' architectures ASCs do not store trends or schedules but instead rely upon a Building Controller to provide those functions.
BACnet/IP	An approved BACnet network type which uses an Ethernet carrier and IP addressing.
BACnet MS/TP	An approved BACnet network type which uses a Master-Slave Token Passing configuration. MS/TP networks are unique to BACnet and utilize EIA485 twisted pair topology running at 9600 to 76,800 bps.
BACnet over ARCNET	An approved BACnet network type which uses an ARCNET (attached resource computer network) carrier. ARCNET is an industry standard that can utilize several speeds and wiring standards. The most common configuration used by BACnet controllers is an EIA485 twisted pair topology running at 156,000 bps.
Binary Input	An on/off indication that has a maximum cycle rate of 1 Hz. This is typically sensing a contact closure.
Binary Output	A contact closure on the controller that will cause inaction in the system.

Binary Value	A network-visible binary point whose value is determined by a controller computation.
Building Controller	A fully programmable control module which is capable of storing trends and schedules, serving as a router to devices on a subnet, and initiating read and write requests to other controllers. Typically, this controller is located on the Ethernet/IP backbone of the BAS. In many vendors' architectures a Building Controller will serve as a master controller, storing schedules and trends for controllers on a subnet underneath the Building Controller.
Building Management System	Integrated DDC Temperature control system used both for system operation and troubleshooting meeting the requirements of this specification.
Direct Digital Control	A control system in which a digital computer or microprocessor is directly connected to the valves, dampers, and other actuators which control the system, as opposed to indirectly controlling a system by resetting set points on an analog pneumatic or electronic controller.
Integrate	The physical connections from a control system to all specified equipment through an interface as required to allow the specified control and monitoring functions of the equipment to be performed via the control system.
Interface	The physical device required to provide integration capabilities from an equipment vendor's product to the control system. The equipment vendor most normally furnishes the interface device. An example of an interface is the chilled water temperature reset interface card provided by the chiller manufacturer in order to allow the control system to integrate the chilled water temperature reset function into the control system.
kW Demand Limiting	An energy management strategy that reduces energy consumption when a system's electric power meter exceeds an operator-defined threshold. When power consumption exceeds defined levels, the system automatically adjust set points, de-energizes low priority equipment, and takes other pre-programmed actions to avoid peak demand charges. As the demand drops, the system restores loads in a predetermined manner.
Local Operating Network	A control network technology platform for designing and implementing interoperable control devices and networks.
Occupant Override Switch; or Timed Local Override	A control option that allows building occupants to override the programmed HVAC schedule for a limited period of time. When the override time expires, the zone returns to its unoccupied state.
Occupant set point adjustment	A control option that allows building occupants to adjust – within limits set by the HVAC control system – the heating and cooling set points of selected zones. Typically, the user interface for this function is built into the zone sensor.

Optimal Start/ Start-up	A control strategy that automatically starts an HVAC system at the latest possible time yet ensures comfort conditions by the time the building becomes occupied. In a typical implementation, a controller measures the temperature of the zone and the outside air. Then, using design heating or cooling capacity at the design outside air temperature, the system computes how long a unit must run at maximum capacity to bring the zone temperature to its occupied set point. The optimal start algorithm often includes a self-learning feature to adjust for variations from design capacity. A distributed system must use Run on Request with Optimal Start. (See below.)
Protocol Implementation Conformance Statement	A written document, created by the manufacturer of a device, which identifies the particular options specified by BACnet that are implemented in the device.
Provide	Furnish and Install
Requested, or Run on Request	A control strategy that optimizes the runtime of a source piece of equipment that supplies one or more receiving units – such as an air handler unit supplying zone terminal units with heating, cooling, ventilation, or similar service. Source equipment runs only when needed, not on a fixed schedule. The source equipment runs when one or more receiving units request its services. An operator determines how many requests are required to start the source equipment. For example, if all the zones in a building are unoccupied and the zone terminal units do not need heating or cooling, the AHU will shut down. However, if a zone becomes occupied or needs cooling, the terminal unit will send a run request to the AHU to initiate the start-up sequence. If this AHU depends on a central chiller, it can send a run request to the chiller. The run-on request algorithm also allows an operator to schedule occupancy for individual zones based on the needs of the occupants without having to adjust the schedules of related AHUs and chillers.
Smart Actuator	An actuator which is controlled by a network connection rather than a binary or analog signal. (0-10v, 4-20mA, relay, etc.)
Smart Sensor	A sensor which provides information to the BAS via network connection rather than a binary or analog signal. (0-10000 ohm, 4-20mA, dry contact, etc.)
Trimmed and Respond, or Set point Optimization	A control strategy that optimizes the set point of a source piece of equipment that supplies one or more receiving units – such as an air handler unit supplying zone terminal units with heating, cooling, ventilation, or similar service. The source unit communicates with receiving units to determine heating, cooling, and other requirements, and then adjusts its set point. For example, if all zones are comfortable and do not request cooling, the AHU will gradually increase (trim) its supply air set point. When a zone requests cooling, the AHU responds by dropping its set point. The more zones that request cooling, the more it drops the set point. The AHU repeats this process throughout the day to keep zones cool, but with a supply air set point that is no cooler than necessary.

Web Services — Web services are a standard method of exchanging data between computer systems using the XML (extensible markup language) and SOAP (simple object access protocol) standards. Web services can be used at any level within a Building Automation System (BAS), but most commonly they are used to transfer data between BAS using different protocols or between a BAS and a non-BAS system such as a tenant billing system or a utility management system.

1.5 DESCRIPTION

A. Provide labor, materials, equipment, and services as required for the complete installation indicated in Contract Documents. The workstation shall display dynamic, real-time point data on color graphic displays for all points. Provide all required software and hardware. Provide wiring and conduit required to connect devices furnished as a part of, or accessory to, this automatic control system.

B. The BMS shall be as indicated on the drawings and described in these specifications. System must be fully integrated and coordinated with mechanical equipment DDC controllers furnished and installed in the equipment manufacturer's factory as specified in those sections. The intent of the BMS is to integrate all mechanical equipment into the existing campus Siemens Control system for global monitoring, control, and alarming associated with the building. BMS manufacturer is responsible to provide all the design, engineering, and field coordination required to ensure all equipment sequence of operations are met as specified and the designated BMS operators have the capability of managing the building mechanical system to ensure occupant comfort while maintaining energy efficiency.

C. Integrate new controls system to communicate and display graphics on the existing Siemens front end control system that is currently utilized. All interconnection and communication from the new control system to the existing shall be the responsibility of the controls contractor.

D. The BMS shall meet open protocol communication standards to ensure the system maintains "interoperability" to avoid proprietary arrangements that will make it difficult for the Owner to consider other BMS manufacturers in future projects.

E. DDC technology shall be used to provide the functions necessary for control of mechanical systems and terminal devices on this project.

F. The BMS shall accommodate simultaneous multiple user operation. Access to the control system data should be limited only by operator password. Multiple users shall have access to all valid system data. An operator shall be able to log onto any workstation on the control system and have access to all appropriate data.

G. The mechanical systems and terminal devices shall be provided with factory mounted DDC controls that will permit each system to operate in a stand-alone fashion were indicated on drawing schedules. As such, in the event of a BMS network communication failure, or the loss of an individual controller, the other DDC controllers shall continue to independently operate and communicate to the BMS.

H. Communication between DDC controllers and all workstation(s) shall be over a high-speed network. All nodes on this network shall be peers. The operator shall not have to know the controller identifier or location to view or control a point (object). Application Specific Controllers shall be constantly scanned by the Building Controllers to update point information and alarm information globally.

I. The BMS manufacturer shall provide all hardware and software necessary to implement the functions and sequence of operations specified.

J. This contractor is responsible to provide all required devices for proper system operation, including, but not limited to: transformers, relays, pushbutton stations, controllers, panels, actuators, sensors, meters, etc. This contractor is responsible to provide wiring to all devices provided, in accordance with requirements of "Electric Wiring" in Section 260519, and the National Electrical Code. Control wiring 'Wiring' is defined as wiring up to and including 120 volts, and included power distribution wiring to operate devices. This contractor is responsible to coordinate and provide all power distribution and breakers from panel boards to the control panels.

K. Freestanding panels shall be supported from "Unistrut" securely fastened to walls.

L. This contractor is responsible to coordinate and provide Ethernet data drops at main building controller and at operator workstations.

M. Provide services and manpower necessary to support of all commissioning activities as described in specification section 230800, in coordination with the Mechanical Contractor, the TAB agent, and the Owner's Representative.

1.6 ACTION SUBMITTALS

A. BMS manufacturer shall provide shop drawings and manufacturers' standard specification data sheets on all hardware and software being provided for this project. No work may begin on any segment of this project until the Engineer and Owner have reviewed submittals for conformity with the plan and specifications.

B. Provide the Engineer and Owner, any additional information or data which is deemed necessary to determine compliance with the specifications or which is deemed valuable in documenting and understanding the system to be provided.

C. Submit for review the following:

1. A complete bill of materials of equipment to be used indicating quantities, manufacturers, and model numbers.
2. Provide all manufacturers' technical cut sheets for major system components. When technical cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means.
3. Each submitted product literature and drawings shall clearly reference the specification page and section number and/or drawing number associated with the product. Include:

a. Building Controllers
b. Custom Application Controllers
c. Application Specific Controllers
d. Operator Workstations
e. Portable Operator Terminals
f. Auxiliary Control Devices
g. Proposed Building Automation System architectural diagram depicting various controller types, workstations, device locations, addresses, and communication cable requirements.
h. Detailed termination drawings showing all required field and factory terminations, as well as terminal tie-ins to DDC controls provided by mechanical equipment manufacturers. Terminal numbers shall be clearly labeled.
i. Points list showing all system objects and the proposed English language object names.
j. Sequence of operation for each controlled mechanical system and terminal end devices.
k. Provide a Protocol Implementation Conformance Statement (PICS) for each system level device (i.e., Building Controller & Operator Workstations) type. This defines the point list for proper coordination of interoperability with other building systems if applicable for this project.
l. Provide Certification and functional profile SNVT's for unitary-level controllers (i.e., chillers, RTU's, AHU's, Terminal VAV boxes, FCU's, UV's, etc.) for interoperability with other building systems if applicable for this project.

4. Detailed piping and wiring control diagrams, components, and systems description for each system under control.
5. Detailed layout and nameplate list for component control panels and DDC panels.
6. Submit a valve, actuator, and damper scheduled showing size, manufacturer, model number, pressure drop configuration, capacity, and locations. Provide apparatus Bulletins and data sheets for all control system components.
7. Submit an airflow station schedule showing size, manufacturer, model number, airflow, velocity, and locations.
8. A complete listing of input and output points, control loops and/or routines, including time of day functions, and facilities management system functions for each controlled system. This listing shall include point logical names, identifiers, and alarmable ranges.
9. Provide as part of a separate submittal a hard copy of all graphics showing system components, sensor locations, set points and fixed/variable data. Contractor to submit to the Engineer for review and approval of graphic format prior to final acceptance of system.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and manufacturer.

B. Product test reports: For major control components such as valves, dampers, actuators, controllers, sensors, transformers, transmitter, airflow stations, flow meters, and any other major control component.

1.8 CLOSEOUT SUBMITTALS

A. Upon completion of installation, submit three (3) copies of record (as-built) documents. The documents shall be submitted for approval prior to final completion and include:

1. Project Record Drawings - These shall be as-built versions of the submittal shop drawings. One set of electronic media including CAD .dwg or .dxf drawing files and .pdf files shall also be provided.
2. Testing Reports and Checklists signed off by trained factory (equipment manufacturers) and field (BMS) commissioning personnel.
3. Operating and Maintenance (O & M) Manuals - These shall be as-built versions of the submittal product data. In addition to the information required for the submittals, Operating & Maintenance manual shall include:

    a. Names, address, and 24-hour/7-day per week telephone numbers of Contractor personnel managing and installing equipment, along with service personnel responsible for supporting the ongoing warranty and services of the control system.
    b. Procedures for operating the BMS including logging on/off, alarm management, generation of reports, trends, overrides of computer control, modification of set points, and other interactive system requirements.
    c. Description of the programming language including syntax, statement descriptions, algorithms, calculations, point database creation and modification, program creation and modification, and operator use of the editor.
    d. Explanation of how to design and install new points, new DDC controllers, and other BMS hardware.
    e. Preventative Maintenance and calibration procedures; hardware troubleshooting; and hardware repair and/or replacement procedures.
    f. Documentation of all software program logic created for Custom Programmable Controllers including the overall point database. Provide one set of magnetic media containing files of the software and point database.
    g. One set of electronic media containing files of all operator color graphic screens for the project.
    h. A list of recommended spare parts including pricing, manufacturer, supplier, and part numbers.
    i. Documentation, installation, and maintenance information for all third-party hardware/software products provided including personal computers, printers, hubs, sensors, valves, etc.
    j. Original issue media for all software provided, including operating systems, programming language, operator workstation software, and graphics software.
    k. Licenses, Guarantee, and Warranty documents for all equipment and systems.
    l. Recommended preventive maintenance procedures for all system components including a schedule of tasks (inspection, cleaning, calibration, etc.) and task descriptions.

1.9 QUALITY ASSURANCE

A. The BMS manufacturer authorized representative shall have an established business office within 50 miles of the project site and must provide 24 hours/day, 7 days/week response in the event of a customer warranty or service call.

B. The BMS Manufacturer authorized representative installer shall have a minimum of five years' experience in systems of similar size, type and complexity installed within a 50-mile radius.

C. The BMS Manufacturer authorized representative shall have factory trained and certified personnel, in the regular employment of the approved manufacturer's local office, providing all engineering, service, startup, and commissioning field labor for the project from their local office location. BMS manufacturer authorized representative shall be able to provide training certifications for all local office personnel upon request.

D. The BMS shall be provided by a single manufacturer and this manufacturer's equipment must consist of operator workstation software, Web-based hardware/software, Open Standard Protocol hardware/software, Custom application Programming Language, Graphical Programming Language, Building Controllers, Custom Application Controllers, and Application Specific Controllers. All other products specified herein (i.e., sensors, valves, dampers, actuators, etc.) need not be manufactured by the BMS manufacturer.

E. Multiple independent representatives of BMS manufacturers are not acceptable. BMS vendor must be corporate owned authorized representative entity of BMS manufacturer.

F. The complete automatic temperature control system shall be comprised of electric control devices with a microprocessor based Direct Digital Control System. All work shall be installed only by skilled mechanics employed by the BMS Manufacturer authorized representative temperature control contractor or subcontractor.

G. All components shall be fully tested and documented to operate as a complete system.

H. Supplier must guarantee that all replacement parts will be carried in stock for a period of 5 years minimum from the date that the system is commissioned.

I. All products used in this installation shall be currently manufactured, and shall have been applied to a minimum of three previous projects. This installation shall not be used as a test site for any new products unless explicitly approved by the Owner's representative in writing prior to bid date.

1.10 DELIVERY, STORAGE, AND HANDLING

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

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

1.11 COORDINATION

A. Coordinate location of thermostats, carbon dioxides sensors, pressure sensors, humidistats, and other exposed control sensors with plans and room details before installation.

B. Coordinate equipment location.

C. Coordinate supply of conditioned electrical branch circuits and power requirements for control units and operator workstation.

D. Coordinate with the Owner's IT department/provider on locations of NSC's, Ethernet communication cabling, and TCP/IP addresses.

E. Work incidental to the Temperature Control installer:

1. Products furnished, but not installed under this section:

a. Piping:

1) Control valves.
2) Flow switches.
3) Temperature sensor wells and sockets.
4) Flow meters (refer to specification 230519 "Meters and Gauges for HVAC Piping.")

b. Ductwork:

1) Automatic dampers.
2) Airflow stations.
3) Terminal unit controllers.

2. Products not furnished or installed, but integrated with the work of this section:

a. Variable frequency drives: pump controls, fan controls.
b. Smoke detectors.
c. Electric meters.

3. Miscellaneous:

a. All automatic dampers, the temperature control installer shall assemble multiple section dampers with required interconnecting linkages and extend required number of shafts through duct for external mounting of damper motors.
b. The contractor shall provide access doors or other means of access through ducts and/or ceilings/walls for service and adjustment of controllers, valves, and dampers.
c. Control system manufacturer shall furnish written details, instructions, and supervision for the above trades to ensure proper installation, size, and location of any equipment furnished.

1.12 SYSTEM COMMISSIONING

A. Each point in the system shall be tested for both hardware and software functionality. In addition, each mechanical and electrical system under control of the BAS will be tested against the appropriate sequence of operation specified herein. Successful completion of the system test shall constitute the beginning of the warranty period. A written report will be submitted to

the owner indicating that the installed system functions in accordance with the plans and specifications.

B. The BAS contractor shall commission and set in operating condition all major equipment and systems, such as the chilled water, hot water, and all air handling systems, in the presence of the equipment manufacturer's representatives, as applicable, and the Owner and Architect's representatives.

C. The BAS Contractor shall provide a technician to assist the HVAC Contractor and Balancing Contractor in testing, adjusting, and balancing all systems in the building. The BAS Contractor shall coordinate all requirements to provide a complete air and hydronic balance with the Balancing Contractor and shall include all labor and materials in his contract.

D. Equipment Start-up: Upon completion of installation, all equipment being controlled shall be initially started and tested on site. If the permanent workstation is not available, use a contractor-provided temporary workstation able to communicate with all individual controllers of entire installed system. Additionally perform the following:

1. Measurement of voltage sources, primary and secondary
2. Verification of proper controller power wiring.
3. Verification of labeling on components and wiring.
4. Verification of connection integrity and quality (loose strands and tight connections).
5. Verification of bus topology, grounding of shields and installation of termination devices.
6. Verification of component inventory when compared to the submittals.
7. Each I/O device is landed per the submittals and functions per the sequence of control.
8. Verification of point checkout.
9. Measure, calibrate and adjust all analog inputs.
10. Analog sensors are properly scaled, and a value is reported.
11. Documentation of analog sensor calibration (measured value, reported value and calculated offset).
12. Binary sensors have the correct normal position, and the state is correctly reported.
13. Analog outputs have the correct normal position and move full stroke when so commanded. Verify that all linkage adjustments are set properly.
14. Binary outputs have the correct normal state and respond appropriately to energize/de-energize commands.
15. Valves and Dampers shall fully close and provide tight shut-off.
16. Adjust set points so that equipment operates properly. Tune all PID control loops to avoid unnecessary cycling of control equipment, its overheating, sub-cooling, tripping the freezestats and other limit switches and safeties. Create trends and print the results to verify tuning operation.
17. Documentation of Loop tuning (sample rate, gain and integral time constant).
18. Provide reasonable control and operational assistance to the balancing personnel as needed to achieve reliable and energy-efficient system operation.

E. A performance verification test shall also be completed for the operator interaction with the system. Test elements shall be written to require the verification of all operator interaction tasks including, but not limited to the following:

1. Graphics navigation.
2. Trend data collection and presentation.

3. Alarm handling, acknowledgement, and routing.
4. Time schedule editing.
5. Application parameter adjustment.
6. Manual control.
7. Report execution.
8. Automatic backups.
9. Web Client access.

F. Communication Network Start-up: Verify from a host computer that all configured controllers are engaged in proper communication passing all configured points to viewing stations. Verify communication speed and level of transactions until it is acceptable and meets the requirements of this specification.

G. Software Verification: All programs and software functions shall be verified for proper sequence of operation.

H. Contractor shall, during the ensuing four seasons (one year), conduct periodic inspections to fine-tune all dynamic elements of the system with all costs of testing to be included in this scope of work. In addition, the Contractor shall dedicate one full day during each of the four subsequent seasons, during which all necessary tuning of dynamic parameters shall be conducted in the field.

I. As built Drawings: All drawings shall be reviewed after the final installation and corrected to provide accurate, as-built representation of the complete system.

J. Systems Startup Report: A report shall be provided to the Engineer detailing the dates, times, and person(s) performing the start-up. This report shall detail when and who performed the individual processes mentioned above.

K. Commissioning is considered completed only if the physical walk-though of the project, together by Controls Contractor and the Owner was concluded and the complete set of required documentation and software has been transferred to the Owner. The Owner has no right to refuse or delay a reasonably scheduled walk-through meeting, during which time every major component should be inspected if the Owner wishes so

1.13 INSTRUCTIONS TO THE OWNER'S REPRESENTATIVE

A. Provide competent control technicians to instruct the Owner's operating personnel and turn over three copies of maintenance manual. Provide a minimum of 24 hours of instruction at the site, 16 hours during start-up and 8 hours after six months. Instruction sessions shall be scheduled at the owner's convenience and shall be limited to four (4) hours per session.

B. Training Manuals: The BMS manufacturer shall provide a course outline and copies of training manuals at least two weeks prior to the start of any corporate training class to be attended by the Owner.

C. All project developed hardware and software shall become the property of the Owner. This includes but is not limited to:

1. Operator Graphic files
2. As-built hardware design drawings
3. Operating & Maintenance Manuals
4. BMS System software database
5. Controller application programming databases
6. Application Specific Controller configuration files
7. Required Licensed software.

1.14 CONTROL SYSTEM GUARANTEES/WARRANTY.

A. BMS system labor and materials shall be warranted free from defects for a period of twelve (12) months after final completion acceptance by the Owner. BMS failures during the warranty period shall be adjusted, repaired, or replaced at no charge to the Owner. The BMS manufacturer shall respond to the Owner's request for warranty service within 24 hours of the initiated call and will occur during normal business hours (8AM-5PM).

B. At the end of the final start-up/testing, if equipment and systems are operating satisfactorily to the Owner and Engineer, the Owner shall sign certificates certifying that the BMS is operational, and has been tested and accepted in accordance with the terms of this specification. The date of Owner's acceptance shall be the start of the warranty period.

C. Operator workstation software, project specific software, graphics, database, and firmware updates shall be provided to the Owner at no charge during the warranty period. Written authorization by the Owner must be granted prior to the installation of these updates.

D. The BMS manufacturer shall provide a web-accessible Users Network for the proposed System and give the Owner free access to question/answer forum, graphics library, user tips, upgrades, and training schedules for a one-year period of time correlating with the warranty period.

1.15 SYSTEM MAINTENANCE

A. Perform Building Automation System preventative maintenance and support for a period of 1 year (beginning the date of substantial completion)

1. Make a minimum of 4 complete Building Automation System inspections, in addition to normal warranty requirements. Inspections to include:

a. System Review – Review the BMS to correct programming errors, failed points, points in alarm, and points that have been overridden manually.
b. Seasonal Control Loop Tuning – Control loops are reviewed to reflect changing seasonal conditions and / or facility heating and cooling loads.
c. Sequence of operation verification – Systems all verified to be operating as designed and in automatic operation. Scheduling and set points are reviewed and modified.
d. Database back-up.
e. Operator coaching.

2. Technician shall review critical alarm log and advise owner of additional services that may be required.
3. Technician shall provide a written report to owner after each inspection.

B. Do not assign or transfer maintenance service to agent or subcontractor without prior written consent of owner.

PART 2 - PRODUCTS

2.1 CONTROL SYSTEM

A. This contractor is responsible to provide a complete building automation system including all necessary hardware and all operating and applications software necessary to perform the control sequences per specification section 230993 “Sequences of Operation”. Network level components of the system – workstations, servers, etc. shall communicate using the BACnet protocol. No gateways shall be used for communication to controllers furnished under this section.

B. Control system shall consist of, but not be limited to, all necessary Ethernet Network Controllers, Standalone Digital Control Units, Room Controllers, workstations, software, sensors, transducers, relays, valves, dampers, damper operators, control panels, and other accessory equipment, along with complete system of electrical interlocking wiring to fill the intent of the specification and provide for a complete and operable system.

1. Except as otherwise specified, provide operators for equipment, such as dampers, if the equipment manufacturer does not provide them. Coordinate these requirements with the equipment manufacturer.

C. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories to control mechanical systems.

2.2 MANUFACTURER

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to:

    a. Johnson Controls, Inc.
    b. Schneider Electric
    c. Siemens Building Technologies, Inc
    d. Trane

2. All bidders must be authorized distributors of branch offices of the manufacturer specified.

2.3 SYSTEM PERFORMANCE

A. Performance Standards. The BMS system shall conform to the following:

1. Graphic Display. The system shall display a graphic with a minimum of 20 dynamic points. All current data shall be displayed within 20 seconds of the operator's request.
2. Graphic Refresh. The system shall update all dynamic points with current data within 30 seconds.
3. Object Command. The maximum time between the command of a binary object by the operator and the reaction by the device shall be 10 seconds. Analog objects shall start to adjust within 10 seconds.
4. Object Scan. All changes of state and change of analog values shall be transmitted over the high-speed network such that any data used or displayed at a controller or workstation will be current within the prior 60 seconds.
5. Alarm Response Time. The maximum time from when an object goes into alarm to when it is annunciated at the workstation shall not exceed 45 seconds.
6. Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 seconds. The Contractor shall be responsible for selecting execution times consistent with the mechanical process under control.
7. Programmable Controllers shall be able to execute DDC PID control loops at a selectable frequency from at least once every 5 seconds. The controller shall scan and update the process value and output generated by this calculation at this same frequency.
8. Multiple Alarm Annunciations. All workstations on the network shall receive alarms within 5 seconds of each other.
9. Reporting Accuracy. Table below lists minimum acceptable reporting accuracies for all values reported by the specified system.

Measured Variable	Reported Accuracy
Space temperature	±1°F
Ducted air	±2°F
Outside air	±2°F
Water temperature	±1°F
Delta-T	±0.25°F
Relative humidity	±5% RH
Water flow	±5% of full scale
Air flow (terminal)	±10% of reading *Note 1
Air flow (measuring stations)	±5% of reading
Air pressure (ducts)	±0.1 "W.G.
Air pressure (space)	±0.01 "W.G.
Water pressure	±2% of full scale *Note 2
Electrical Power	5% of reading *Note 3
Carbon Monoxide (CO)	± 50 PPM
Carbon Dioxide (CO_2)	± 50 PPM

Note 1: (10%-100% of scale) (cannot read accurately below 10%)
Note 2: for both absolute and differential pressure
Note 3: * not including utility supplied meters
General Note: Sensors to be selected such that the measured media is near the middle third of sensor range

2.4 ENCLOSURES

A. For all I/O requiring field interface devices, these devices where practical will be mounted in a field interface panel (FIP). The Contractor shall provide an enclosure which protects the device(s) from dust, moisture, conceals integral wiring and moving parts.

B. FIPs shall contain power supplies for sensors, interface relays and contactors, and safety circuits.

C. The FIP enclosure shall be of steel construction with baked enamel finish; NEMA 1 rated with a hinged door and keyed lock. The enclosure will be sized for twenty percent spare mounting space. All locks will be keyed identically.

D. All wiring to and from the FIP will be to screw type terminals. Analog or communications wiring may use the FIP as a raceway without terminating. The use of wire nuts within the FIP is prohibited.

E. All outdoor mounted enclosures shall meet the NEMA-4 rating.

F. The wiring within all enclosures shall be run in plastic track. Wiring within controllers shall be wrapped and secured.

2.5 DIRECT DIGITAL CONTROL SYSTEM

A. The basic elements of the Direct Digital Control System structural shall consist of standard components kept in inventory by the equipment supplier. The components shall not require customizing other than setting jumpers and switches, adding firmware modules or software programming to perform required functions. The system may be expanded to its full capacity by adding sensors and entering programs in available random-access memory (RAM). Future expansion shall not require hardware modifications to the controller. The entire system shall be a Direct Digital processing type.

B. The DDC system shall consist of the following:

1. Central DDC panels (UNC).
2. Application specific controllers (ASCI).
3. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. Each DDC panel (Central or ASC) shall operate independently by performing its own specified control, alarm management, operator I/O, and historical data collection. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

2.6 Central DDC panels shall be able to access any data form, send control commands and alarm reports directly to any other DDC panel, operator workstation, or printer on the network.

2.7 ARCHITECTURE/COMMUNICATION

A. This project shall be comprised of a high-speed Ethernet network communications between System Controllers and Workstations. Communications between System Controllers and sub-networks of Custom Application Controllers and/or Application Specific Controllers shall utilize open protocol communications.

1. Each System Controller shall perform communications to a network of Custom Application and Application Specific Controllers using open protocol communication.
2. The Owner will provide all communication media, connectors, repeaters, network switches, and routers necessary for the high-speed Ethernet network. An active Ethernet port will be provided adjacent to each System Controller and operator interface (PC) for connection to this high-speed Ethernet network.
3. All values within the system (i.e., schedules, data logs, points, software variables, custom program variables) shall be readable and controllable (where appropriate) by any System Controller
4. Provide all required convertor control panels between equipment manufacturer supplied controllers and BMS to allow for required communication. Example includes Modbus to BACnet convertors.

2.8 OPERATOR INTERFACE

A. Furnish (1) PC based operator interface. Each operator interfaces shall be able to access all information in the system. The operator interface shall reside on the Enterprise-wide network, which is same high-speed communications network as the System Controllers. The Enterprise-wide network will be provided by the owner and supports the Internet Protocol (IP).

1. Each PC based operator interface shall include the following:

a. Hardware type

1) PC
2) Minimum 24” flat panel monitor

b. Operating Systems

1) Windows XP
2) Windows 7

c. Minimum Hardware

1) Pentium Core I5 or better
2) 8 GB RAM DDR 3
3) 1 TB hard drive space

4) Internet Browser compatible with operator interface requirements outlined in the operator interface section.
5) Java Runtime Environment (JRE) V6.0 or higher

B. Operator Interface. Workstation shall reside on high-speed network with building controllers. A standard browser connected to the network shall be able to access all system information.

1. The operator interface shall support the following Internet web browsers:

   a. Internet Explorer latest version
   b. Firefox latest version
   c. Chrome latest version

2. The operator interface shall support the following mobile web browsers:

   a. Latest version of apple iOS
   b. Latest version of Android

C. Mobile App Operator Interface

1. Mobile App Operator Interface shall support the following Operating systems.

   a. Latest version of apple iOS
   b. Latest version of Android

2. The operator interface shall support system access on a mobile device via a mobile app to:

   a. Alarm log
   b. System Status
   c. Equipment status
   d. Space Status
   e. Standard Equipment graphics

3. The operator interface shall support actions on a mobile device via a mobile app to:

   a. Override set points
   b. Override occupancy
   c. Acknowledge Alarms
   d. Comment on Alarms

D. System Security

1. Each operator shall be required to login to the system with a username and password in order to view, edit, add, or delete data.
2. User Profiles shall restrict the user to only the objects, applications, and system functions as assigned by the system administrator.
3. Each operator shall be allowed to change their user password.
4. The System Administrator shall be able to manage the security for all other users.

5. The system shall include pre-defined “roles” that allow a system administrator to quickly assign permissions to a user.
6. User logon/logoff attempts shall be recorded.
7. The system shall protect itself from unauthorized use by automatically logging off following the last keystroke. The delay time shall be user definable.
8. All system security data shall be stored in an encrypted format.

E. Database

1. Database Save. A system operator with the proper password clearance shall be able to archive the database on the designated operator interface PC.
2. Database Restore. The system operator shall also be able to clear a panel database and manually initiate a download of a specified database to any panel in the system.

F. On-Line Help and Training

1. Provide a context sensitive, online help system to assist the operator in operation and configuration of the system.
2. On-line help shall be available for all system functions and shall provide the relevant data for each particular screen.

G. System Diagnostics

1. The system shall automatically monitor the operation of all network connections, building management panels, and controllers.
2. The failure of any device shall be annunciated to the operators.

H. Equipment & Application Pages

1. The operator interface shall include standard pages for all equipment and applications. These pages shall allow an operator to obtain information relevant to the operation of the equipment and/or application, including:
2. Animated Equipment Graphics for each major piece of equipment and floor plan in the System. This includes all scheduled equipment.

    a. These graphics shall show all points dynamically as specified in the points list.
    b. Animation capabilities shall include the ability to show a sequence of images reflecting the position of analog outputs, such as valve or damper positions. Graphics shall be capable of launching other web pages.

3. Alarms relevant to the equipment or application without requiring a user to navigate to an alarm page and perform a filter.
4. Historical Data (As defined in Automatic Trend Log section below) for the equipment or application without requiring a user to navigate to a data log page and perform a filter.

I. System Graphics. Operator interface shall be graphically based and shall include at least one graphic per piece of equipment or occupied zone, graphics for each cooling system and heating system, and graphics that summarize conditions on each floor of each building included in this contract. Indicate thermal comfort on floor plan summary graphics using colors to represent zone temperature relative to zone set point.

1. Functionality. Graphics shall allow operator to monitor system status, to view a summary of the most important data for each controlled zone or piece of equipment, to use point and-click navigation between zones or equipment, and to edit set points and other specified parameters.
2. Graphic imagery – graphics shall use 3D images for all standard and custom graphics. The only allowable exceptions will be photo images, maps, schematic drawings, and selected floor plans.
3. Animation. Graphics shall be able to animate by displaying different Image lies for changed object status.
4. Alarm Indication. Indicate areas or equipment in an alarm condition using color or other visual indicator.
5. Format. Graphics shall be saved in an industry-standard format such as BMP, JPEG, PNG, or GIF. Web-based system graphics shall be viewable on browsers compatible with World Wide Web Consortium browser standards. Web graphic format shall require no plug-in (such as HTML and JavaScript) or shall only require widely available no-cost plug-ins (such as Active-X and Macromedia Flash)

J. Custom Graphics

1. The operator interface shall be capable of displaying custom graphics in order to convey the status of the facility to its operators.
2. Graphical Navigation. The operator interface shall provide dynamic color graphics of building areas, systems, and equipment.
3. Graphical Data Visualization. The operator interface shall support dynamic points including analog and binary values, dynamic text, static text, and animation files.
4. Custom background images. Custom background images shall be created with the use of commonly available graphics packages such as Adobe Photoshop. The graphics generation package shall create and modify graphics that are saved in industry standard formats such as GIF and JPEG

K. Graphics Library. Furnish a library of standard HVAC equipment such as chillers, air handlers, terminals, fan coils, unit ventilators, rooftop units, and VAV boxes, in 3-dimensional graphic depictions. The library shall be furnished in a file format compatible with the graphics generation package program.

L. Manual Control and Override

1. Point Control. Provide a method for a user to view, override, and edit if applicable, the status of any object and property in the system. The point status shall be available by menu, on graphics or through custom programs.
2. Temporary Overrides. The user shall be able to perform a temporary override wherever an override is allowed, automatically removing the override after a specified period of time.
3. Override Owners. The system shall convey to the user the owner of each override for all priorities that an override exists.
4. Provide a specific icon to show timed override or operator override, when a point, unit controller or application has been overridden manually.

M. Engineering Units

1. Allow for selection of the desired engineering units (i.e., Inch pound or SI) in the system.
2. Unit selection shall be able to be customized by locality to select the desired units for each measurement.
3. Engineering units on this project shall be IP.

N. Scheduling. A user shall be able to perform the following tasks utilizing the operator interface:

1. Create a new schedule, defining the default values, events, and membership.
2. Create exceptions to a schedule for any given day.
3. Apply an exception that spans a single day or multiple days.
4. View a schedule by day, week, and month.
5. Exception schedules and holidays shall be shown clearly on the calendar.
6. Modify the schedule events, members, and exceptions.

O. Trend logs

1. Trend Logs Definition

   a. The operator interface shall allow a user with the appropriate security permissions to define a trend log for any data in the system.
   b. The operator interface shall allow a user to define any trend log options as described in the Application and Control Software section.

2. Trend Log Viewer

   a. The operator interface shall allow Trend Log data to be viewed and printed.
   b. The operator interface shall allow a user to view trend log data in text-based (time –stamp/value).
   c. The operator shall be able to view the data collected by a trend log in a graphical chart in the operator interface.
   d. Trend log viewing capabilities shall include the ability to show a minimum of 5 points on a chart.
   e. Each data point trend line shall be displayed as a unique color.
   f. The operator shall be able to specify the duration of historical data to view by scrolling and zooming.
   g. The system shall provide a graphical trace display of the associated time stamp and value for any selected point along the x-axis.

3. Export Trend Logs

   a. The operator interface shall allow a user to export trend log data in CSV or PDF format for use by other industry standard word processing and spreadsheet packages.

P. Alarm/Event Notification

1. An operator shall be notified of new alarms/events as they occur while navigating through any part of the system via an alarm icon.
2. Alarm/Event Log. The operator shall be able to view all logged system alarms/events from any operator interface.

a. The operator shall be able to sort and filter alarms from events. Alarms shall be sorted in a minimum of 4 categories based on severity.
b. Alarm/event messages shall use full language, easily recognized descriptors.
c. An operator with the proper security level may acknowledge and clear alarms/events.
d. All alarms/events that have not been cleared by the operator shall be stored by the building controller.
e. The alarm/event log shall include a comment field for each alarm/event that allows a user to add specific comments associated with any alarm.

3. Alarm Processing.

a. The operator shall be able to configure any object in the system to generate an alarm when transitioning in and out of a normal state.
b. The operator shall be able to configure the alarm limits, warning limits, states, and reactions for each object in the system.

Q. Reports and Logs

1. The operator interface shall provide a reporting package that allows the operator to select reports.
2. The operator interface shall provide the ability to schedule reports to run at specified intervals of time.
3. The operator interface shall allow a user to export reports and logs from the building controller in a format that is readily accessible by other standard software applications including spreadsheets and word processing. Acceptable formats include:

a. CSV, HTML, XML, PDF

4. Reports and logs shall be readily printed to the system printer.
5. Provide a means to list and access the last 10 reports viewed by the user.
6. The following standard reports shall be available without requiring a user to manually configure the report:

a. All Points in Alarm Report: Provide an on-demand report showing all current alarms.
b. All Points in Override Report: Provide an on-demand report showing all overrides in effect.
c. Commissioning Report: Provide a one-time report that lists all equipment with the unit configuration and present operation.
d. Points report: Provide a report that lists the current value of all points.

2.9 APPLICATION AND CONTROL SOFTWARE

A. Provide the following applications software for building and energy management. All software applications shall reside and run in the system controllers. Editing of applications shall occur at the operator interface.

1. Scheduling. Provide the capability to schedule each object or group of objects in the system. Each of these schedules shall include the capability for start, stop, optimal start, optimal stop, and night economizer actions. Each schedule may consist of up to [10] events. When a group of objects are scheduled together, provide the capability to define advances and delays for each member. Each schedule shall consist of the following:

    a. Weekly Schedule. Provide separate schedules for each day of the week.
    b. Exception Schedules. Provide the ability for the operator to designate any day of the year as an exception schedule. This exception schedule shall override the standard schedule for that day. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed it will be discarded and replaced by the standard schedule for that day of the week.
    c. Holiday Schedules. Provide the capability for the operator to define up to 99 special or holiday schedules. These schedules may be placed on the scheduling calendar and will be repeated each year. The operator shall be able to define the length of each holiday period.
    d. Optimal Start. The scheduling application outlined above shall support an optimal start algorithm. This shall calculate the thermal characteristics of a zone and start the equipment prior to occupancy to achieve the desired space temperature at the specified occupancy time. The algorithm shall calculate separate sets of heating and cooling rates for zones that have been unoccupied for less then and greater than 24 hours. Provide the ability to modify the start algorithm based on outdoor air temperature. Provide an early start limit in minutes to prevent the system from starting before an operator determined time limit.

2. Trend Log Application

    a. Trend log data shall be sampled and stored on the System Controller panel and shall be capable of being archived to a Workstation for longer term storage.

        1) Trend logs shall include interval, start-time, and stop-time.
        2) Trend log intervals shall be configurable as frequently as 1 minute and as infrequently as 1 year.

    b. Automated Trend Logs

        1) The system controller shall automatically create trend logs for defined key measurements for each controlled HVAC device and HVAC application.
        2) The automatic trend logs shall monitor these parameters for a minimum of 7 days at 15-minute intervals. The automatic trend logs shall be user adjustable.
        3) Coordinate with owner for final automatic trending parameters.

    c. Alarm/Event Logs

        1) Any object in the system shall be configurable to generate an alarm when transitioning in and out of a normal or fault state.
        2) Any object in the system shall allow the alarm limits, warning limits, states, and reactions to be configured for each object in the system.
        3) An alarm/event shall be capable of triggering any of the following actions.

a) Route the alarm/event to one or more alarm log- The alarm message shall include the name of the alarm location, the device that generated the alarm, and the alarm message itself.
b) Route an e-mail message to an operator(s)
c) Log a data point(s) for a period of time.
d) Run a custom control program.

4) Point Control. User shall have the option to set the update interval, minimum on/off time, event notification, custom programming on change of events.
5) Timed Override. A standard application shall be utilized to enable/disable temperature control when a user selects on/cancel at the zone sensor, operator interface, or the local operator display. The amount of time that the override takes precedence will be selectable from the operator interface.
6) Anti-Short Cycling. All binary output points shall be protected from short cycling.

2.10 SYSTEM CONTROLLERS

A. There shall be one or more independent, standalone microprocessor-based System Controllers to manage the global strategies described in Application and Control Software section.

1. The System Controller shall have sufficient memory to support its operating system, database, and programming requirements.
2. The controller shall provide a USB communications port for connection to a PC.
3. The operating system of the Controller shall manage the input and output communications signals to allow distributed controllers to share real and virtual point information and allow central monitoring and alarms.
4. All System Controllers shall have a real time clock.
5. Data shall be shared between networked System Controllers.
6. The System Controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall:

   a. Assume a predetermined failure mode.
   b. Generate an alarm notification.
   c. Create a retrievable file of the state of all applicable memory locations at the time of the failure.
   d. Automatically reset the System Controller to return to a normal operating mode.

7. Environment. Controller hardware shall be suitable for the anticipated ambient conditions. Controller used in conditioned ambient shall be mounted in an enclosure, and shall be rated for operation at -40 F to 122 F
8. Clock Synchronization

   a. All System Controllers shall be able to synchronize with a NTP server for automatic time synchronization.
   b. All System Controllers shall be able to accept a time synchronization command for automatic time synchronization.

c. All System Controllers shall automatically adjust for daylight savings time if applicable.

9. Serviceability

   a. Provide diagnostic LEDs for power, communications, and processor.
   b. The System Controller shall have a display on the main board that indicates the current operating mode of the controller.
   c. All wiring connections shall be made to field removable, modular terminal connectors.
   d. The System controller shall utilize standard DIN mounting methods for installation and replacement.

10. Memory. The System Controller shall maintain all BIOS and programming information indefinitely without power to the System controller.
11. Immunity to power and noise. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shut-down below 80% nominal voltage.
12. Test Labs (BTL) Listing. Each System Controller shall be listed as a Building Controller (B-BC) by the Test Labs

2.11 PROGRAMMABLE CONTROLLERS

A. For Stand-Alone Operation, the Central Plant and Air Handling Controllers Shall:

1. Operate a schedule in a standalone application using a Real Time Clock with a 7-day power backup.

   a. The Controller shall have a built-in schedule (assessable with or without a display)
   b. Support will be for at least 3 schedules with up to 10 events for each day of the week.
   c. Each of the 3 schedules can be Analog, Binary or Multi-State
   d. The controller shall support a minimum of 25 exceptions each with up to 10 events.

2. For ease of troubleshooting, the Controller shall support data trend logging.

   a. 25,000 samples minimum
   b. Trends shall be capable of being collected at a minimum sample rate of once every second.
   c. Trends shall be capable of being scheduled or triggered.

3. To meet the sequence of operation for each application, the Controller shall use library programs provided by the controller manufacturer that are either factory loaded or downloaded with service tool to the Controller.
4. Environment. Controller hardware shall be suitable for the anticipated ambient conditions.

   a. Storage conditions:

1) Temperature: -67°F to 203°F
2) Humidity: Between 5% to 100% RH (non-condensing)

b. Operating conditions

1) Temperature: -40°F to 158°F
2) Humidity: Between 5% to 100% RH (non-condensing)

c. Controllers used indoors shall be mounted in a NEMA 1 enclosure at a minimum.
d. Controllers used outdoors and/or in wet ambient shall be mounted within NEMA 4 type waterproof enclosures, and shall be rated for operation at -40 F to 158 F

5. Input/Output: The Controller shall have on board or through expansion module all I/O capable of performing all functionality needed for the application. Controls provided by the equipment manufacture must supply the required I/O for the equipment. In addition, other controls must meet the following requirements:

a. Shall support flexibility in valve type, the controllers shall be capable of supporting the following valve control types 0-10VDC, 0-5VDC, 4-20mA, 24VAC - 2 position.
b. Shall support flexibility in sensor type, the Controller shall be of reading sensor input ranges of 0 to10V, 0 to 20mA, 50ms or longer pulses, 200 to 20Kohm and RTD input.
c. Shall support flexibility in sensor type, all Analog Outputs shall have the additional capability of being programmed to operate as Universal Inputs or Pulse Width Modulation Outputs.
d. Shall support flexibility in sensor type, the Controller and/or expansion modules shall support dry and wetted (24VAC) binary inputs.
e. The controller support pulse accumulator for connecting devices like energy meters.
f. In order to support a wide range of devices, the Controller's binary output shall be able to drive at least 10VA each.
g. Any I/O that is unused by functionality needed for the equipment shall be available to be used by custom program on the Controller and by any other controller on the network.
h. The Controller shall provide 24VAC and 24VDC power terminals sensors and other devices required.
i. The Controller shall provide a dedicated static pressure input.

6. Input/Output Expandability – The Controller shall provide the following functionality in order to meet current and future application needs.

a. For the application flexibility, the Controller shall be capable of expanding to a total of at least 100 hardware I/O terminations.
b. Expansion I/O can be mounted up to 200m from control.
c. Expansion I/O can be added in as small as 4-point increments.
d. To keep MS/TP network traffic to a minimum, expansion I/O must communicate via an internal controller communication bus (point expansion via the MS/TP network is not allowed)

7. Serviceability – The Controller shall provide the following in order to improve serviceability of the Controller.

    a. Diagnostic LEDs for power/normal operation/status, open protocol communications, sensor bus communications, and binary outputs. All wiring connections shall be clearly labeled and made to be field removable.
    b. Binary and analog inputs and outputs shall use removable connectors or be connected to terminal strip external to the control box.
    c. Software service tool connection through all of the following methods: direct cable connection to the Controller, connection through another controller on protocol link and through the Controller's zone sensor.
    d. For configuration, programming, and testing of controller programs must, for safety purposes, be able to be accomplished with the power off to the equipment and the controller.
    e. The Controller software tool service port shall utilize standard of-the-shelf USB printer cable.
    f. Capabilities to temporarily override the point values with built-in time expiration in the Controller.
    g. To aid in service replacement, the Controller shall easily attach to standard DIN rail mounting.
    h. For future expansion, the Controller shall be capable of adding sequence of operation programming utilizing service tools software with a graphical programming interface (editing or programming in line code is not permissible).
    i. To aid in service replacement, the Controller shall allow for setting its address must be rotary switches that correspond to a numerical value for the address to allow the setting of the address without the need of a service tool or the control being powered (DIP switch methodologies are not allowed).
    j. Controller data shall persist through a power failure.

8. Software Retention: All Controller operating parameters, set points, BIOS, and sequence of operation code must be stored in non-volatile memory in order to maintain such information for months without power.
9. Transformer for the Controller must be rated at minimum of 115% of ASC power consumption, and shall be fused or current limiting type. 24 VAC, +/- 15% nominal, 50-60 Hz, 24 VA plus binary output loads for a maximum of 12 VA for each binary output
10. Controller must meet the following Agency Compliance:

    a. UL916 PAZX, Open Energy Management Equipment
    b. UL94-5V, Flammability
    c. FCC Part 15, Subpart B, Class B Limit
    d. cUL Marked for international compliance.
    e. CE Marked for international compliance.

2.12 APPLICATION SPECIFIC CONTROLLERS

A. Application Specific Controllers (ASC) shall be microprocessor-based DDC controllers which through hardware or firmware design control specified equipment. They are not user programmable, but are customized for operation within the confines of the equipment they are designed to serve.

B. Zone Controllers are controllers that operate equipment that control the space temperature of single zone.

C. Software

1. To meet the sequence of operation for each zone control, the controller shall use programs developed and tested by the controller manufacturer that are either factory loaded or downloaded with service tool to the controller.
2. Stand-Alone Operation: Each piece of equipment identified on in the drawing schedules to have stand-alone controllers shall be controlled by a single controller and provide stand-alone control in the event of communication failure. In case of communications failure stand-alone operation shall use default values or last values for remote sensors read over the network such as outdoor air temperature.
3. For controlling ancillary devices and for flexibility to change to sequence of operation in the future, the controller shall be capable running custom programs written in a graphical programming language.

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

1. Storage: -55 to 203 ^{0}F and 5 to 95% Rh, non-condensing.
2. Operating: -40 to 158 ^{0}F and 5 to 95% Rh, non-condensing.
3. Controllers used indoors shall be mounted in a NEMA 1 enclosure at a minimum.
4. Controllers used outdoors and/or in wet ambient shall be mounted within NEMA 4 type waterproof enclosures, and shall be rated for operation at -40 F to 158 F

E. Input/Output

1. For flexibility in selection and replacement of valves, the controllers shall be capable of supporting all of the following valve control types 0-10VDC, 0-5VDC, 4-20mA, 24VAC floating point, 24VAC - 2 position (Normally Open or Normally Closed).
2. For flexibility in selection and replacement of sensors, the controllers shall be capable of reading sensor input ranges of 0 to10V, 0 to 20mA, pulse counts, and 200 to 20Kohm.
3. For flexibility in selection and replacement of binary sensors, the controller shall support dry and wetted (24VAC) binary inputs.
4. For flexibility in selection and replacement devices, the controllers shall have binary output which are able to drive at least 12VA each.
5. For flexibility in selection and replacement of motors, the controller shall be capable of outputting 24VAC (binary output), DC voltage (0 to 10VDC minimum range) and PWM (in the 80 to 100 Hz range).
6. For future needs, any I/O that is unused by functionality of equipment control shall be available to be used by custom program on the controller and by another controller on the network.

F. Serviceability – The controller shall provide the following in order to improve serviceability of the controller.

1. Diagnostic LEDs shall indicate correct operation or failures/faults for all of the following: power, sensors, protocol communications, and I/O communications bus.
2. All binary output shall have LED’s indicating the output state.
3. All wiring connections shall be removable without the use of a tool.

4. Software service tool connection through all of the following methods: direct cable connection to the controller, connection through another controller on protocol link and through the controller's zone sensor.
5. For safety purposes, the controller shall be capable of being powered by a portable computer for the purposes of configuration, programming, and testing programs so that this work can be accomplished with the power off to the equipment.
6. Capabilities to temporarily override of point values with built-in time expiration in the controller.
7. Mack Address shall be set using decimal (0-9) based rotary switches.
8. Configuration change shall not be made in a programming environment, but rather by a configuration page utilizing dropdown list, check boxes, and numeric boxes.
9. Trending objects resident on controller

    a. Minimum of 20,000 trending points total on controller.
    b. Shall be capable of trending all points used by controller.
    c. Shall be capable of 1 second sample rates on all points.

G. Software Retention: All Zone Controller operating parameters, set points, BIOS, and sequence of operation code must be stored in non-volatile memory in order to maintain such information for months without power.

H. Transformer for the controller must be rated at minimum of 115% of ASC power consumption, and shall be fused or current limiting type. 24 VAC, +/- 15% nominal, 50-60 Hz, 24 VA plus binary output loads, for a maximum of 12 VA for each binary output.

I. Agency Approval: The controller shall have met the Agency Compliance:

1. UL916 PAZX, Open Energy Management Equipment
2. UL94-5V, Flammability
3. FCC Part 15, Subpart B, Class B Limit

2.13 CONTROL DEVICE

A. Control Dampers:

1. Dampers are available in two mounting types: i.e., "Installed in Duct" or "Flanged to Duct". Dampers over 48 in. In length and height shall be made into multiple sections.
2. Dampers are available with either opposed blade action or parallel blade action. Opposed blade dampers are standard.
3. Dampers are designed for operation in temperatures ranging between -40°F and 212°F.
4. Leakage class 1A at 1" w.g. Static pressure differential. Standard air leakage data is certified under the AMCA Certified Ratings Program.
5. Blades are extruded aluminum profiles. Aluminum end caps are press fitted to blade ends. Blade and frame seals are extruded silicone and are secured in an integral slot within the aluminum extrusions.

    a. Provide thermally broken frame design where use of standard frame could cause condensation at building envelope.

b. Dampers at exterior walls and roof openings shall be insulated blade, thermal break design.

6. Bearings are composed of a Celcon inner bearing fixed to a 7/16" aluminum hexagon blade pin, rotating within a polycarbonate outer bearing inserted in the frame, resulting in no metal-to-metal or metal-to-plastic contact.
7. Linkage hardware is installed in the frame side and constructed of aluminum and corrosion-resistant, zinc-plated steel, complete with cup-point trunnion screws for a slip-proof grip.
8. Two position dampers: Pressure drop of a fully open 48" x 48" damper shall not exceed .02" w.g. At 1000 fpm.
9. Modulating Control Dampers: Shall be sized by the temperature control manufacturer. Maximum velocity shall be 1500 fpm and maximum pressure drop shall be 0.15 in w.g. Dampers shall be of adequate authority and sized and positioned to allow for smooth modulation of controlled air streams.
10. Design make: Tamco 1500 series (standard), Tamco 9000 series (insulated – where specified).
11. Installation:

    a. Installation of dampers shall be in accordance with current manufacturer's installation instructions.

B. Actuator:

1. The actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the rotation of the actuator.
2. Where shown, for power-failure/safety applications, an internal mechanical, spring return mechanism shall be built into the actuator housing. Floating point actuation allowed only where specifically noted elsewhere in the contract documents.
3. All rotary spring return actuators shall be capable of either clockwise or counterclockwise spring return operation. Linear actuators shall spring return to the retracted position.
4. All non-spring return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring return actuators with more than 60 in-lb. torque capacity shall have a manual crank for this purpose.
5. Actuators shall be provided with a conduit fitting and a minimum 18" electrical cable and shall be pre-wired to eliminate the necessity of opening the actuator housing to make electrical connections.
6. Actuators shall be Underwriters Laboratories Standard 873 listed.
7. Actuators shall be designed for a minimum of 60,000 full stroke cycles at the actuator's rated torque.
8. Valve:

    a. Provide modulating 24 VAC control operators that are 0-10 VDC input proportional with spring return as needed by control sequence and designed for water service valve bodies. Operator shall be synchronous motor driven and force sensor safety stop.
    b. Provide two position 24 VAC control operators as needed by control sequence for unitary control such as heat pump control and designed for water service valve bodies. Operator shall be synchronous motor driven and force sensor safety stop.

c. Run time: 60 seconds or less.
d. Valve Close-off: Water = 120% of total system (pump) head. Steam = 200% of system operating (inlet) pressure. Valves to be used on this project shall be suitable for complete close-off to the levels stated under modulating duty. In the event that manufacturer's data provides a separate maximum differential pressure under modulating duty, both criteria shall exceed the above requirements.
e. Valve fail positions shall be generally as follows:

1) Hot water radiation: Fail Last
2) Duct mounted reheat coils: Fail Last
3) Fan coil cooling coils: normally closed with spring return.
4) Pre-heat coils in air handling units: normally open with spring return
5) Chilled water coils in air handling units: normally closed with spring return.
6) Chilled beam cooling: normally closed with spring return.

9. Damper:

a. Electronic Damper Actuators: Direct-coupled type non-hydraulic designed for minimum 100,000 full-stroke cycles at rated torque. The actuator shall have rating of not less than twice the thrust needed for actual operation of the damper.

1) Coupling: V-bolt and V-shaped, toothed cradle.
2) Overload Protection: Electronic overload or digital rotation-sensing circuitry.
3) Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on non-spring-return actuators.
4) Actuators shall have the ability to be tandem mounted.
5) All spring-return actuators shall have a manual override. Complete manual override shall take no more than 10 turns.
6) Power Requirements (Two-Position Spring Return): 24V ac or dc, Maximum 10VA.
7) Power Requirements (Modulating): Maximum 15 VA at 24V ac.
8) Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
9) Housing: Minimum requirement NEMA type 2.
10) Temperature Rating: -22°F to 140ºF.
11) Run Time: 200 seconds open, 40 seconds closed.
12) Size for running torque calculated as follows, verify with damper manufacturer that damper actuators provide required torque to comply with leakage rate specifications for damper:

a) Parallel-Blade Damper with Edge Seals: 7 inch-pounds/sq. ft. of damper.
b) Opposed-Blade Damper with Edge Seals: 5 inch-pounds/sq. ft. of damper.
c) Parallel-Blade Damper without Edge Seals: 4 inch-pounds/sq. ft. damper.
d) Opposed-Blade Damper without Edge Seals: 3 inch-pounds/sq. ft. of damper.

e) Dampers with 2 to 3 Inches wg. of Pressure Drop or Face Velocities of 1000 to 2500 FPM Multiply the minimum full-stroke cycles above by 1.5.

f) Dampers with 3 to 4 Inches wg. of Pressure Drop or Face Velocities of 2500 to 3000 FPM Multiply the minimum full-stroke cycles above by 2.0.

13) Spring Return Manual Override actuators shall a factory set 5 Degree Damper Preload.

C. Electronic Valve/Damper Position Indication: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.

D. Safety/Status Devices:

1. Low Limit Detector: Electric type, with 20' long serpentine element, with manual reset and auxiliary contacts to the DDC, set for 37°F for "freeze" protection and 55°F for fan discharge application. Provide a 20' long element for every 25 sq. ft. of coil face area.
2. High Limit Detector: Electric type, with manual reset and auxiliary contacts to the DDC, UL listed for fire, set for 180°F.
3. Pump status shall be provided through adjustable range current sensing element on pump motor.
4. Fan status shall be provided through adjustable range current sensing element on the fan motor.

E. Miscellaneous Devices

1. Provide necessary, relays, transformers, accumulators, three-way air valves, positioners, pneumatic electric switches, air switches, required for a complete and operable system.
2. Locate these devices in a separate panel unless specified otherwise.

2.14 AUXILIARY EQUIPMENT/DEVICES

A. Electronic Temperature Sensors: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.

1. Resistance Temperature Detectors: Platinum, thermistors, or Balco.
2. Accuracy: +/-1% at calibration point over a range of -30ºF - 230ºF; +/-0.5% accurate over a range of 40ºF - 100ºF. Thermistors shall have a maximum 5-year drift of no more than .225°F maximum error of no more than .36°F.
3. Wire: Twisted, shielded-pair cable.
4. Duct Probe Sensor: 8" long, single point, sensing element shall be fully encapsulated in potting material within a stainless-steel probe. Useable in air handling applications where the coil or duct area is less than 4 square feet, or where not affected by temperature stratification. Basis of Design: Veris TD Series.
5. Duct Averaging Sensor: Averaging sensors shall be employed in ducts which are larger 60 inches long (96 inches when duct is greater than 24 inches wide), flexible for use where prone to temperature stratification or where ducts are larger than 4 sq. ft.; 264 inches long, flexible for use where prone to temperature stratification or where ducts are

larger than 16 sq. ft; length as required. The averaging sensor tube shall contain at least one thermistor for every 3 feet, with a minimum tube length of 6 feet. The averaging sensor shall be constructed of rigid or flexible copper tubing. Basis of Design: Veris TA Series.

6. Pipe Immersion Sensor: Immersion sensors shall be employed for measurement of temperature in all chilled and hot water applications as well as refrigerant applications. Provide sensor probe length suitable for application. Provide each sensor with a corresponding pipe-mounted sensor well, unless indicated otherwise. Sensor wells shall be stainless steel for non-corrosive fluids below 250 degrees F and 300 series stainless steel for all other applications. Basis of Design: Veris TI Series.
7. Outside: Provide sensing element on the building's north side. Sensing element shall be fully encapsulated in potting material within a stainless-steel probe. Probe shall be encased in PVC solar radiation shield and mounted in a weatherproof enclosure. Operating range -40 to 122 F, Basis of Design: Veris TO Series.
8. Space Temperature Sensors: Space temperature sensors shall be 5000 or 10,000 ohm thermistor type with wall plate adapter and blank cover assembly. Space temperature sensors shall include temperature adjustment and occupancy overrides. Space temperature sensors shall be mounted 60 in. above the finished floor surface.

    a. Space sensors in public spaces such as corridors, lobbies, etc... shall be provided without local temperature indication, set point adjustment, or setback override.
    b. Space sensors in private / staff only spaces shall be equipped with set-point adjustment, override switch, display, and/or communication port as shown on the drawings.
    c. The space temperature, set point, and override confirmation will be annunciated by a digital display for each zone sensor. The set point will be selectable utilizing buttons.
    d. Where space sensors are connected to dedicated terminal unit controllers, they shall be equipped with local communication interface for troubleshooting and balancing purposes. Provide all required wiring from the terminal controllers to the space sensor to allow for interface to a local laptop interface device.
    e. Room Security Sensors: Stainless steel cover plate with insulated back and security screws.

B. Thermostats:

1. Low-Voltage Space Thermostats. Low-voltage space thermostats shall be 24 V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed set point adjustment, 55°F-85°F set point range, 2°F maximum differential, and vented ABS plastic cover.

2. Line-Voltage Space Thermostats. Line-voltage space thermostats shall be bimetal-actuated, open-contact type or bellows-actuated, enclosed, snap-switch type or equivalent solid-state type, with heat anticipator, UL listing for electrical rating, concealed set point adjustment, 55°F-85°F set point range, 2°F maximum differential, and vented ABS plastic cover.

C. Differential Pressure Switch: Differential pressure switches (air or water service) shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum) and shall have scale range and

differential suitable for intended application and NEMA 1 enclosure unless otherwise specified.

D. Differential Fluid Pressure Sensor:

1. Pressure range to suit application. Accuracy of 0.25%. Maximum working pressure of 250 psig. Maximum differential and static pressure shall be 250% of rated range. Type 304 stainless steel construction. 100% solid state dual diffused piezoresistive silicon sensing elements compatible with all medusa encountered in HVAC applications. Factory calibrated and tested. Easily accessible adjustments for zero and span. 1/8 in. NPT pressure port connections. Input limiting capability by precisely clipping to transducers output. Adjustable output averaging from 1 to 10 seconds. Provide an external regulated power supply. Transducer shall be complete with 4 to 20 mA output, required mounting brackets, and five-valve manifold.
2. Make: Setra #C230.

E. Humidity Sensors: Accurate at +/- 2 % at full scale. Replaceable sensing element. Thin-film capacitive. Output shall be field selectable 4-20 mA or 0-10 VDC. 12-30 VDC or 24 VAC supply power. Sensor element shall contain multipoint calibration on-board in non-volatile memory. Option of an integrated temperature sensor.

1. Wall:

a. Operating range shall be 0 - 100% RH noncondensing, 50 to 95 F.
b. Transmitter shall have option of having an LCD display.
c. Basis of Design: Veris HWL Series

2. Duct:

a. Transmitter shall be fully encapsulated in potting material within a stainless-steel probe.
b. Operating range shall be 0 - 100% RH noncondensing, -40 to 122 F.
c. Basis of Design: Veris HD Series

3. Outdoor:

a. Transmitter shall be fully encapsulated in potting material within a stainless-steel probe. Probe shall be encased in PVC solar radiation shield and mounted in a weatherproof enclosure.
b. Operating range shall be 0 - 100% RH noncondensing, -40 to 122 F.
c. Basis of Design: Veris HO Series

F. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.

1. Accuracy: +/- 1 % of full scale with repeatability of 0.5 %.
2. Output: 4 to 20 mA, 0-5 vDC, 0-10 vDC.
3. Duct Static-Pressure Range: 0 to 1, 0 to 2.5, 0 to 5, 0 to 10 IN WC., jumper adjustable.

G. Pressure Transmitters:

1. Pressure transmitters shall be of 2-wire, 4-20 mA output type with a capacitance element having an accuracy of +/- 1% over the entire range. Transmitter shall include protection against reverse polarity and supply voltage transients. Accuracy and zero span adjustment shall be provided with each transmitter to allow for recalibration, as necessary.

2. Liquid Pressure:

    a. The operating range shall be -4.0 to 185.0 F.
    b. Proof pressure shall be 2x max full-scale range. Burst pressure shall be 5x max full-scale range.
    c. Transmitter shall have 4 field selectable ranges.
    d. Transmitter shall be +/-1% accurate over full scale, 2% accurate over full scale in lowest selectable range.
    e. Transmitter shall be stainless steel where it contacts fluid.
    f. Transmitter shall use two independent pressure sensors to measure and calculate differential pressure.
    g. Output shall be field selectable for 4-20 mA or 0-10 VDC.
    h. Transmitter shall have local LCD display.
    i. Transmitter shall accept 12-30 VDC of 24 VAC power supply.
    j. Transmitter shall have ability for field zero of reading and output.
    k. Shall be contained in an aluminum NEMA-4 enclosure.
    l. Sensor warranty shall be 3 years.
    m. Design Make: Veris PW

3. Air Pressure:

    a. The operating range shall be -40.0 to 176.0 F.
    b. Safe overpressure shall be a minimum of 200% of the rated pressure.
    c. Transmitter range to be field selectable between 0.1” and 10” WC.
    d. Transmitter shall be +/-1% accurate in each selectable range.
    e. Transmitter shall be field configurable for wall or duct (w/ static probe) mounting.
    f. Transmitter shall be field selectable for unidirectional or bidirectional.
    g. Output shall be field selectable for 4-20 mA or 0-10 VDC.
    h. Transmitter shall have local LCD display.
    i. Transmitter shall accept 12-30 VDC of 24 VAC power supply.
    j. Transmitter shall have ability for field zero of reading and output.
    k. Shall be contained in an aluminum NEMA-1 enclosure.
    l. Not to be provided when Space Pressure Monitor (SPM) / Room Pressure Monitor (RPM) is specified or called out on the drawings.
    m. Sensor warranty shall be 3 years.
    n. Design Make: Veris model PXU.

H. Equipment operation sensors as follows:

1. Status Inputs for Fans: Differential-pressure switch with adjustable range of 0 to 5 IN WC.
2. Status Inputs for Pumps: Differential-pressure switch piped across pump with adjustable pressure-differential range of 8 to 60 psig.
3. Status Inputs for Electric Motors: Current-sensing relay with current transformers, adjustable and set to 175 % of rated motor current.

I. Flow Switches:

1. Flow-proving switches shall be either paddle or differential pressure type, as shown.
2. Paddle type switches (water service only) shall be UL listed, SPDT snap-acting with pilot duty rating (125 VA minimum). Adjustable sensitivity with NEMA 1 Type enclosure unless otherwise specified:
3. Differential pressure type switches (air or water service) shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum), NEMA 1 Type enclosure, with scale range and differential suitable for intended application, or as specified.
4. Current sensing relays may be used for flow sensing or terminal devices.

J. Carbon Dioxide Sensors:

1. Duct:

   a. 0 to 10 VDC or 4-20mA signal output, non-dispersive infrared operation.
   b. Accuracy shall be +/- 30 ppm or +/-2% of measured value, whichever is less.
   c. Repeatability shall be +/-20 ppm or +/-1% of measured value whichever is less.
   d. Response time less than 60 seconds.
   e. 12-30 VDC or 24 VAC power supply to transmitter.
   f. Output rage shall be 0-2000 ppm.
   g. Recommended 5-year calibration interval.
   h. Design Make: Veris CDL.

2. Wall:

   a. 0 to 10 VDC or 4-20mA signal output, non-dispersive infrared operation.
   b. Accuracy shall be +/- 30 ppm or +/-2% of measured value, whichever is less.
   c. Repeatability shall be +/-20 ppm or +/-1% of measured value whichever is less.
   d. Response time less than 60 seconds.
   e. 12-30 VDC or 24 VAC power supply to transmitter. LCD display, with faceplate.
   f. Integrated temperature sensor w/ set point slider, integrated humidity sensor.
   g. Output rage shall be 0-2000 ppm.
   h. Recommended 5-year calibration interval.
   i. Design Make: Veris CWL.

K. VOC Sensors:

1. Contain calibration algorithm for correlation to CO2 concentration levels. Optional temperature and humidity sensing, coordinate with the zone requirements. Local LCD display or VOC concentration.
2. Design Make: BAPI BA/BS3 or approved equivalent (VOC-D-BB for duct applications)

L. Relays

1. Control relays shall be UL listed plug-in type with dust cover. Contact rating, configuration, and coil voltage suitable for application.
2. Time delay relays shall be UL listed solid-state plug-in type with adjustable time delay. Delay shall be adjustable plus or minus 200% (minimum) from set-point shown on plans.

Contact rating, configuration, and coil voltage suitable for application. Provide NEMA 1 Type enclosure when not installed in local control panel.

M. Override Timers: Unless implemented in control software, override timers shall be spring-wound line voltage, UL Listed, with contact rating and configuration required by application. Provide 0-6 hour calibrated dial unless otherwise specified. Flush mount timer on local control panel face or where shown.

N. Current Switches: Current-operated switches shall be self-powered, solid state with adjustable trip current. The switches shall be selected to match the current of the application and output requirements of the DDC system.

O. Current Transmitter: AC current transmitters shall be self-powered, combination split-core current transformer type with built-in rectifier and 4-20 mA two-wire output. Full-scale unit ranges shall be 10 A, 20 A, 50 A, 100 A, 150 A, and 200 A, with internal zero and span adjustment. Unit accuracy shall be ±1% full-scale at 500-ohm maximum burden. Transmitter shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA recognized. Unit shall be split-core type for clamp-on installation on existing wiring.

P. Current Transducer / Equipment Relay:

1. Low Voltage, Single Phase:

a. Combined status sensor, command relay, and hand-off-auto switch.
b. Sized for monitor and control of small motors.
c. Field selectable relay output.
d. High and low voltage isolation.
e. Industrial grade load switching relay.
f. Mountable on single or double gang boxes, flush on starter enclosures, or stand-alone.
g. Approved for installation in the following environmental conditions:

1) 0-95% relative humidity, non-condensing.
2) 0° to 140°F

h. Design equipment: Veris Hawkeye H500.
i. Alternative components combining the total functionality of the specified device may be submitted for approval.

Q. Current Transformer: AC current transformers shall be UL/CSA recognized and shall be completely encased (except for terminals) in approved plastic material. Transformers shall be available in various current ratios and shall be selected for ±1% accuracy at 5 A full-scale output. Use fixed-core transformers for new wiring installation and split-core transformers for existing wiring installation.

R. Voltage Transmitter: AC voltage transmitters shall be self-powered single-loop (two-wire) type, 4-20 mA output with zero and span adjustment. Adjustable full-scale unit ranges shall be 100-130 Vac, 200-250 Vac, 250-330 Vac, and 400-600 Vac. Unit accuracy shall be ±1% full-scale at 500-ohm maximum burden. Transmitters shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA recognized at 600 Vac rating.

S. Voltage Transformer: AC voltage transformers shall be UL/CSA recognized, 600 Vac rated, and shall have built-in fuse protection. Transformers shall be suitable for ambient temperatures of 4°C-55°C (40°F-130°F) and shall provide ±0.5% accuracy at 24 Vac and 5 VA load. Windings (except for terminals) shall be completely enclosed with metal or plastic.

T. Pressure-Electric Switches: PE switches shall be UL listed, pilot duty rated (125 VA minimum) or motor control rated, metal or neoprene diaphragm actuated, operating pressure rated for 0-25 psig, with calibrated scale minimum set point range of 2-18 psig.

U. Power Monitors

1. Selectable rate pulse output for: Voltage, amperage, real power (kW), consumption (kWh), and reactive power (kVARar), and power factor (PF) per phase and total load for a single load. Factory calibrated as a system using split core CT's. Neutral voltage connection is required.
2. Voltage input: 208 – 480 VAC, 60 Hz.
3. Current input: up to 2400 A.
4. 1.0% accuracy 2-100% of the rated current of the CT's. Operating temperature range of 32-122ºF.
5. Output: Pulse, BACnet.
6. Display: Backlit LCD.
7. NEMA 1 enclosure.
8. UL508 or equivalent.
9. Design Make: Veris Industries H81xx00 series.

V. Local Control Panels

1. All indoor control cabinets shall be fully enclosed NEMA 1 Type construction with hinged door, and removable sub-panels or electrical sub-assemblies.
2. Interconnections between internal and face-mounted devices shall be pre-wired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL listed for 600-volt service, individually identified per control/interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings.
3. Provide on/off power switch with over-current protection for control power sources to each local panel.

W. Airflow Measuring Station (AFS):

1. Manufacturers: Subject to compliance with requirements, provide a Thermal Dispersion Technology Airflow Measuring Station by one of the following:

    a. Ebtron
    b. Ruskin

2. Qualifications:

    a. UL listed and compliant with FCC regulations.
    b. Third party verification by FCC, UL, AMCA, NIST, and ISO 9001.

3. General:

    a. AFS Accuracy:

        1) Airflow (ducted): +/-3% of reading when installed in accordance with AMCA figure 5.3.
        2) Airflow (non-ducted outdoor air intakes): +/-5% of reading when installed in accordance with AMCA figures 5.1 or 5.4.
        3) Accuracy is dependent on placement and installed conditions.

    b. Each AFS shall be provided with the correct number of probes and sensors for the application. Single AFS shall be capable of connecting up to 15 probes and 128 total sensors. Sensor density approximately one (1) sensor per 0.5 sqft or measurement area.

        1) Wiring between sensors shall be connected in daisy-chain fashion, with cabling as recommended by the manufacturer.

    c. Warranty: 36 months parts.

4. Sensors:

    a. Description- Bi-directional airflow and pressure measurement, utilizing thermistors to determine the airflow rate, and temperature at each sensing location.
    b. Sensor accuracy

        1) Airflow: +/-2% of reading over the entire calibrated airflow range.
        2) Repeatability: +/-0.25% repeatability
        3) Temp: +/-0.15 degree F

    c. Sensor range:

        1) Velocity: 0-5000 fpm
        2) Temperature: -20ºF to 120ºF
        3) Humidity: 0 to 99% RH, non-condensing

    d. Sensors shall be factory cabled to the end of the probe.

    e. Cable assembly (between probe and transmitter when transmitter is remote mounted):

        1) Type UL plenum rated PVC jacket, or twisted shielded pair.
        2) Length: 50 [500] ft minimum

        3) Termination:

            a) 0.875 in plug [transmitter end], gold plated pins.

5. Probe:

a. Construction: Aluminum alloy
b. Mounting: Insertion or stand-off brackets for face mount on dampers and louvers. Mounting hardware shall be aluminum or stainless steel.
c. Probe shall not be affected by direct or sustained exposure or moisture.
d. Internal wiring connections shall be capable of direct exposure to water without affecting instrument operation.
e. Probe design shall allow replacement of defective or damaged thermistors in the field when necessary.

6. User Interface:

a. Description: airflow and temperature transmitter capable of direct communication with building management system via analog interface or BACNet MS/TP.
b. User interface to include 16-character LCD display.
c. Filed configuration and diagnostic to be accomplished through a push button interface on the main circuit board for selection of units of measure, display units, output scaling, dampening filter, diagnostics, and instrument status.
d. Provide an output offset and gain adjustment feature to be engaged for installation where field calibration or adjustment is necessary.
e. Calibrated airflow range:

1) Velocity: 0-5000 fpm
2) Airflow calibration: To NIST traceable standards
3) Temperature range: -20ºF to 120ºF
4) Humidity range: 0 to 99% (non-condensing)
5) Power requirements: 24 VAC at 6 to 15 VA

f. Transmitter enclosure:

1) Transmitter construction: Hinged or sliding cover.
2) Wall mounting kit to include 304 stainless steel face plate with stainless steel screen.

g. Output interface:

1) Two (2) Analog outputs: Isolated analog 0-5/0-10 VDC or 4-20 mA linear. Each output field configurable to output either average temperature or average airflow.
2) Analog output resolution: 0-10 VDC: 0.10 % of full scale; 0-5VDC: 0.20% of full scale
3) 10 Base-T Ethernet output: Field selectable BACnet shall provide average air flow rate, average air temperature, high and low airflow alarm, high and low temperature alarms.
4) Programmable alarm: Alarm for user defined hi/low limit with user defined set point and dead-band.
5) Repeatability: 0.25% of reading
6) K factor configuration: Automated 1, 2, or 3 point field adjustment to factory calibration.
7) Airflow low limit cutoff: forces output to zero below user-specified value.

8) Transmitter capable of identifying sensor malfunction and automatically ignore the sensor in fault mode.

7. Installation:

a. Inspect the areas to receive flow instrument. Notify the Engineer if conditions that would adversely affect the installation of, or the subsequent utilization of the flow the instrument. Do not proceed with installation until unsatisfactory conditions are corrected.
b. Refer to manufacturer's publish installation guidelines for positioning within duct system, and required equivalent length of straight duct upstream and downstream of flow instrument.
c. Verify network interface and modification to temperature control system to integrate flow instrument.
d. Supplier to provide on-site product sizing and placement review, and support for sheet metal installer and field support for commissioning service by TAB.

2.15 SURGE SUPPRESSION (SP) RECEPTACLE

A. Provide at each DDC panel and operator workstation locations, a surge suppression receptacle with metal oxide varister to dissipate the electrical energy of voltage spikes. 20 ampere, duplex, NEMA 5-20R configuration. Back and side wiring, high impact nylon body.

B. Acceptable Make: Hubbell 5352-S

PART 3 - EXECUTION

3.1 GENERAL SYSTEM REQUIREMENTS

A. The control of each system shall be guaranteed to perform as described in the Sequence of Operation Section. Equipment, remote switches, in finished rooms shall be flush-mounted, if possible.

B. Verify that conditioned power supply is available to control units and operator workstation.

3.2 REMOVALS AND EXISTING WORK

A. Remove controls which do not remain as part of the building automation system, all associated abandoned wiring and conduit, and all associated pneumatic tubing. The Owner will inform the Contractor of any equipment which is to be removed that will remain the property of the Owner. All other equipment which is removed will be disposed of by the Contractor.

B. Existing controls which are to be reused must each be tested and calibrated for proper operation. Existing controls which are to be reused and are found to be defective requiring replacement, will be noted to the Owner. The Owner will be responsible for all material and labor costs associated with their repair.

C. Demolition of existing control system shall occur after the new temperature control system is in place, including new sensors and new field interface devices. Switch-over from the existing control system to the new system will be fully coordinated with the Owner. A representative of the Owner will be onsite during the switch-over. Contractor shall minimize control system downtime during switch-over. Sufficient installation mechanics shall be onsite so that the entire switch-over can be accomplished in a minimal amount of time.

3.3 INSTALLATION

A. The Contract Documents shall be thoroughly examined for coordination of control devices their installation, wiring, and commissioning. Coordinate and review mechanical equipment specifications, locations, and identify any discrepancies, conflicts, or omissions that shall be reported to the Architect/Engineer for resolution before rough-in work is started.

B. The BMS manufacturer shall inspect the jobsite in order to verify that control equipment can be installed as required, and any discrepancies, conflicts, or omissions shall be reported to the Architect/Engineer for resolution before rough-in work is started.

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

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

E. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation.

F. Install automatic dampers according to Section 233300 "Air Duct Accessories."

G. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

H. Identification: Identify all control wires with labeling tape or sleeves. Identification shall be easily cross referenced with the as-built drawings. All field enclosures, other than controllers, shall be identified with engraved nameplate, white lettering against a black background, easily cross referenced to the as-built drawings, and matching the nomenclature within the system architecture. Junction boxes marked as part of the BAS system. Field devices, except space sensors, not mounted within FIPs shall be identified with nameplates as described above. All I/O field devices mounted within FIPs shall be labeled. Where applicable, mark IP address on device.

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

J. Install duct volume-control dampers according to Section 233113 "Metal Ducts" and Section 233116 "Nonmetal Ducts" and cabinets according to Section 260533 "Raceways and Boxes for Electrical Systems."

3.4 GENERAL WORKMANSHIP

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

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

C. Install all equipment in readily accessible location as defined by National Electric Code (NEC). Control panels shall be attached to structural walls or properly supported in a free-standing configuration, unless mounted in equipment enclosure specifically designed for that purpose. Panels shall be mounted to allow for unobstructed access for service.

D. Verify integrity of all control wiring to ensure continuity and freedom from shorts and grounds prior to commencing the startup and commissioning procedures.

E. All control device installation, and wiring shall comply with Contract Documents, acceptable industry specifications, and industry standards for performance, reliability, and compatibility. Installation and wiring shall be executed in strict adherence to local codes and standard practices referenced in Contract Documents

3.5 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Where Class 2 wires are in concealed and accessible locations; including ceiling return air plenums, approved cables outside of electrical raceway can be used provided that the following conditions are met.

1. Circuits meet NEC Class 2 (current-limited) requirements. (Low-voltage power circuits shall be sub-fused when required to meet Class 2 current-limit.)
2. All cables shall be UL listed for application (i.e., cables used in ceiling plenums shall be UL listed specifically for that purpose)

B. Do not install Class 2 wiring in conduits containing Class 1 wiring.

C. Where Class 2 wiring is run exposed, wiring shall be run parallel along a surface or perpendicular to it, and bundled, using approved wire ties at no greater than 10 ft intervals. Such bundled cable shall be fastened to the structure, using industry approved fasteners, at 5 ft intervals or more often to achieve a neat and workmanlike result. Do not affix wires to pipes, conduits, ductwork, etc.

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

E. Where different wiring classes terminate within the same enclosure, maintain clearances, and install barriers per the National Electric Code.

F. Maximum allowable voltage for control wiring shall be 120Vac. If only higher voltages are available for use, the BMS system installer shall provide step-down transformers to achieve the desired control voltages.

G. All control wiring shall be installed as continuous lengths, where possible. Any required splices, equipment terminations, and transitions from EMT to flexible conduit shall be made only within an approved junction box or other approved protective device. Interior dry location J-boxes shall be galvanized pressed steel, nominal four-inch square with blank cover. Exterior and damp location JH-boxes shall be cast alloy FS boxes with threaded hubs and gasketed covers.

H. Where space above the ceiling is a supply or return plenum, the wiring shall be plenum rated. Teflon wiring can be run without conduit above suspended ceilings. EXCEPTION: Any wire run in suspended ceilings that is used to control outside air dampers or to connect the system to the fire management system shall be in conduit. Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations in accordance with Contract Documents and National and/or Local Codes.

I. Conduit and wire sizing shall be determined by the BMS system installer in order to maintain manufacturer’s recommendation and must meet National and Local Codes.

J. Fiber optic cable shall include the following sizes: 50/125, 62.5/125 or 100/140. Fiber optic cable shall only be installed and terminated by an experienced contractor. The BAS contractor shall submit to the Engineer the name of the intended contractor of the fiber optic cable with his submittal documents.

K. Control and status relays are to be located in pre-fabricated enclosures that meet the application. These relays may also be located within packaged equipment control panel enclosures as coordinated. These relays shall not be located within Class 1 starter enclosures.

L. Follow manufacturer's installation recommendations for all communication and network bus cabling. Network or communication cabling shall be run separately from all control power wiring.

M. BMS system installer shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.

N. Flexible metal conduits and liquid-tight flexible metal conduits shall not exceed 3' in length and shall be supported at each end. Flexible metal conduit less than 1/2" electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal conduits shall be used.

O. The 120VAC power wiring to each Ethernet or Remote Site controller shall be a dedicated run, with a separate breaker. Each run will include a separate hot, neutral, and ground wire. The ground wire will terminate at the breaker panel ground. This circuit will not feed any other circuit or device.

P. A true earth ground must be available in the building. Do not use a corroded or galvanized pipe, or structural steel.

Q. Install raceways, boxes, and cabinets according to Section 260533 "Raceways and Boxes for Electrical Systems."

R. Install building wire and cable according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables.", and cabinets according to Section 260533 "Raceways and Boxes for Electrical Systems."

S. Install signal and communication cable:

1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
2. Install exposed cable in raceway.
3. Install concealed cable in raceway.
4. Bundle and harness multi-conductor instrument cable in place of single cables where several cables follow a common path.
5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.

T. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

U. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.6 PROGRAMMING

A. Provide sufficient internal memory for all controllers to ensure specified sequence of operations, alarming, trending, and reporting requirements are achieved. BMS manufacturer shall provide a minimum of 25% spare memory capacity for future use.

B. Software Programming

1. Provide programming for individual mechanical systems to achieve all aspects of the sequence of operation specified. It is the BMS manufacturer’s responsibility to ensure all mechanical equipment functions and operates as specified in sequence of operations. Provide sufficient programming comments in controller application software to clearly describe each section of the program. The comment statements shall reflect the language used in the sequence of operations.

C. BMS Operator’s Interface

1. When Operator Workstation is specified, provide color graphics for each piece of mechanical equipment depicting sufficient I/O to monitor and troubleshoot operation. Additionally, provide individual floor plans of the building allowing an operator to quickly view the overall floor plan area for any out of tolerance conditions that may need addressing. These standard graphics shall depict all points dynamically as specified in the points list and/or indicated in sequence of operation.

2. The BMS manufacturer shall provide all the labor necessary to install, initialize, start-up, and trouble-shoot all operator interface software and their functions as described in this section. This includes any operating system software, the operator interface data base, and any third-party software installation and integration required for successful operation of the operator interface.
3. As part of this execution phase, the BMS manufacturer shall perform a complete test of the operator interface. Test duration shall be a minimum of (8) hours on-site. Tests shall be made in the presence of the Owner and/or Engineer.
4. Demonstration: A complete demonstration of the capabilities of the BMS system shall be performed by the BMS manufacturer's field personnel. The BMS manufacturer shall dedicate a minimum of (16) hours on-site with the Owner representatives, and Engineer to demonstrate a complete functional test of all the BMS system requirements, including demonstrating correct sequence f operation. This BMS demonstration shall constitute an acceptance inspection, and will represent the process of approving the BMS as designed and specified.

3.7 SYSTEM COMPONENTS

A. Controllers mounted vertically per manufacturer's installation instructions.

B. Valves: Union or flanged connected. Locate close to apparatus controlled with pipe reducers and increasers located closest to valve. Locate, arrange, and pipe per installation diagram.

C. Mounting height for all new room thermostats or sensors shall be 48 in. to the top of the cover or match existing if sensor is being replaced. Refer to mechanical plans.

D. Locate thermostats or sensors on walls symmetrical with adjacent items. Verify exact room location to avoid doors, fixed and portable equipment. Install to minimize damage. Do not install adjacent to lighting dimmers or other heat generating equipment.

E. Dampers and Damper Operators: Tag dampers for proper location. Install per manufacturer's printed instruction as to motor size and quantity, linkage arrangement, drive connection point. Adjust to close tightly. Allow for conduit sleeve or blank space for roof fan dampers. Where ducts are insulated, set damper operators at least 2 in. away from side of duct to allow for insulation.

F. Thermometers: Provide with diagrams indicating exact locations prior to start of Work. Arrange for easy reading.

G. Well-mounted sensors will include thermal conducting compound within the well to insure good heat transfer to the sensor.

H. Actuators will be firmly mounted to give positive movement and linkage will be adjusted to give smooth continuous movement throughout 100% of the stroke.

I. For duct static pressure sensors, the high-pressure port shall be connected to a metal static pressure probe inserted into the duct pointing upstream. The low-pressure port shall be left open to the plenum area at the point that the high-pressure port is tapped into the ductwork.

J. For building static pressure sensors, the high-pressure port shall be inserted into the space via a metal tube. Pipe the low-pressure port to the outside of the building.

3.8 FIRE/FAN SHUTDOWN

A. Provide a signal to stop air handling unit fans upon activation of the fire alarm system. Wiring to be directly to the individual motor starters, unless otherwise indicated on drawings.

B. Provide a signal to the DDC control system that the fire alarm system is activated.

3.9 LOW LIMIT SAFETY FUNCTIONS

A. Provide for all supply fan units. Wiring to be directly to the motor starter. Low limit shall be located as shown on drawings. Low limit shall: prevent fan from operating, set heating coils to full heat operate coil pumps, fully close the outside air damper, fully close the relief air dampers, open return air damper, and alarm DDC system until reset.

3.10 SYSTEM TESTING

A. At the time of installation, systems shall be tested for control device operation prior to the systems acceptance. A report of each systems performance shall be submitted to the Owner's Representative. The report shall include:

1. Field verification and demonstration checklist of analog input calibration, analog output operation, digital input function, and digital output operation.
2. Trend log of inputs and outputs, printed every two hours, for one week.
3. Refer to "Instructions and Adjustments"
4. Field verification and demonstration of sequence of operations.

3.11 INTEGRATION WITH EQUIPMENT CONTROL

A. The DDC system shall fully integrate to provide full monitoring and control functions for equipment shown.

3.12 POINT DESCRIPTION AND PROGRAM LIST

A. General:

1. Points listed are the minimum number of points to be provided. Provide additional points as required to satisfy the sequence and operational requirements.
2. Provide spare points. After the system has been completed and tested, the following minimum quantity of spare points shall be available for future connection at each DCP:

   a. Binary inputs: 2
   b. Binary outputs: 2

c. Analog inputs: 1
d. Analog outputs: 1

3. Provide proportional-integral-derivative algorithms for all control programs.
4. Determine, through operation of the system, proportional bands, interval time, integral periods, adjustment rates, and any other input information required to provide stable operation of the control programs.
5. The following definitions apply to the letter descriptors used in the point lists:

   a. RT - Run time of a piece of equipment. This shall be the total operating time since initial start-up of a piece of equipment.
   b. T - Indicates the point shall be trendable.
   c. A - Indicates the system shall alarm when the point is outside its range, or upon contact closure or opening.
   d. CS - Current Sensor

6. All alarms shall be trendable. All equipment start/stops shall be trendable.
7. At a minimum, each sequence and accompanying point list shall be represented by an individual graphic. Each point listed shall appear on the graphic. Where appropriate and approved, multiple sequences and point lists may be combined into a single graphic.

   a. For analog outputs, display on the graphic the percent of full signal (percent open for valves and dampers, percent of speed for variable speed drives, percent open for vortex dampers, etc.).
   b. For analog outputs controlled by analog inputs, provide a probe at the graphic to redefine the proportional, integral, and derivative gains.
   c. Alarm set points and ranges shall be resettable from the graphic. Control set points and ranges shall be resettable from the graphic.
   d. Where average point values are called for in the sequence, the average value shall be displayed on the graphic. In response to a probe on the graphic, the individual sensor values and sensor locations shall be displayed.

8. Where dampers operate in conjunction with fan operation, the damper open signal shall precede the fan start signal by 10 to 15 seconds. The damper close signal shall be delayed 10 to 15 seconds after the fan stop signal.

3.13 FIELD QUALITY CONTROL

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

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
2. Test and adjust controls and safeties.
3. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
4. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
5. Test each point through its full operating range to verify that safety and operating control set points are as required.

6. Test each control loop to verify stable mode of operation and compliance with sequence of operation.
7. Test each system for compliance with sequence of operation.
8. Test software and hardware interlocks.

B. DDC Verification:

1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
2. Check instruments for proper location and accessibility.
3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
4. Check temperature instruments and material and length of sensing elements.
5. Check control valves. Verify that they are in correct direction.
6. Check DDC system as follows:

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

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

3.14 ADJUSTING

A. Calibrating and Adjusting:

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

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

5. Flow:

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

6. Pressure:

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

7. Temperature:

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

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

B. Adjust initial temperature and humidity set points.

END OF SECTION