ADDENDUM NO. 1

February 6, 2025

PORTER COUNTY SHERIFF'S OFFICE AND JAIL FACILITY RENOVATIONS

TO: ALL BIDDERS OF RECORD

This Addendum forms a part of and modifies the Bidding Requirements, Contract Forms, Contract Conditions, the Specifications, and the Drawings dated January 8, 2025 by DLZ. Acknowledge receipt of the Addendum in the space provided on the Bid Form. Failure to do so may subject the Bidder to disqualification.

This Addendum consists of Page ADD 1-1 through ADD 1-2 and attached Addendum No. 1 from DLZ dated February 5, 2025 and consisting of 4 pages, Questions and Clarifications Sheet, Added Specification Section 23 05 48 - Vibration Controls for HVAC, Revised Specification Section 23 09 23 - Direct Digital Control (DDC) System for HVAC, and 18 drawings.

A. SPECIFICATION SECTION 00 00 20 - TABLE OF CONTENTS

1. **Add:**

   Specification Section 23 05 48 - Vibration Controls for HVAC

B. SPECIFICATION SECTION 00 31 00 - INDIANA BID FORM

1. **Replace:**

   Indiana Bid Form with the attached revised Indiana Bid Form

C. SPECIFICATION SECTION 01 12 00 - MULTIPLE CONTRACT SUMMARY
Under 3.03 - Bid Categories

F. BID CATEGORY NO. 6 - MECHANICAL

1. Add:

Specification Section 23 05 48 - Vibration Controls for HVAC

D. SPECIFICATION SECTION 01 23 00 - ALTERNATES

1. **Add:**

ALTERNATE NO. 7: State the cost to provide Security Plumbing Fixtures, Electronic Water Management System, and components (Including but not limited to: Push Buttons, Controllers, Flush Valves) in Spec Section 22 46 00 by Willoughby if not already included in your base bid.

2. **Add:**

ALTERNATE NO. 8: State the cost to provide Temperature Controls / Building Automation in Spec Section 23 09 23 by Precision Controls if not already included in your base bid.

CONTRACTOR'S BID FOR PUBLIC WORKS FORM NO. 96

Format (Revised 2013)
(Amended for PCBC)

Porter County Sheriff's Office and Jail Facility Renovations

Porter County Board of Commissioners
Valparaiso, IN

PART I

(To be completed for all bids. Please type or print)

Date (month, day, year):_____

BIDDER (Firm) _____

Address _____ P.O. Box _____

City/State/Zip _____

Telephone Number: _____ Email Address: _____

Person to contact regarding this Bid_____

Pursuant to notices given, the undersigned offers to furnish labor and/or materials necessary to complete the public works project of:

_____
Insert Category No. (s) and Name(s)

Public works project, ***Porter County Sheriff's Office and Jail Facility Renovations***, in accordance with Plans and Specifications prepared by ***DLZ, 138 North Delaware Street, Indianapolis, IN 46204***, as follows:

BASE BID

For the sum of _____
(Sum in words)

_____DOLLARS ($_____)
(Sum in figures)

The undersigned acknowledges receipt of the following Addenda:
Receipt of Addenda No. (s) _____

PROPOSAL TIME

Bidder agrees that this Bid shall remain in force for a period of sixty (60) consecutive calendar days from the due date, and Bids may be accepted or rejected during this period. Bids not accepted within said sixty (60) consecutive calendar days shall be deemed rejected.

Attended pre-bid conference YES _____ NO_____

Has visited the jobsite YES _____ NO_____

The Bidder has reviewed the Guideline Schedule in Section 01 32 00 and the intent Of the schedule can be met.

YES _____ NO_____

Bidder has included their Written Drug Testing Plan that covers all employees of the bidder who will perform work on the public work project and meets or exceeds the requirements set in IC 4-13-18-5 or IC 4-13-18-6.

YES _____ NO_____

The Skillman Corporation's diversity initiative is to create a program to encourage, assist and measure the active participation of Minority- Owned, Women-Owned, Veteran – Owned and Disabled Individual-Owned Businesses. The Program is to ensure that MWVDBEs are provided full and equal opportunity to participate in all Skillman Corporation's Projects.

Bidder has included:

DBE: YES _____% NO _____
MBE: YES _____% NO _____
WBE: YES _____% NO _____
VBE: YES _____% NO _____

The undersigned further agrees to furnish a bond or certified check with this Bid for an amount specified in the Notice to Bidders. If Alternate Bids apply, submit a proposal for each in accordance with the Plans and Specifications.

If additional units of material included in the contract are needed, the cost of units must be the same as that shown in the original contract if accepted by the governmental unit. If the bid is to be awarded on a unit basis, the itemization of the units shall be shown on a separate attachment.

The contractor and his subcontractors, if any, shall not discriminate against or intimidate any employee, or applicant for employment, to be employed in the performance of this contract, with respect to any matter directly or indirectly related to employment because of race, religion, color, sex, national origin, or ancestry. Breach of this covenant may be regarded as a material breach of the contract.

CERTIFICATION OF USE OF UNITED STATES STEEL PRODUCTS
(if applicable)

I, the undersigned bidder, or agent as a contractor on a public works project, understand my statutory obligation to use steel products made in the United States (I.C. 5-16-8-2). I hereby certify that I and all subcontractors employed by me for this project will use U.S. steel on this project if awarded. I understand that violations hereunder may result in forfeiture of contractual payments.

ALTERNATE BIDS

A blank entry or an entry of "No Bid", "N/A", or similar entry on any Alternate will cause the bid to be rejected as non-responsive only if that Alternate is selected. If no change in the bid amount is required, indicate "No Change".

****MARK "ADD" OR "DEDUCT" FOR EACH ALTERNATE****

Alternate Bid No. 1 – AHU 9

Change the Base Bid the sum of_____
(sum in words)

_____DOLLARS ($_____) ADD DEDUCT
(sum in figures)

Alternate Bid No. 2 – Duct Cleaning

Change the Base Bid the sum of_____
(sum in words)

_____DOLLARS ($_____) ADD DEDUCT
(sum in figures)

Alternate Bid No. 3 – Grilles / Diffusers Replacement

Change the Base Bid the sum of_____
(sum in words)

_____DOLLARS ($_____) ADD DEDUCT
(sum in figures)

Alternate Bid No. 4 – Joint Sealants

Change the Base Bid the sum of_____
(sum in words)

_____DOLLARS ($_____) ADD DEDUCT
(sum in figures)

Alternate Bid No. 5 – Security Glazing

Change the Base Bid the sum of_____
(sum in words)

_____DOLLARS ($_____) ADD DEDUCT
(sum in figures)

Alternate Bid No. 6 – LED Lighting Replacement

Change the Base Bid the sum of_____
(sum in words)

_____DOLLARS ($_____) ADD DEDUCT
(sum in figures)

Alternate Bid No. 7 – Plumbing Fixtures & Water Management

Change the Base Bid the sum of_____
(sum in words)

_____DOLLARS ($_____) ADD DEDUCT
(sum in figures)

Alternate Bid No. 8 – Temperature Controls

Change the Base Bid the sum of_____
(sum in words)

_____DOLLARS ($_____) ADD DEDUCT
(sum in figures)

PART II

(For projects of $150,000 or more – IC 36-1-12-4)

These statements to be submitted under oath by each bidder with and as a part of his bid. (Attach additional pages for each section as needed.)

SECTION I EXPERIENCE QUESTIONNAIRE

1. What public works projects has your organization completed for the period of one (1) year prior to the date of the current bid?

Contract Amount	Class of Work	Completion Date	Name and Address of Owner

2. What public works projects are now in the process of construction by your organization?

Contract Amount	Class of Work	Completion Date	Name and Address of Owner

3. Have you ever failed to complete any work awarded to you?_____If so, where and why?

_____

_____

_____

4. List references from private firms for which you have performed work.

_____

_____

_____

SECTION II PLAN AND EQUIPMENT QUESTIONNAIRE

1. Explain your plan or layout for performing proposed Work. (Examples could include a narrative of when you could begin, complete the project, number of workers, etc. and any other information which you believe would enable the governmental unit to consider your bid.)

2. Please list the names and addresses of all subcontractors (i.e. persons or firms outside your own firm who have performed part of the work) that you have used on public works projects during the past five (5) years along with a brief description of the work done by each subcontractor.

3. If you intend to sublet any portion of the work, state the name and addresses of each subcontractor, equipment to be used by the subcontractor, and whether you will require a bond. However, if you are unable to currently provide a listing, please understand a listing must be provided prior to contract approval. Until the completion of the proposed project, you are under a continuing obligation to immediately notify the governmental unit in the event that you subsequently determine that you will use a subcontractor on the proposed project.

4. What equipment do you have available to use for the proposed Project? Any equipment used by subcontractors may also be required to be listed by the governmental unit.

_____

_____

_____

_____

5. Have you into contracts or received offers for all materials which substantiate the prices used in preparing your proposal? If not, please explain the rationale used which corroborate the process listed.

_____

_____

_____

_____

SECTION III CONTRACTOR'S FINANCIAL STATEMENT

Attachment of Bidder's financial statement is mandatory. Any Bid submitted without said financial statement as required by statute shall thereby be rendered invalid. The financial statement provided hereunder to the governing body awarding the Contract must be specific enough in detail so that said governing body can make a proper determination of the Bidder's capability for completing the Project if awarded.

SECTION IV CONTRACTOR NON-COLLUSION AFFIDAVIT

The undersigned Bidder or agent, being duly sworn on oath, says that he has not, nor has any other member, representative, or agent of the firm, company, corporation or partnership represented by him, entered into any combination, collusion or agreement with any person relative to the price to be bid by anyone at such letting nor to prevent any person from bidding nor to induce anyone to refrain from bidding, and that this Bid is made without reference to any other bid and without any agreement, understanding or combination with any other person in reference to such bidding.

He further says that no person or persons, firms, or corporations has, have, or will receive directly or indirectly, any rebate, fee, gift, commission, or thing of value on account of such contract.

SECTION V OATH AND AFFIRMATION

I HEREBY AFFIRM UNDER THE PENALTIES OF PERJURY THAT THE FACTS AND INFORMATION CONTAINED IN THE FOREGOING BID FOR PUBLIC WORKS ARE TRUE AND CORRECT

Dated at _____this _____ day of _____, 20

_____
(Name of Organization)

By

_____

_____
(Title of Person Signing)

ACKNOWLEDGEMENT

STATE OF _____)
) SS:
COUNTY OF _____)

Before me, a Notary Public, personally appeared the above-named

_____

Swore that the statements contained in the foregoing document are true and correct.

Subscribed and sworn to before me this _____ day of _____,

_____
(Title)

_____
Notary Public

My Commission Expires: _____

County of Residence: _____

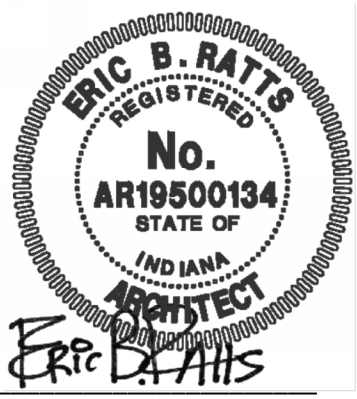
END OF SECTION 00 31 00

ADDENDUM NO. 1

PROJECT:	**PORTER COUNTY SHERIFF'S OFFICE AND JAIL FACILITY RENOVATIONS** 2755 State Road 49 Valparaiso, IN 46383
TO:	All Prospective Bidders and others to whom Plans and Specifications for the above referenced Project have been issued.
OWNER:	**PORTER COUNTY BOARD OF COMMISSIONERS** 155 Indiana Avenue Valparaiso, IN 46383
ARCHITECT	**DLZ INDIANA, LLC** 138 N. Delaware Street Indianapolis, Indiana 46204
DATE:	February 5th, 2025

The items included in this Addendum are to become a part of the original Contract Documents including Drawings and Project Manual dated January 08, 2025, as if included herein. Only these items are to be altered. The remainder of the original Drawings and Project Manual remain valid in their entirety. Bidders must acknowledge receipt of this Addendum in the space provided on the Proposal Form. Failure to do so may subject the Bidder to disqualification.

CERTIFIED BY:



Eric B. Ratts, AIA
Vice President
State of Indiana No. 19500134

PROJECT MANUAL

ITEM NO. 1. SECTION 012300 – ALTERNATES
- a. Added Alternate #7 Electronic Water Management System
- b. Added Alternate #8 Direct Digital Control (DDC) System for HVAC

ITEM NO. 2. SECTION 230548 – VIBRATION CONTROLS FOR HVAC
- a. Added section 230548 in its entirety.

ITEM NO. 3. SECTION 230923 – DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC
- a. Added to the list of acceptable manufacturers.

DRAWINGS

ITEM NO. 4. M0.1 – GENERAL INFORMATION
- a. Keynote 230005 and 230001 revised to include "RESIZE EQUIPMENT PAD AS NECESSARY TO MAINTAIN 6'' SPACE AROUND PERIMETER OF EQUIPMENT."
- b. Keynote 022304 and 022302 revised to include ''CONCRETE PAD EXISTING TO REMAIN.''

ITEM NO. 5. MD2.1A – FIRST FLOOR MECHANICAL DEMOLITION PLAN – AREA A
- a. Existing concrete pads indicated for AHUs shown.
- b. Keynote 022304 revised to include ''CONCRETE PAD EXISTING TO REMAIN.''

ITEM NO. 6. MD2.1E – FIRST FLOOR MECHANICAL DEMOLITION PLAN – AREA E
- a. Existing concrete pads indicated for AHU-8.
- b. Keynote 022304 revised to include ''CONCRETE PAD EXISTING TO REMAIN.''

ITEM NO. 7. MD4.1 – ENLARGED MECHANICAL REMOVAL PLAN
- a. Existing concrete pads indicated for AHUs and ERV shown.
- b. Keynote 022304 revised to include ''CONCRETE PAD EXISTING TO REMAIN.''

ITEM NO. 8. MD4.2 – AHU REMOVAL SECTIONS
- a. Existing concrete pads indicated existing to remain for AHUs shown.

ITEM NO. 9. MD4.3 – AHU REMOVAL SECTIONS II
- a. Existing concrete pads indicated existing to remain for AHUs shown.

ITEM NO. 10. MD4.4 – ENLARGED MECHANICAL REMOVAL PLAN AND AHU REMOVAL SECTIONS
- a. Existing concrete pad indicated existing to remain for ERV and boilers shown.
- b. Keynote 022302 revised to include "CONCRETE PAD EXISTING TO REMAIN."

ITEM NO. 11. M2.1A – FIRST FLOOR MECHANICAL INSTALLATION PLAN – AREA A
- a. Concrete pads indicated as resized for AHUs shown.

ITEM NO. 12. M2.1E – FIRST FLOOR MECHANICAL INSTALLATION PLAN – AREA E
- a. Concrete pads indicated as resized for AHU-8.
- b. Keynote 230005 revised to include "RESIZE EQUIPMENT PAD AS NECESSARY TO MAINTAIN 6'' SPACE AROUND PERIMETER OF EQUIPMENT."

ITEM NO. 13. M2.2B – SECOND FLOOR MECHANICAL INSTALLATION PLAN – AREA B
a. Concrete pads indicated as resized for AHUs shown.

ITEM NO. 14. M4.1 – ENLARGED PLANS
a. Concrete pads indicated as resized for AHUs and boilers shown.
b. Keynote 230005 and 230001 revised to include "RESIZE EQUIPMENT PAD AS NECESSARY TO MAINTAIN 6'' SPACE AROUND PERIMETER OF EQUIPMENT."

ITEM NO. 15. M4.2 – ENLARGED PLANS II
a. Concrete pads indicated as resized for AHUs shown.
b. Keynote 230005 revised to include "RESIZE EQUIPMENT PAD AS NECESSARY TO MAINTAIN 6'' SPACE AROUND PERIMETER OF EQUIPMENT."

ITEM NO. 16. M4.4 – AHU SECTIONS
a. Concrete pads shown for AHUs indicated with note "RESIZE EQUIPMENT PAD AS NECESSARY"

ITEM NO. 17. M4.5 – AHU SECTIONS II
a. Concrete pads shown for AHUs indicated with note "RESIZE EQUIPMENT PAD AS NECESSARY"

ITEM NO. 18. M4.6 – AHU SECTIONS III
a. Concrete pads shown for AHUs indicated with note "RESIZE EQUIPMENT PAD AS NECESSARY"

ITEM NO. 19. M5.1 – MECHANICAL DETAILS – 1
a. Added detail 16/M5.1 to indicate chiller piping detail.

ITEM NO. 20. M5.2 – MECHANICAL DETAILS – 2
a. Removed halftone from concrete pads for CWP-1 and CWP-2 to indicate new.

ITEM NO. 21. M6.2 – MECHANICAL EQUIPMENT SCHEDULES – II
a. Adjusted note 9 on air cooled chiller schedule to refer to details 1/M5.2 and 16/M5.1.

ATTACHMENTS:

OTHER
1. Questions and Clarifications

PROJECT MANUAL
2. SECTION 012300 – ALTERNATES
3. SECTION 230548 – VIBRATION CONTROLS FOR HVAC
4. SECTION 230923 – DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

DRAWINGS
5. M0.1 – GENERAL INFORMATION
6. MD2.1A – FIRST FLOOR MECHANICAL DEMOLITION PLAN – AREA A
7. MD2.1E – FIRST FLOOR MECHANICAL DEMOLITION PLAN – AREA E
8. MD4.1 – ENLARGED MECHANICAL REMOVAL PLAN
9. MD4.2 – AHU REMOVAL SECTIONS
10. MD4.3 – AHU REMOVAL SECTIONS II
11. MD4.4 – ENLARGED MECHANICAL REMOVAL PLAN AND AHU REMOVAL SECTIONS

12. M2.1A – FIRST FLOOR MECHANICAL INSTALLATION PLAN – AREA A
13. M2.1E – FIRST FLOOR MECHANICAL INSTALLATION PLAN – AREA E
14. M2.2B – SECOND FLOOR MECHANICAL INSTALLATION PLAN – AREA B
15. M4.1 – ENLARGED PLANS
16. M4.2 – ENLARGED PLANS II
17. M4.4 – AHU SECTIONS
18. M4.5 – AHU SECTIONS II
19. M4.6 – AHU SECTIONS III
20. M5.1 – MECHANICAL DETAILS – 1
21. M5.2 – MECHANICAL DETAILS – 2
22. M6.2 – MECHANICAL EQUIPMENT SCHEDULES – II

END OF ADDENDUM No. 1

Questions and Clarifications

ITEM NO. 1.

Question: (Gatlin Plumbing) Pertaining to the P 2.0 A-E drawings… Will there be a formal process to the camera and rodding of existing sewer lines? Will the engineer or owner have a list of parameters they expect to be met for this work to be determined complete or acceptable? Will there be a spec section or more direction be provided?

Answer: Contractor to utilize industry best practices to clear existing sanitary lines to greatest extent possible. Notify the Construction Manager and Engineer of any issues.

ITEM NO. 2.

Question: Can a different FP pipe type be connected to existing XL pipe serving the video visitation room?

Answer: Contractor to match existing pipe material.

ITEM NO. 3.

Question: Can a note be added for AHU's and other large equipment to resize concrete housing pad as necessary for new equipment?

Answer: Notes will be added via Addendum.

ITEM NO. 4.

Question: Please clarify if Inertia Bases are required for CWP 1-5? If so, please provide specification. Per Flow diagram on M5.2 it alludes that the Pad for CWP 1&2 will remain, and new pads will be needed for CWP 3,4&5. Please advise how to proceed.

Answer: Spec section has been added for inertia bases. CWP 1&2 will need new pads. Both shall be addressed in next Addendum.

ITEM NO. 5.

Question: Please provide a piping detail for the chilled water at each chiller. There is a piping detail for most everything else but not the chiller. I suspect there is a little more required than what the flow diagram alludes. Per Manufacturer Warranty a Y-strainer is usually required to protect the equipment (in this case the chillers.) This is not shown in the flow diagram. Will a Y-strainer be required?

Answer: Added detail for chiller piping via addendum.

ITEM NO. 6.

Question: What is the existing slab thickness?

Answer: The original construction documents indicate that the typical concrete slab on grade is 5" thick with 6x6 – 2.1x2.1 WWF on 6" granular fill. Existing slab thickness will need to be field verified.

ITEM NO. 7.

Clarification: The mezzanine security barrier color shall be black.

SECTION 230548 - VIBRATION CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Elastomeric isolation pads.
2. Post-installed concrete anchors.
3. Concrete inserts.
4. Vibration isolation equipment bases.

1.2 DEFINITIONS

A. IBC: International Building Code.

B. OSHPD: Office of Statewide Health Planning and Development (State of California).

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Include load rating for each wind-force-restraint fitting and assembly.
3. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and seismic-and wind-restraint component.
4. Annotate to indicate application of each product submitted and compliance with requirements.
5. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of vibration isolation device installation and seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.

B. Qualification Data: For testing agency.

C. Welding certificates.

D. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct testing indicated, be an NRTL as defined by OSHA in 29 CFR 1910.7, and be acceptable to authorities having jurisdiction.

B. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.1 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads:

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

    a. Ace Mountings Co., Inc.
    b. CADDY; brand of nVent Electrical plc.
    c. California Dynamics Corporation.
    d. Isolation Technology, Inc.
    e. Kinetics Noise Control, Inc.
    f. Korfund.
    g. NOVIA; a division of Carpenter & Paterson.
    h. VMC GROUP.
    i. Vibration Eliminator Co., Inc.
    j. Vibration Isolation.
    k. Vibration Management Corp.

2. Source Limitations: Obtain elastomeric isolation pads from single manufacturer.
3. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
4. Size: Factory or field cut to match requirements of supported equipment.
5. Pad Material: Oil and water resistant with elastomeric properties. Neoprene rubber, silicone rubber, or other elastomeric material.
6. Surface Pattern: Smooth, ribbed, or waffle pattern.
7. Infused nonwoven cotton or synthetic fibers.
8. Load-bearing metal plates adhered to pads.
9. Sandwich-Core Material: Resilient and elastomeric.

a. Infused nonwoven cotton or synthetic fibers.

2.2 POST-INSTALLED CONCRETE ANCHORS

A. Mechanical Anchor Bolts:

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

   a. Atkore Unistrut.
   b. B-Line; a division of Eaton, Electrical Sector.
   c. Hilti, Inc.
   d. Powers Fasteners.

2. Source Limitations: Obtain mechanical anchor bolts from single manufacturer.
3. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength for anchor and as tested according to ASTM E488/E488M.

B. Provide post-installed concrete anchors that have been prequalified for use in wind-load applications. Post-installed concrete anchors must comply with all requirements of ASCE/SEI 7-05, Ch. 13.

1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.
2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.

C. Expansion-type anchor bolts are not permitted for equipment in excess of 10 hp that is not vibration isolated.

1. Undercut expansion anchors are permitted.

2.3 CONCRETE INSERTS

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

1. Atkore Unistrut.
2. B-Line; a division of Eaton, Electrical Sector.
3. Hilti, Inc.
4. Powers Fasteners.

B. Source Limitations: Obtain concrete inserts from single manufacturer.

C. Provide preset concrete inserts that are seismically prequalified in accordance with ICC-ES AC466 testing.

D. Comply with ANSI/MSS SP-58.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

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

3.2 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

B. Hanger-Rod Stiffeners: Install where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry present and future static, wind load, and seismic loads within specified loading limits.

3.3 INSTALLATION OF VIBRATION-CONTROL DEVICES

A. Provide vibration-control devices for heating hot water pumps.

B. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

C. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

D. Mechanical Anchor Bolts:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.

2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors to be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive-Type Anchor Bolts: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

3.4 INSTALLATION OF VIBRATION ISOLATION EQUIPMENT BASES

A. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

B. Coordinate dimensions of steel equipment rails and bases, concrete inertia bases, and restrained isolation roof-curb rails with requirements of isolated equipment specified in this and other Sections. Where dimensions of these bases are indicated on Drawings, dimensions may require adjustment to accommodate actual isolated equipment.

3.5 ADJUSTING

A. Adjust isolators after system is at operating weight.

B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Tests and Inspections:

1. Perform tests and inspections with the assistance of a factory-authorized service representative.
2. Test and adjust restrained-air-spring isolator controls and safeties.

D. Remove and replace malfunctioning units and retest as specified above.

E. Units will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION 230548

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

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1.3 DEFINITIONS

A. DDC: Direct digital control.

B. I/O: Input/output.

C. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.

D. MS/TP: Master slave/token passing.

E. PC: Personal computer.

F. PID: Proportional plus integral plus derivative.

G. RTD: Resistance temperature detector.

1.4 SYSTEM PERFORMANCE

A. Comply with the following performance requirements:

1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.
2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.
3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.

5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
8. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:

    a. Water Temperature: Plus or minus 1 deg F.
    b. Water Flow: Plus or minus 5 percent of full scale.
    c. Water Pressure: Plus or minus 2 percent of full scale.
    d. Space Temperature: Plus or minus 1 deg F.
    e. Ducted Air Temperature: Plus or minus 1 deg F.
    f. Outside Air Temperature: Plus or minus 2 deg F.
    g. Dew Point Temperature: Plus or minus 3 deg F.
    h. Temperature Differential: Plus or minus 0.25 deg F.
    i. Relative Humidity: Plus or minus 5 percent.
    j. Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale.
    k. Airflow (Terminal): Plus or minus 10 percent of full scale.
    l. Air Pressure (Space): Plus or minus 0.01-inch wg.
    m. Air Pressure (Ducts): Plus or minus 0.1-inch wg.
    n. Carbon Monoxide: Plus or minus 5 percent of reading.
    o. Carbon Dioxide: Plus or minus 50 ppm.
    p. Electrical: Plus or minus 5 percent of reading.

1.5 SEQUENCE OF OPERATION

A. See Construction Documents.

1.6 SUBMITTALS

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

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

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

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

    a. Wiring diagrams for control units with termination numbers.
    b. Schematic diagrams and floor plans for field sensors and control hardware.
    c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.

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

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

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

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

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

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

F. Qualification Data: For Installer and manufacturer.

G. Field quality-control test reports.

H. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

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

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with ASHRAE 135 for DDC system components.

D. Smoke control systems shall comply with Indiana Building Code Section 909 and UL864 UULK 10th Edition. This includes, but is not limited to:
1. UL864 listed controllers.
2. All smoke control wiring, regardless of voltage, shall be in conduit.
3. Positive positive proof of airflow for fans via airflow switch or DP switch (VFD status or current-sensing relays not acceptable).
4. Positive positive proof of damper position (actuator feedback not acceptable).
5. Provide damper actuators with stroke times of 60 seconds or less.
6. Furnish UL864 listed Firefighters Smoke Control Station (FSCS) per IFC section 909.16 & UL864, plus all required software to interface between FSCS and building automation system per UL864.
7. Automatically perform weekly test per IBC/IFC 909.12 & UL864.
8. Controllers shall be on standby power source.
9. Smoke Control System shall have the capability to bypass hand-off-auto or start/stop switches located on motor controllers, and bypass temperature low-limit safeties and/or return duct smoke detectors per UL864.
10. Network communications shall be installed per control system manufacturer's UL864 UUKL listing.

1.8 DELIVERY, STORAGE, AND HANDLING

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

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

1.9 COORDINATION

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

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

1.10 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Replacement Materials: One replacement diaphragm or relay mechanism for each unique valve motor, controller, or thermostat.
2. Maintenance Materials: One thermostat adjusting key(s).

PART 2 - PRODUCTS

2.1 CONTROL SYSTEM

A. Manufacturers:

1. Precision Controls, Inc.
2. Johnson Controls, Inc.
3. Delta Controls by Innovative Control Solutions.
4. Automated Logic Corporation by Emcor Services.
5. Tridium.

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

C. Applications for the Smoke Management System include, but are not limited to the following:

1. Requirements applicable to controls serving air-handling units AHU-1 and 2, associated smoke exhaust fans, variable air volume boxes, return and transfer air duct mounted dampers, and supply dampers for diffusers in hallway as indicated on plans.
2. Smoke design:
    a. IBC/IFC 909.2 – General Design Requirements: Buildings, structures, or parts

thereof required by this code to have a smoke control system or systems shall have such systems designed in accordance with the applicable requirements of Section 909 and the generally accepted and well-established principles of engineering relevant to the design.

b. The control systems shall meet UL 864 listing regarding smoke control

3. Provide a dedicated server(s) to the system.

   a. The BAS contractor shall provide the server to be utilized for the BAS system. For the purposes of this specification, this server shall be referenced as the Dedicated Application and Database Server (DADS) file server.
   b. The BAS contractor shall provide all software, setup and configuration of this Dedicated Application and Database Server (DADS) file server. Provide software, setup and configuration of remote workstations for accessing the DADS file server and BAS over the local LAN and internet.
   c. The BAS contractor shall be responsible for all software and network integration for this DADS file server to be compatible with the BAS system.

4. Provide wall mounted fire fighter's smoke control unit located in the Main Control Room. All air handling unit fans (supply, return, and exhaust) and smoke control exhaust fans shall be shown on the fire-fighter's control panel. A clear indication of the direction of airflow and the relationship of components shall be displayed. Status indicators shall be provided for each smoke control compartment, annunciated by fan and compartment.

   a. The system shall automatically open and close fire/smoke dampers, activate exhaust fans, and modify air handling unit fan operations as scheduled to maintain a differential pressure to surrounding compartments of 0.05 inches water gage to prevent smoke from leaving the compartment of origin.

   b. The fire fighter's control panel shall provide control capability of the complete smoke control system equipment. On-Auto-Off control over each smoke compartment system that can also be controlled from other sources.

   c. Smoke Control System shall interface to the BAS. Within the BAS, specific graphical interface shall be provided by floor showing the individual dampers relating to smoke control to allow Open/Close overrides for testing.

   d. Panel to show a graphical representation of floor plan with location of each of the smoke zones and indication of the fans associated with each zone.

5. Provide all rough-in wall boxes and conduits in the walls for control of fire/smoke dampers specified below, as noted on the drawings and in accordance with manufacturer.
6. Provide all line and low voltage equipment and electrical wiring systems and devices.
7. Calibrate, program, check out, and verify operation to the Engineer, a computerized Building Automation System (BAS) to control the mechanical equipment as herein specified and indicated on the contract drawings.
8. Provide all hardware and software necessary for a complete control system as required to accomplish the objectives of Indiana Building Code pressurization method 909.6 to control smoke as herein specified and indicated on the contract drawings.

9. Provide all the necessary initial programming and any revisions to the software to accomplish the desired sequence of operation, comfort levels and energy consumption as required by the Engineer. This shall include any software revisions during any of the warranty periods that may be required by the Engineer and/or the Owner.
10. Provide all modifications and updates to the database file server and workstations necessary to comply with the intent of these specifications and as required to provide the operator interface as specified.
11. Install, electrically wire, calibrate and checkout all controls associated with the installation of the Building Automation System as required by the component manufacturer and as stated in this specification.
12. All wiring for the smoke control system shall be in conduit.
13. Interface of the Building Automation System with mechanical systems.
14. Emergency power is required for all systems associated with smoke control.
15. UL555S Dampers are required to control smoke.
16. Control feedback shall be required on all devices associated with smoke control.
17. The UL 864 system will reside on its own dedicated Ethernet network. The UL 864 listed smoke control system network will make a single connection to the owner's network using a Ethernet network switch that is listed as part of the controls system for the application.
18. Prior to occupancy the smoke control system shall be undergo operational testing according to IBC/IFC 909.20.3 which shall include all equipment such as initiating devices, fans, dampers, controls, doors and windows.
19. Smoke Control systems and associated components shall meet required UL-864 ratings and requirements of Section 909 of the Indiana Building Code.

D. ASHRAE 135 Protocol:
1. ASHRAE 135 communication protocol shall be sole and native protocol used on throughout the entire DDC system.
2. DDC system shall not require use of gateways to integrate HVAC equipment and other building systems and equipment not required to use ASHRAE 135 protocol.
3. If used, gateways shall connect to DDC system using ASHRAE 135 communication protocol and Project object properties and read/write serviced indicated by interoperability schedule.
4. Operator workstations, controllers and other network devices shall be tested and listed by BACnet Testing Laboratories.

2.2 DDC EQUIPMENT

A. Operator Interface Via Web Browser
1. Furnish one compact Web server interface as shown on the system drawings. Operators shall be able to access all necessary operational information in the system via personal computer utilizing standard Web browser software. Computer and Web browsing software shall not be furnished under this section. The Web server shall reside on the same Peer-to-Peer network as the Building Controllers.
2. Web Server shall connect via Ethernet to a LAN and be able to serve up controller information to simultaneous operators connected via the Ethernet or telephone with

standard Web Browsers. Each standard browser connected to server shall be able to access all system information.

3. In addition to the primary operator interface, the system shall include a secondary interface compatible with a locally available commercial wireless network and viewable on a commercially available wireless device such as a Wireless Access Protocol (WAP) enabled cellular telephone or personal digital assistant (PDA). This secondary interface may be text-based and shall provide a summary of the most important data.

B. Web Server Hardware:

1. Furnish one compact Web server router with ethernet port for operator computer access. The web server shall have an integrated RS-485 port for connection to the peer to peer controller network. The web server shall not require a permanent keyboard or monitor, however shall have an integrated terminal port for connecting a terminal and keyboard during installation and configuration. The Web server shall allow file transfer of files from another system for use as graphics backgrounds or custom displays.

C. Web Browser Interaction

1. The Web server shall be capable of providing the operator, at a Web Browser, with both tabular or graphical pages of controller data. An operator with the proper password level shall be able to change setpoint and occupancy schedules or override points and remove overrides. Dynamic objects shall include analog and binary values, dynamic text, static text, and animation files. Graphics shall have the ability to show animation by shifting image files based on the status of the object.
2. Custom Graphics: Custom graphic files may be created with the use of a graphics generation package. Graphics may be downloaded to the Web server to use as graphical backgrounds for Dynamic data sent to a Web browser.
3. Graphics Library: Furnish a library of standard HVAC equipment graphics such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators. The library shall be furnished in a file format compatible with the graphics generation package program. Upon connection to the controls system the Web Server shall have the capability to learn the controls system and automatically present default web pages for each controller found.
4. Alarms. An operator shall be able to access a tabular listing of the systems most recent alarm messages from a standard Web browser. This listing shall allow the operator to manage the alarms and acknowledge, print, delete and hyperlink to trouble areas.
5. Display Information. An operator shall have the capability to perform setup of the Web Server from a standard Web browser. Setup shall include learning new controllers that are added to the controls system, setting the time in controllers and changing the display units of the data presented between Metric and Imperial units.

D. Performance Standards

1. System shall conform to the following minimum standards over network connections.
    a. Graphic Display. A graphic with 20 dynamic points shall display with current data within 10 sec.
    b. Graphic Refresh. A graphic with 20 dynamic points shall update with current data within 10 sec. and shall automatically refresh every 15 sec.

c. Configuration and Tuning Screens. Screens used for configuring, calibrating, or tuning points, PID loops, and similar control logic shall automatically refresh within 10 sec.
d. Object Command. Devices shall react to command of a binary object within 2 sec. Devices shall begin reacting to command of an analog object within 2 sec.
e. Alarm Response Time. An object that goes into alarm shall be annunciated at the web browser within 15 sec.

E. Operator Functions
1. Operator interface shall allow each authorized operator to execute the following functions as a minimum:
a. Log In and Log Out. System shall require user name and password to log in to operator interface.
b. Point-and-click Navigation. Operator interface shall be graphically based and shall allow operators to access graphics for equipment and geographic areas using point-and-click navigation.
c. View and Adjust Equipment Properties. Operators shall be able to view controlled equipment status and to adjust operating parameters such as setpoints, PID gains, on and off controls, and sensor calibration.
d. View and Adjust Operating Schedules. Operators shall be able to view scheduled operating hours of each schedulable piece of equipment on a weekly or monthly calendar-based graphical schedule display, to select and adjust each schedule and time period, and to simultaneously schedule related equipment. System shall clearly show exception schedules and holidays on the schedule display.
e. View and Respond to Alarms. Operators shall be able to view a list of currently active system alarms, to acknowledge each alarm, and to clear (delete) unneeded alarms.
f. View and Configure Trends. Operators shall be able to view a trend graph of each trended point and to edit graph configuration to display a specific time period or data range. Operator shall be able to create custom trend graphs to display on the same page data from multiple trended points.
g. View and Configure Reports. Operators shall be able to run preconfigured reports, to view report results, and to customize report configuration to show data of interest.
h. Manage Control System Hardware. Operators shall be able to view controller status and download new control modifications to each controller.
i. Manage Operator Access. Typically, only a few operators are authorized to manage operator access. Authorized operators shall be able to view a list of operators with system access and of functions they can perform while logged in. Operators shall be able to add operators, to delete operators, and to edit operator function authorization. Operator shall be able to authorize each operator function separately.

F. System Software
1. Operating System. Web server shall have an industry-standard professional-grade operating system. Acceptable systems shall be Microsoft Windows (current version).
2. 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 chilled water

and hot water 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 dynamic colors to represent zone temperature relative to zone setpoint.

a. 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 setpoints and other specified parameters.
b. Animation. Graphics shall be able to animate by displaying different image files for changed object status.
c. Alarm Indication. Indicate areas or equipment in an alarm condition using color or other visual indicator.
d. Format. Graphics shall be saved in an industry-standard format such as JPEG, 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).

G. System Tools

1. System shall provide the following functionality to authorized operators as an integral part of the operator interface or as stand-alone software programs. If furnished as part of the interface, the tool shall be available from each workstation or web browser interface. If furnished as a stand-alone program, software shall be installable on standard IBM-compatible PCs with no limit on the number of copies that can be installed under the system license.
   a. Automatic System Database Configuration. Each web server shall store on its hard disk a copy of the current system database. Stored database shall be easily updated with each system configuration or controller firmware or software change.
   b. Controller Download. Operators shall be able to download configuration from the system database to each controller.
   c. System Configuration. Operators shall be able to configure the system.
   d. Online Help. Context-sensitive online help for each tool shall assist operators in operating and editing the system.
   e. Security. System shall require a user name and password to view, edit, add, or delete data.

      1) Operator Access. Each user name and password combination shall define accessible viewing, editing, adding, and deleting functions in each system application, editor, and object. Authorized operators shall be able to vary and deny each operator's accessible functions based on equipment or geographic location.
      2) Automatic Log Out. Automatically log out each operator if no keyboard or mouse activity is detected. Operators shall be able to adjust automatic log out delay.
      3) Encrypted Security Data. Store system security data including operator passwords in an encrypted format. System shall not display operator passwords.

2. System Diagnostics. System shall automatically monitor controller and I/O point operation. System shall annunciate controller failure and I/O point locking (manual overriding to a fixed value).
3. Alarm Processing. System input and status objects shall be configurable to alarm on departing from and on returning to normal state. Operator shall be able to enable or disable each alarm and to configure alarm limits, alarm limit differentials, alarm states, and alarm reactions for each system object. Configure and enable alarm points as specified in Points List. Alarms shall be BACnet alarm objects and shall use BACnet alarm services.
4. Alarm Messages. Alarm messages shall use an English language descriptor without acronyms or mnemonics to describe alarm source, location, and nature.
5. Alarm Reactions. Operator shall be able to configure (by object) actions workstation or web server shall initiate on receipt of each alarm. As a minimum, workstation or web server shall be able to log, print, display messages, send e-mail, send page, and audibly annunciate.
6. Alarm Maintenance. Operators shall be able to view system alarms and changes of state chronologically, to acknowledge and delete alarms, and to archive closed alarms to the workstation or web server hard disk from each workstation or web browser interface.
7. Trend Configuration. Operator shall be able to configure trend sample or change of value (COV) interval, start time, and stop time for each system data object and shall be able to retrieve data for use in spreadsheets and standard database programs. Controller shall sample and store trend data and shall be able to archive data to the hard disk. Configure trends as specified in Points List. Trends shall be BACnet trend objects.
8. Object and Property Status and Control. Operator shall be able to view, and to edit if applicable, the status of each system object and property by menu or on graphics.
9. Reports and Logs. Operator shall be able to select, to modify, to create, and to print reports and logs. Operator shall be able to store report data in a format accessible by standard spreadsheet and word processing programs.
10. Standard Reports. Furnish the following standard system reports:

    a. Reports shall be filtered based upon the selected equipment
    b. Alarm Reports
        - Alarm Summary - Current alarms
        - Alarm Sources – List of equipment and associated alarm conditions
        - Alarm Actions – Configured alarm actions such as e-mail and alarm pop-up
    c. Schedule Reports
        - Effective Schedules – Displays effective schedules for each equipment
        - Schedule Instances – Displays all schedules entered
    d. Security Reports – Maintains audit of all actions taken through user interface
    e. Commissioning Reports – Provide equipment checkout status and notes
    f. Equipment Reports – Provide reports showing trended points and available network points.

11. Custom Reports. Operator shall be able to create custom reports that retrieve data, including archived trend data, from the system, then organize the data and present results in tabular or graphical format. Reports shall be launched from the operator interface.

12. Graphics Generation. Graphically based tools and documentation shall allow Operator to edit system graphics, to create graphics, and to integrate graphics into the system. Operator shall be able to add analog and binary values, dynamic text, static text, and animation files to a background graphic using a mouse.
13. Graphics Library. Complete library of standard HVAC equipment graphics shall include equipment such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators. Library shall include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. Library graphic file format shall be compatible with graphics generation tools.

H. Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.

1. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation or diagnostic terminal unit.
2. Stand-alone mode control functions operate regardless of network status. Functions include the following:

    a. Global communications.
    b. Discrete/digital, analog, and pulse I/O.
    c. Monitoring, controlling, or addressing data points.
    d. Software applications, scheduling, and alarm processing.
    e. Testing and developing control algorithms without disrupting field hardware and controlled environment.

3. Standard Application Programs:

    a. Electric Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, night setback/setup, on-off control with differential sequencing, staggered start, antishort cycling, PID control, DDC with fine tuning, and trend logging.
    b. HVAC Control Programs: Optimal run time, supply-air reset, and enthalpy switchover.
    c. Programming Application Features: Include trend point; alarm processing and messaging; weekly, monthly, and annual scheduling; energy calculations; run-time totalization; and security access.
    d. Remote communications.
    e. Maintenance management.
    f. Units of Measure: Inch-pound and SI (metric).

4. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
5. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.

I. Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.

1. Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.
2. Stand-alone mode control functions operate regardless of network status. Functions include the following:

    a. Global communications.
    b. Discrete/digital, analog, and pulse I/O.
    c. Monitoring, controlling, or addressing data points.

3. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
4. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.

J. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.

1. Binary Inputs: Allow monitoring of on-off signals without external power.
2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
3. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.
4. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation with three-position (on-off-auto) override switches and status lights.
5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA) with status lights, two-position (auto-manual) switch, and manually adjustable potentiometer.
6. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.
7. Universal I/Os: Provide software selectable binary or analog outputs.

K. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:

1. Output ripple of 5.0 mV maximum peak to peak.
2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.

L. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:

1. Minimum dielectric strength of 1000 V.
2. Maximum response time of 10 nanoseconds.
3. Minimum transverse-mode noise attenuation of 65 dB.
4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

2.3 UNITARY CONTROLLERS

A. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.

1. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 72-hour battery backup.
2. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform scheduling with real-time clock. Perform automatic system diagnostics; monitor system and report failures.
3. ASHRAE 135 Compliance: Communicate using read (execute and initiate) and write (execute and initiate) property services defined in ASHRAE 135. Reside on network using MS/TP datalink/physical layer protocol and have service communication port for connection to diagnostic terminal unit.
4. Enclosure: Dustproof rated for operation at 32 to 120 deg F.

2.4 ANALOG CONTROLLERS

A. Step Controllers: 6- or 10-stage type, with heavy-duty switching rated to handle loads and operated by electric motor.

B. Electric, Outdoor-Reset Controllers: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range, adjustable set point, scale range minus 10 to plus 70 deg F, and single- or double-pole contacts.

C. Electronic Controllers: Wheatstone-bridge-amplifier type, in steel enclosure with provision for remote-resistance readjustment. Identify adjustments on controllers, including proportional band and authority.

1. Single controllers can be integral with control motor if provided with accessible control readjustment potentiometer.

D. Fan-Speed Controllers: Solid-state model providing field-adjustable proportional control of motor speed from maximum to minimum of 55 percent and on-off action below minimum fan speed. Controller shall briefly apply full voltage, when motor is started, to rapidly bring motor up to minimum speed. Equip with filtered circuit to eliminate radio interference.

E. Receiver Controllers: Single- or multiple-input models with control-point adjustment, direct or reverse acting with mechanical set-point adjustment with locking device, proportional band adjustment, authority adjustment, and proportional control mode.

1. Remote-control-point adjustment shall be plus or minus 20 percent of sensor span, input signal of 3 to 13 psig.
2. Proportional band shall extend from 2 to 20 percent for 5 psig.
3. Authority shall be 20 to 200 percent.

4. Air-supply pressure of 18 psig, input signal of 3 to 15 psig, and output signal of zero to supply pressure.
5. Gages: 2-1/2 inches in diameter, 2.5 percent wide-scale accuracy, and range to match transmitter input or output pressure.

2.5 TIME CLOCKS

A. Manufacturers:
1. Precision Controls, Inc.
2. Approved equal.

B. Solid-state, programmable time control with 8 separate programs each with up to 100 on-off operations; 1-second resolution; lithium battery backup; keyboard interface and manual override; individual on-off-auto switches for each program; 365-day calendar with 20 programmable holidays; choice of fail-safe operation for each program; system fault alarm; and communications package allowing networking of time controls and programming from PC.

2.6 ELECTRONIC SENSORS

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

B. Thermistor Temperature Sensors and Transmitters:

1. Manufacturers:

a. ACI
b. BEC Controls Corporation.
c. Ebtron, Inc.
d. Heat-Timer Corporation.
e. I.T.M. Instruments Inc.
f. Johnson Controls
g. MAMAC Systems, Inc.
h. RDF Corporation.
i. Trane.

2. Accuracy: Plus or minus 0.5 deg F at calibration point.
3. Wire: Twisted, shielded-pair cable.
4. Insertion Elements in Ducts: Single point, 8 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft..
5. Averaging Elements in Ducts: 36 inches long, flexible; use where prone to temperature stratification or where ducts are larger than 10 sq. ft..
6. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches.
7. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
8. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.

C. RTDs and Transmitters:

1. Manufacturers:

a. BEC Controls Corporation.
b. MAMAC Systems, Inc.
c. Johnson Controls
d. RDF Corporation.
e. Trane.

2. Accuracy: Plus or minus 0.2 percent at calibration point.
3. Wire: Twisted, shielded-pair cable.
4. Insertion Elements in Ducts: Single point, 8 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft..
5. Averaging Elements in Ducts: 24 feet long, flexible; use where prone to temperature stratification or where ducts are larger than 9 sq. ft.; length as required.
6. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches.
7. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
8. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.

D. Humidity Sensors: Bulk polymer sensor element.

1. Manufacturers:

a. ACI
b. BEC Controls Corporation.
c. General Eastern Instruments.
d. Johnson Controls
e. MAMAC Systems, Inc.
f. ROTRONIC Instrument Corp.
g. TCS/Basys Controls.
h. Vaisala.
i. Trane.

2. Accuracy: 2 percent full range with linear output.
3. Room Sensor Range: 20 to 80 percent relative humidity.
4. Duct Sensor: 20 to 80 percent relative humidity range with element guard and mounting plate.
5. Outside-Air Sensor: 20 to 80 percent relative humidity range with mounting enclosure, suitable for operation at outdoor temperatures of minus 22 to plus 185 deg F.
6. Duct and Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.

E. Pressure Transmitters/Transducers:

1. Manufacturers:

a. ACI
b. BEC Controls Corporation.
c. General Eastern Instruments.
d. Johnson Controls.
e. MAMAC Systems, Inc.
f. ROTRONIC Instrument Corp.
g. TCS/Basys Controls.
h. Vaisala.
i. Veris.

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

a. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
b. Output: 4 to 20 mA.
c. Building Static-Pressure Range: 0- to 0.25-inch wg.
d. Duct Static-Pressure Range: 0- to 5-inch wg.

3. Water Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure; linear output 4 to 20 mA.
4. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure and tested to 300-psig; linear output 4 to 20 mA.
5. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.
6. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; linear output 4 to 20 mA.

F. Room Sensor Cover Construction: Manufacturer's standard locking covers.

1. Set-Point Adjustment: Concealed.
2. Set-Point Indication: Concealed.
3. Thermometer: Concealed.
4. Color: To be selected by architect from manufacturers standard colors.
5. Orientation: Horizontal.

G. Room sensor accessories include the following:

1. Insulating Bases: For sensors located on exterior walls.
2. Guards: Locking, solid metal, ventilated.
3. Adjusting Key: As required for calibration and cover screws.

2.7 STATUS SENSORS

A. Status Inputs for Fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch wg.

B. Status Inputs for Pumps: Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range of 8 to 60 psig, piped across pump.

C. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.

D. Voltage Transmitter (100- to 600-V ac): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.

E. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.

F. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.

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

H. Water-Flow Switches: Bellows-actuated mercury or snap-acting type with pilot-duty rating, stainless-steel or bronze paddle, with appropriate range and differential adjustment, in NEMA 250, Type 1 enclosure.

1. Manufacturers:

a. BEC Controls Corporation.
b. I.T.M. Instruments Inc.

2.8 GAS DETECTION EQUIPMENT

A. Manufacturers:

1. B. W. Technologies.
2. CEA Instruments, Inc.
3. Ebtron, Inc.
4. Gems Sensors Inc.
5. Greystone Energy Systems Inc.
6. INTEC Controls, Inc.
7. I.T.M. Instruments Inc.
8. Johnson Controls
9. MSA Canada Inc.
10. QEL/Quatrosense Environmental Limited.
11. Sauter Controls Corporation.
12. Sensidyne, Inc.
13. TSI Incorporated.
14. Vaisala.
15. Vulcain Inc.

B. Carbon Monoxide Detectors: Single or multichannel, dual-level detectors using solid-state plug-in sensors with a 3-year minimum life; suitable over a temperature range of 32 to 104 deg F; with 2 factory-calibrated alarm levels at 35 and 200 ppm.

C. Carbon Dioxide Sensor and Transmitter: Single detectors using solid-state infrared sensors; suitable over a temperature range of 23 to 130 deg F and calibrated for 0 to 2 percent, with continuous or averaged reading, 4- to 20-mA output;, for wall mounting.

2.9 THERMOSTATS

A. Manufacturers:

1. Erie Controls.
2. Danfoss Inc.; Air-Conditioning and Refrigeration Div.
3. Johnson Controls
4. Sauter Controls Corporation.
5. tekmar Control Systems, Inc.
6. Theben AG - Lumilite Control Technology, Inc.
7. Trane.

B. Low-Voltage, On-Off Thermostats: NEMA DC 3, 24-V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed set-point adjustment, 55 to 85 deg F set-point range, and 2 deg F maximum differential.

C. Line-Voltage, On-Off Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch or equivalent solid-state type, with heat anticipator; listed for electrical rating; with concealed set-point adjustment, 55 to 85 deg F set-point range, and 2 deg F maximum differential.

1. Electric Heating Thermostats: Equip with off position on dial wired to break ungrounded conductors.
2. Selector Switch: Integral, manual on-off-auto.

D. Lockable Thermostat Covers: Metal Thermostat Guard, probe resistant, with lockable cover for installation in security areas as indicated on the Construction Drawings.

E. Remote-Bulb Thermostats: On-off or modulating type, liquid filled to compensate for changes in ambient temperature; with copper capillary and bulb, unless otherwise indicated.

1. Bulbs in water lines with separate wells of same material as bulb.
2. Bulbs in air ducts with flanges and shields.
3. Averaging Elements: Copper tubing with either single- or multiple-unit elements, extended to cover full width of duct or unit; adequately supported.
4. Scale settings and differential settings are clearly visible and adjustable from front of instrument.
5. On-Off Thermostat: With precision snap switches and with electrical ratings required by application.

6. Modulating Thermostats: Construct so complete potentiometer coil and wiper assembly is removable for inspection or replacement without disturbing calibration of instrument.

F. Immersion Thermostat: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range and adjustable set point.

G. Airstream Thermostats: Two-pipe, fully proportional, single-temperature type; with adjustable set point in middle of range, adjustable throttling range, plug-in test fitting or permanent pressure gage, remote bulb, bimetal rod and tube, or averaging element.

H. Electric, Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic- reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or below set point.

1. Bulb Length: Minimum 20 feet.
2. Quantity: One thermostat for every 20 sq. ft. of coil surface.

I. Electric, High-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic- reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or above set point.

1. Bulb Length: Minimum 20 feet.
2. Quantity: One thermostat for every 20 sq. ft. of coil surface.

J. Heating/Cooling Valve-Top Thermostats: Proportional acting for proportional flow, with molded-rubber diaphragm, remote-bulb liquid-filled element, direct and reverse acting at minimum shutoff pressure of 25 psig, and cast housing with position indicator and adjusting knob.

2.10 HUMIDISTATS

A. Manufacturers:

1. MAMAC Systems, Inc.
2. Johnson Controls
3. ROTRONIC Instrument Corp.
4. Trane.

B. Duct-Mounting Humidistats: Electric insertion, 2-position type with adjustable, 2 percent throttling range, 20 to 80 percent operating range, and single- or double-pole contacts.

2.11 ACTUATORS

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

1. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
2. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
3. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
4. Spring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running and breakaway torque of 150 in. x lbf.
5. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
6. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.

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

1. Manufacturers:
   a. Belimo Aircontrols (USA), Inc.
   b. Johnson Controls
   c. Or approved equal

2. Actuators associated with the Smoke Control System shall meet all required stated in Part 2.1 of this specification and all applicable codes.

3. Valves: Size for torque required for valve close off at maximum pump differential pressure.
4. Dampers: Size for running torque calculated as follows:

   a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
   b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
   c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft of damper.
   d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.
   e. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.
   f. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.

5. Coupling: V-bolt and V-shaped, toothed cradle.
6. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
7. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
8. Power Requirements (Two-Position Spring Return): 24-V ac.
9. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
10. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
11. Temperature Rating: 40 to 104 deg F.

12. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F.
13. Run Time: 12 seconds open, 5 seconds closed.

2.12 CONTROL VALVES

A. Manufacturers:

1. Belimo.
2. Danfoss Inc.; Air Conditioning & Refrigeration Div.
3. Erie Controls.
4. Hayward Industrial Products, Inc.
5. Johnson Controls
6. Magnatrol Valve Corporation.
7. Neles-Jamesbury.
8. Parker Hannifin Corporation; Skinner Valve Division.
9. Sauter Controls Corporation.

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

C. Hydronic system globe valves shall have the following characteristics:

1. NPS 2 and Smaller: Class 125 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure.
2. NPS 2-1/2 and Larger: Class 125 iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.
3. Internal Construction: Replaceable plugs and stainless-steel or brass seats.

    a. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom.
    b. Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom.

4. Sizing: 5-psig maximum pressure drop at design flow rate or the following:

    a. Two Position: Line size.
    b. Two-Way Modulating: Either the value specified above or twice the load pressure drop, whichever is more.

5. Flow Characteristics: Two-way valves shall have equal percentage characteristics.
6. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system (pump) head for two-way valves and 100 percent of pressure differential across valve or 100 percent of total system (pump) head.

D. Butterfly Valves: 200-psig, 150-psig maximum pressure differential, ASTM A 126 cast-iron or ASTM A 536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals.

1. Body Style: Wafer.
2. Disc Type: Nickel-plated ductile iron.
3. Sizing: 1-psig maximum pressure drop at design flow rate.

E. Terminal Unit Control Valves: Bronze body, bronze trim, two or three ports as indicated, replaceable plugs and seats, and union and threaded ends.

1. Rating: Class 125 for service at 125 psig and 250 deg F operating conditions.
2. Sizing: 3-psig maximum pressure drop at design flow rate, to close against pump shutoff head.
3. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.

F. Self-Contained Control Valves: Bronze body, bronze trim, two or three ports as indicated, replaceable plugs and seats, and union and threaded ends.

1. Rating: Class 125 for service at 125 psig and 250 deg F operating conditions.
2. Thermostatic Operator: Wax-filled integral sensor with integral adjustable dial.

2.13 DAMPERS

A. Manufacturers:

1. Air Balance Inc.
2. Don Park Inc.; Autodamp Div.
3. Greenheck.
4. Johnson Controls
5. Ruskin.
6. TAMCO (T. A. Morrison & Co. Inc.).
7. United Enertech Corp.
8. Vent Products Company, Inc.

B. Dampers: AMCA-rated, opposed-blade design; 0.108-inch-minimum thick, galvanized-steel or 0.125-inch-minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-inch-thick galvanized steel with maximum blade width of 8 inches and length of 48 inches.

1. Secure blades to 1/2-inch-diameter, zinc-plated axles using zinc-plated hardware, with oil-impregnated sintered bronze blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
2. Operating Temperature Range: From minus 40 to plus 200 deg F.
3. Edge Seals, Standard Pressure Applications: Closed-cell neoprene.

C. Dampers associated with the smoke control system shall meet all requirements indicated in Part 2.1 of this specification and all applicable codes.

2.14 CONTROL CABLE

A. Electronic and fiber-optic cables for control wiring are specified in Division 27 Section "Communications Copper Horizontal Cabling."

B. All control cable associated with the Smoke Control System shall be in conduit.

PART 3 - EXECUTION

3.1 EXAMINATION

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

B. Verify that duct-, pipe-, and equipment-mounted devices are installed before proceeding with installation.

3.2 INSTALLATION

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

B. Connect and configure equipment and software to achieve sequence of operation indicated on drawings.

C. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches above the floor.

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

D. Install guards on thermostats in the following locations:

1. Entrances.
2. Public areas.
3. Where indicated.

E. Install automatic dampers according to Division 23 Section "Air Duct Accessories."

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

G. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."

H. Install hydronic instrument wells, valves, and other accessories according to Division 23 Section "Hydronic Piping."

I. Install duct volume-control dampers according to Division 23 Sections specifying air ducts.

J. Install electronic and fiber-optic cables according to Division 27 Section "Communications Horizontal Copper Cabling."

3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Install raceways, boxes, and cabinets according to Division 26 Section "Raceway and Boxes for Electrical Systems."

B. Install building wire and cable according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Install signal and communication cable according to Division 27 Section "Communications Horizontal Copper Cabling."

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 multiconductor 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.
7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.

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

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

F. All wiring associated with the Smoke Control System shall be in conduit.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

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

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

C. DDC Verification:

1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
2. Check instruments for proper location and accessibility.
3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
4. Check instrument tubing for proper fittings, slope, material, and support.
5. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.
6. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
7. Check temperature instruments and material and length of sensing elements.
8. Check control valves. Verify that they are in correct direction.
9. 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.

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

3.5 ADJUSTING

A. Calibrating and Adjusting:

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

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

5. Flow:

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

6. Pressure:

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

7. Temperature:

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

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

B. Adjust initial temperature and humidity set points.

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

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Division 01 Section "Demonstration and Training."

B. All training shall be videotaped.

END OF SECTION 230923