ADDENDUM NO. 02

February 6, 2025

Renovation of Fall Creek Intermediate School
12011 Olio Road
Fishers, IN 46038

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 6, 2025, by krM Architecture. 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 Pages ADD 2-1 through ADD 2-2 and attached krM Architecture Addendum No. 2 dated February 6, 2025, consisting of six pages of Architectural narrative, one page of Civil narrative, two pages of MEP narrative, revised specification section 230923 – Direct Digital Control (DDC) System for HVAC, and 18 Drawing Sheets.

A. SECTION 00 31 00 – BID FORM

1. Replace this specification in entirety with version included as part of this Addendum 02 to include updated list of Alternates.

B. SECTION 01 12 00 – MULTIPLE CONTRACT SUMMARY

1. Replace this specification in entirety with version included as part of this Addendum 02. Specific items that have been updated are highlighted within the specification section.

C. SECTION 01 23 00 – BID ALTERNATES

1. Replace this specification in entirety with version included as part of this Addendum 02.

D. SECTION 01 32 00 – SCHEDULES AND REPORTS

1. A Guideline Schedule is included as part of this Addendum 02 for reference by all Contractors.

CONTRACTOR'S BID FOR PUBLIC WORKS FORM NO. 96

Format (Revised 2013)
(Amended for HSE)

Renovation of Fall Creek Intermediate School

(Hamilton Southeastern Schools)
(Hamilton County, Indiana)

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)

Of public works project, **Renovation of Fall Creek Intermediate School**, in accordance with Plans and Specifications prepared by ***krM Architecture, 1020 Jackson Street, Anderson, IN 46016***, 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 bases, 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 – Exterior Window Replacement

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

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

Alternate Bid No. 2 – Air Handling Unit Replacement

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

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

Alternate Bid No. 3 – Replacement of Gas Boilers

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

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

Alternate Bid No. 4 – Provide Instrumentation and Controls

4a. Provide Instrumentation and Controls by Alerton – Installed by Open Control Systems.

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

_____DOLLARS ($_____) ADD DEDUCT

(sum in figures)

4b. Provide Instrumentation and Controls by Johnson Controls – Installed by JCI.

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

_____DOLLARS ($_____) ADD DEDUCT

(sum in figures)

4c. Provide Instrumentation and Controls by Siemens – Installed by Grantham.

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

_____DOLLARS ($_____) ADD DEDUCT

(sum in figures)

4d. Provide Instrumentation and Controls by Siemens (Disego) – Installed by local Branch.

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

_____DOLLARS ($_____) ADD DEDUCT

(sum in figures)

4e. Provide Instrumentation and Controls by TRANE – Installed by local Branch.

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

_____DOLLARS ($_____) ADD DEDUCT

(sum in figures)

Alternate Bid No. 5 – Air-Handling Unit Manufacturer

5a. Provide add or deduct to provide Trane AHUs for base bid work.

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

_____DOLLARS ($_____) ADD DEDUCT

(sum in figures)

5b. Provide add or deduct to provide Trane AHUs for work in Alternate No. 02 (AHUs #04, #05, #06 & #07)

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 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 required 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

SECTION 01 12 00 - MULTIPLE CONTRACT SUMMARY

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of the Sub Contract, including amended General Conditions and other Division 1 Specification Sections, apply to Work of this Section.

1.02 SUMMARY

A. The intent of this Section is to indicate the Work required by the Subcontractors and to provide information regarding the duties, responsibilities, and cooperation required by the Contractors, with similar requirements for the subcontractors and suppliers.

B. Owners right to maintain current operations

C. Occupancy requirements

D. Work by Owner

E. Permits, fees, and notices

F. Labor and materials

G. Verifications of existing dimensions

H. Project security

I. Coordination of work

J. Time of commencement and completion

K. Schedule of contract responsibilities

1.03 WORK UNDER SEPARATE CONTRACTS

A. Sub Contracts are defined to include the following contracts described in the Schedule of Contract Responsibilities included hereinafter; and each is recognized to be a major part of the project, with Work to be performed concurrently and in close coordination with Work of other Sub Contracts.

B. The "Contract Documents," as defined in the General Conditions, include "the Drawings." Although Drawings are grouped and identified by classification of the Work, Contractors shall be responsible for their Work as specified herein and as indicated on the Drawings. Although the majority of the Drawings are "to scale," Contractors are directed to use indicated dimensions for determining material quantities and for other

reasons. No additional monies will be allowed due to Contractors using "scaling instruments" to determine material quantities or for other reasons.

C. Separate Sub contracts will be awarded as per the **"Schedule of Contract Responsibilities"** (see Part 3 – Execution). Subcontractors shall include Work required by the Specifications and Drawings for each contract area defined in the Schedule.

D. Work for the complete construction of the Project will be under multiple Sub contracts with the Owner. The Construction Manager will manage the construction of the Project.

E. Each Subcontractor shall be responsible for demolition and disposal of existing items relative to his Contract.

1.04 ADMINISTRATIVE RESPONSIBILITIES OF SUB CONTRACTORS AND CM

A. The Construction Manager shall be responsible for the maintenance of the Construction Schedule and management of every phase of the Work.
   1. Each Subcontractor shall read the Specifications and Drawings for other separate Contracts for fixed equipment and the like to be incorporated or attached or built in to the Work; and familiarize himself with the requirements and responsibilities of other Contracts to enable the required coordination and supervision.
   2. Each Subcontractor shall also familiarize himself with other items to be incorporated into the Work including equipment and Work by the Owner.
   1. Each Subcontractor shall cooperate with the Construction Manager in notifying him when the Work is at a stage to require the services of other Subcontractors and shall notify the Construction Manager in the event that such other Contractors do not carry out their responsibilities in connection with such notification.

B. Subcontractors shall cooperate with and assist the Construction Manager in the preparation of construction progress and procedures, schedule of product deliveries, and their effect on the overall project progress and completion. Other Subcontractors shall cooperate in getting their Work and the Work of their subcontractors completed according to the schedule as prepared and maintained by the Construction Manager. Each Subcontractor shall immediately notify the Construction Manager of a delay in delivery of products or the scheduled date of completion that may affect the total progress of construction.

C. The Owner will furnish the topographical survey, either as a part of these Drawings or separately, giving the general topographical lines existing at the site and the property lines.

D. Subcontractors required to make connections to existing utilities, especially sewerage where gravity flow occurs, shall verify grades and locations at points of such connections and shall notify the Construction Manager of circumstances which would adversely affect the proper flow or connection to such facilities.

1.05 SUB CONTRACTORS USE OF PREMISES

A. Subcontractors must expend their best effort toward protection of the health, safety, and welfare of occupants on the Owner's property during the course of Work on this Project.

1.06 OWNERS RIGHT TO MAINTAIN OPERATIONS

A. Subcontractors must expend their best effort toward protection of the health, safety, and welfare of occupants on the Owner's property during the course of Work on this Project.

B. Subcontractors shall be subject to such rules and regulations for the conduct of the Work as the Owner may establish. Employees shall be properly and completely clothed while working. Bare torsos, legs and feet will not be allowed. Possession or consumption of alcoholic beverages or drugs, tobacco, and other noxious behavior on the site is strictly prohibited. Violators shall be promptly removed from the site. Smoking is not permitted on the project site.

1.07 OCCUPANCY REQUIREMENTS

A. Partial Owner Occupancy: The Owner reserves the right to occupy and to place and install equipment in completed areas of the building prior to Substantial Completion, provided such occupancy does not interfere with completion of the Work. Such placing of equipment and partial occupancy shall not constitute acceptance of the total Work.
   1. The Construction Manager will prepare a Certificate of Substantial Completion for each specific portion of the Work to be occupied prior to Owner occupancy.
   2. The Construction Manager will obtain a Certificate of Occupancy from local building officials prior to Owner occupancy.
   3. Prior to partial Owner occupancy, mechanical and electrical systems shall be fully operational. Required inspections and tests shall have been successfully completed. Upon occupancy, the Owner will operate and maintain mechanical and electrical systems serving occupied portions of the building.
   4. Upon occupancy, the Owner will assume responsibility for maintenance and custodial service for occupied portions of the building.

1.08 WORK BY OWNER

A. The Owner intends to complete the following items of Work outside the provisions of these Contract Documents. Subcontractors shall not restrict or interfere with the Owner's right to the Project to accomplish this Work.
   1. Equipment and furniture except as scheduled and specified under Divisions 6, 11 and 12 and shown on the Drawings.
   2. Items which may be deleted from Contracts for Work as required by the Contract Documents.
   3. The purchase and supplying of certain materials as noted in the Project Manual.

1.09 PERMITS, FEES, AND NOTICES

A. The Construction Manager will secure the general building permit for the Owner. Each Subcontractor shall secure and pay for other permits, governmental fees, and licenses necessary for the proper execution and completion of his Work, which are applicable at the time the bids are also received. Fees to relocate utilities on Owner's property shall be included in the bid of the Subcontractor doing the relocation.

1. State filing fees for plan approval are the responsibility of the Owner and will be paid by the Owner.

B. Utility Tie-Ins: Shall be arranged with local utility company and other involved parties for minimum interruption of service.

C. Shutdowns of existing systems shall be limited to minimum time required and scheduled with other involved parties. Provide 2 days written notice of shutdown to Construction Manager and Owner.

D. Inspections of installed work shall be performed by the governing authority as arranged for by the Contractor. Work shall not be covered until approved.

E. Each Subcontractor shall give notices and comply with laws, ordinances, rules, regulations, and orders of public authorities bearing on the performance of his Work. If a Subcontractor observes that the Contract Documents are at variance therewith, he shall promptly notify the Construction Manager in writing, and necessary changes shall be adjusted by appropriate notification. If a Subcontractor performs Work knowing it to be contrary to such laws, ordinances, rules, and regulations, and without such notice to the Construction Manager, he shall assume full responsibility therefore and shall bear the costs attributable thereto.

1.10 LABOR AND MATERIALS

a. Unless otherwise specifically noted, the Subcontractor shall provide and pay for labor, materials, equipment, tools, construction equipment and machinery, water, heat, utilities, transportation, and other facilities and services necessary for the proper execution and completion of his Work, whether temporary or permanent and whether or not incorporated or to be incorporated in the Work.

b. Each Subcontractor shall enforce strict discipline and good order among his employees or other persons carrying out Work of his Contract and shall not permit employment of unfit person or persons or anyone not skilled in the task assigned to them.

c. E-Verify Compliance: Pursuant to I.C. 22-5-1.7, Subcontractor shall enroll in and verify the work eligibility status of all newly hired employees of Subcontractor through the E-Verify Program (Program). Subcontractor is not required to verify the work eligibility status of all newly hired employees through the Program if the Program no longer exists. Also pursuant to I.C. 22-5-1.7, Subcontractor must execute an affidavit affirming that the Subcontractor does not knowingly employ an unauthorized alien and confirming Subcontractor’s enrollment in the Program, unless

the Program no longer exists, shall be filed with the Owner prior to the execution of this contract. This contract shall not be deemed fully executed until such affidavit is delivered to the Construction Manager.

d. The Owner is requiring that all contractors' personnel and their onsite employees (trade employees) and subcontractors submit an expanded criminal history check through SafeVendor, a product of Safe Hiring Solutions. Please visit www.safevisitorsolutions.com/safevendor-app-agreement to create your account with SafeVendor. (Contractor is responsible for the cost of this background check). This should meet with the Owner's approval prior to the employee starting work on the project. All contractors' personnel and employees once cleared for work will be issued a project identification badge that must be worn at all times while on site. All contractors will be expected to provide the required name, address, picture state driver's license or picture state identification card information to The Skillman Corporation Site Manager no later than 24 hours in advance of the employee coming to work at the project site.

1.11 CUTTING AND PATCHING

A. Refer to Section 01 73 10 – Cutting and Patching, for provisions on this subject.

1.12 VERIFICATIONS OF EXISTING DIMENSIONS

A. When verification of existing dimensions is required, the Subcontractor requiring said verification for the construction or fabrication of his material shall be the Subcontractor responsible for the procurement of the field information.

1.13 PROJECT SECURITY

A. Each Sub Contractor shall take all reasonable precautions to prevent injury, damage or loss to people and property in, on and adjacent to the project. This shall include not only their own work or property but that of other contractors and the Owner.

B. If deemed necessary by The Construction Manager a project wide security program may be developed for the purpose of preventing damage or loss at the project site or property adjacent thereto. Once accepted by the Owner, Subcontractors shall comply.

1.14 SCHEDULE OF CONTRACT RESPONSIBILITIES - SCOPE

A. Subcontractors shall submit their proposals based on the work included under each contract area as listed herein. Include Work necessary for a complete project, as shown on the Drawings and called for in the Specifications.

B. Questions concerning the phasing or "Schedule of Contract Responsibilities" should be directed to the Construction Manager, who will be the interpreter and be responsible for this Schedule of Contract Responsibilities and Contract Breakdown, prior to submitting proposals and during construction.

C. The requirements of Division 1 are a part of the Work of each and every contract area. The Contractor for any one contract area shall be familiar with the Work and requirements of all other contract areas.

D. Certain Specification Sections describe Work to be performed under several contract areas. (Example: 06100 - Rough Carpentry.) Provide Work of this nature as required for each contract area whether or not enumerated in the Schedule of Contract Responsibilities.

E. The Drawings and Specifications as furnished for each of the Contracts is for the convenience of the Contractor in preparing a proposal for this Project. However, each Contractor is responsible to review the complete set of Drawings and Specifications to assure that Work required to be installed to complete his phase of the Work is included in his proposal. This "Schedule of Contract Responsibilities" is a definition of the work as it is to be bid in separate contracts. Where a specific item of Work is not defined, but is normally inherent to a trade, or is included in the scope of the applicable technical revision, it will be the responsibility of that Contractor to include the Work in his proposal.

F. This "Schedule of Contract Responsibilities" is to aid each Subcontractor in defining the Scope of Work to be included in his proposal. However, omissions from this "Schedule of Responsibilities" do not relieve the Subcontractor from including in his proposal that Work which will be required to complete his Contract. Each Subcontractor should read the "Schedule of Contract Responsibilities" completely to familiarize himself with the Work of other Subcontractors that may have Work in adjacent areas and to coordinate the interfacing problems that may occur as the work is assembled and constructed.

G. Where specific Work is to be completed under a particular phase of the Project and the Work is wholly or partially completed by other trades because of the type of work involved or jurisdictional trade agreements, the Subcontractor will be responsible to subcontract the Work as necessary to complete the Work included in his Contract. No delay in the Work will be allowed due to the failure of the Subcontractor to subcontract related work required by jurisdictional trade agreements.

1.15 COORDINATION OF WORK

A. Each Subcontractor is responsible to coordinate his Work with the Work of other trades and other Subcontractors and requirements of the school system. The Subcontractor must make space allowances for Work of other Contractors; provide necessary openings where indicated or implied by the Drawings and Specifications. Each Subcontractor is responsible to protect his own Work.

1.16 TIME OF COMMENCEMENT AND COMPLETION

A. The Subcontractor shall commence work within ten (10) days after being notified in writing to proceed and shall complete the Work within the time limitations established in the Form of Agreement.
   1. It is anticipated that construction will start within **30** calendar days after receipt of bids.
   2. Construction shall be complete within **760** consecutive calendar days, or earlier, after Notice to Proceed.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 SCHEDULE OF CONTRACT RESPONSIBILITIES

3.02 GENERAL REQUIREMENTS

A. PROVIDED BY THE CONSTRUCTION MANAGER

Section	01 32 00	Schedules and Reports
Section	01 45 10	Testing Laboratory Services
Section	01 59 10	Project Office
Section	01 71 50	Final Cleaning
Section	23 05 93	Testing, Adjusting, and Balancing for HVAC

B. PROVIDED BY ALL CONTRACTORS AS APPLICABLE

Section	00 01 01	Project Title Page
Section	00 01 02	Project Information
Section	01 01 03	Project Summary
Section	01 12 00	Multiple Contract Summary
Section	01 23 00	Alternates
Section	01 25 00	Contract Modification Procedures
Section	01 28 00	Schedule of Values
Section	01 29 00	Applications for Payment
Section	01 31 00	Project Meetings
Section	01 32 00	Schedules and Reports
Section	01 33 00	Submittal Procedures
Section	01 40 00	Quality Requirements
Section	01 45 10	Testing Laboratory Services (Paragraph 1.05)
Section	01 50 50	Temporary Facilities and Controls
Section	01 54 60	Environment Protection
Section	01 54 80	Utility Protection
Section	01 56 30	Water Control
Section	01 56 90	Housekeeping & Safety
Section	01 59 20	Offices and Sheds
Section	01 60 00	Product Requirements
Section	01 72 50	Work Layout

Section	01 73 10	Cutting and Patching
Section	01 77 00	Contract Closeout

All Subcontractors shall provide their Superintendents with radios capable of handling multiple channels and compatible with radios used by the Construction Manager.

Autodesk Build is replacing **PlanGrid**. **Autodesk Build** does not require users to purchase a license. **Contractors** will be invited to the project and required to use this tool. **Autodesk Build** will be used as the **Current Set** and **As-Built Record Drawings.** Additionally, it will be used to track **Issues** for **Safety**, **QA/QC**, **Non-Compliance Issues**, **Work Completion List** and **Punch List**.

C. PROVIDED BY DESIGNATED CONTRACTORS

Section	01 51 10	Temporary Electricity, Lighting and Warning Systems
Section	01 51 30	Temporary Heating, Ventilation and Cooling
Section	01 51 50	Temporary Water
Section	01 51 60	Temporary Sanitary Facilities
Section	01 51 80	Temporary Fire Protection
Section	01 52 10	Construction Aids and Temporary Enclosures
Section	01 52 60	Rubbish Container
Section	01 53 10	Fences (Temporary Security)
Section	01 53 20	Tree and Plant Protection
Section	01 53 30	Barricades
Section	01 55 00	Access Roads and Parking Areas
Section	01 56 20	Dust Control
Section	01 56 80	Erosion Control
Section	01 57 60	Project Signs
Section	01 72 00	Field Engineering

3.03 BID CATEGORIES

A. BID CATEGORY NO. 1 – GENERAL TRADES

General Requirements in Paragraph 3.02.B above.

Section	01 51 60	Temporary Sanitary Facilities
Section	01 51 80	Temporary Fire Protection
Section	01 52 10	Construction Aids and Temporary Enclosures
Section	01 52 60	Rubbish Container
Section	01 53 10	Fences (Temporary Security)
Section	01 53 20	Tree and Plant Protection
Section	01 53 30	Barricades
Section	01 54 80	Utility Protection
Section	01 55 00	Access Roads and Parking Areas
Section	01 56 20	Dust Control
Section	01 56 80	Erosion Control
Section	01 57 60	Project Signs
Section	01 72 00	Field Engineering
Section	02 41 00	Demolition

Section	02 41 19	Selective Demolition
Section	03 30 00	Cast-In-Place Concrete
Section	05 12 00	Structural Steel Framing
Section	05 50 00	Metal Fabrications
Section	05 58 13	Metal Column Covers
Section	06 10 00	Rough Carpentry
Section	06 41 00	Architectural Wood Casework (DELETE as part of Add. 01)
Section	07 21 19	Foamed-In-Place Insulation
Section	07 25 00	Weather Barriers
Section	07 42 13	Perforated Metal Panels
Section	07 42 13.19	Insulated Metal Wall Panels
Section	07 62 00	Sheet Metal Flashing and Trim
Section	07 84 00	Firestopping
Section	07 92 00	Joint Sealants
Section	08 11 13	Hollow Metal Doors and Frames
Section	08 14 16	Flush Wood Doors
Section	08 14 33	Stile and Rail Wood Doors
Section	08 31 00	Access Doors and Panels
Section	08 32 00	Sliding Glass Doors (DELETE as part of Add 02)
Section	08 33 13	Coiling Counter Doors
Section	08 33 26	Overhead Coiling Grilles
Section	09 64 67	Wood Gymnasium Floor Finishing
Section	09 67 00	Fluid-Applied Flooring
Section	09 72 00	Wall Covering
Section	10 11 00	Visual Display Units
Section	10 14 16	Plaques
Section	10 21 13.19	Plastic Toilet Compartments
Section	10 21 23	Cubicle Curtains and Track
Section	10 26 00	Wall and Door Protection
Section	10 28 00	Toilet, Bath, and Laundry Accessories
Section	10 44 00	Fire Protection Specialties
Section	10 51 13	Metal Lockers
Section	10 56 17	Wall Mounted Standards and Shelving
Section	11 52 13	Projection Screens
Section	11 66 23	Gymnasium Equipment
Section	11 66 26	Detention Padded Surface Systems
Section	12 24 00	Window Shades
Section	31 20 00	Earthwork
Section	32 12 16	Asphalt Paving
Section	32 13 13	Concrete Paving
Section	32 92 00	Lawns and Grasses
Section	33 41 00	Storm & Sanitary Drainage

Clarifications:

1. General Trades to include all roofing Work. Refer to Note 3 on A3-1.
2. Contractor is responsible to provide all structural, site, and architectural demolition except for specific instances noted in Clarifications of other Bid Categories.

Demolition is to include hauling away from site and legal disposal.

3. Contractor is responsible for Ground Penetrating Radar (or similar technique) to locate all existing in-wall and/or below slab utilities prior to any demolition activity.

4. Contractor is responsible for private utility locates prior to any excavation or earthmoving. In locations where anticipated utility cannot be located, Contractor shall hydro-vacuum excavate to locate unknown utility.
5. Contractor is responsible to supply dumpsters and rubbish containers for all Contractors and Work for duration of the project. Masonry and Metal Stud & Drywall Contractors are to provide their own dumpsters for their Work.
6. Provide road and parking lot cleaning and sweeping for the duration of the project.
7. Provide and maintain all erosion control measures, including all inspections and documentation required by IDEM following rain events.
8. Provide temporary sanitary facilities for all Contractors for duration of project. Placement of sanitary facilities to be coordinated with Construction Manager.
9. Contractor is responsible to provide and maintain concrete washout for all concrete spoils.
10. Contractor is responsible for 07 25 00 membrane as noted in "Sealing Air Leakage Details."
11. Contractor is responsible for removal of existing batt insulation and installation of new 07 21 19 closed cell spray foam as noted in "Sealing Air Leakage Details."
12. Contractor is responsible for removal and replacement of existing sheet metal in select locations to perform work outlined in Clarification 10 & 11 above.
13. Contractor is responsible for 1/4" sheathing as noted in Detail 7 / A6-1. This is applicable in all similar locations.
14. Contractor is responsible for 2" insulated metal soffit panel system noted in Details 9 / A2-8, 4 / A4-5, 7 / A8-3 and 10 / A8-3.
15. Provide temporary laydown area, including stone, as shown on the site logistics plan. Removal and restoration of this space to be included within the bid. Interior and Exterior Logistics Plans to be issued via Addendum.
16. All in wall blocking is the responsibility of the Metal Studs & Drywall Contractor. "Wall blocking" is to be considered any dimensional lumber, sheathing, plywood, danbacking, or similar material. Specific locations of wood products by this Contractor are noted in other clarifications.
17. Contractor is responsible for all blocking and sheathing required for roof system.
18. In locations where clips, sheathing, nailers, etc. are depicted outside of the wall line to support a finish material or product, the Contractor installing the finish material or product is also responsible for all substrate materials. Reference Detail 1 / A6-1 for example of Z-Clip.
19. Contractor is responsible for metal strap blocking associated with interior window shades. Reference typical window shade detail.
20. Contractor is responsible to provide (6) knock down fames with temporary doors and locking hardware for use in temporary partitions as directed by the Construction Manager.
21. Furnish and provide all FRP and Store Front Door hardware to the Aluminum Storefront and Glazing Contractor. This material is to be shipped directly from the supplier to Contractor’s shop.

22. Contractor is responsible for all locations of gutter patch and/or repair. Reference Detail 2 / A3-1.
23. Plumbing Contractor is responsible for sawcutting and demolition of concrete for plumbing rough-in. Concrete placement is by General Trades. Extent of demolition and pour back depicted on Foundation Demolition Plumbing Plans.
24. Contractor to include sweeping compound and 400 man hours for general building, site cleanup, or other work to be performed by a Skilled Laborer at the direction of Construction Manager.
25. Contractor to include 200 man hours for Skilled Carpenter for use at the discretion of the Construction Manager.
26. Contractor is responsible installation and removal of ¾" plywood protection at gymnasium prior to carpet installation for temporary classrooms. Removal shall include the temporary carpet adhered to the plywood.
27. Contractor is responsible for refinishing of the gymnasium wood flooring.
28. One fully finished classroom in Phase I is to be completed as a mockup for all future classrooms. Other Work in Phase I is not to be delayed while waiting for final mockup review. However, all Contractors shall be prepared for dedicated mobilization(s) or material shipment(s) to ensure the classroom mockup is prioritized.
29. In locations of demolition, General Trades Contractor is responsible for patch, skim coat and refinish of masonry walls, while Metal Studs & Drywall Contractor is responsible for patch, skim coat and refinish of gypsum board walls. General Trades Contractor shall be cautious to limit excessive damage caused by demolition activity. Reference Note #11 on Architectural Floor Plan.
30. Specification section 08 32 00 – Sliding Glass Doors has been removed from this scope of work via Addendum 02.
31. Contractor is responsible for decorative panels (DP-1 through DP-4) noted on A11-1.
32. One full small group nook in Phase I is to be completed as a mockup for all future small group nooks. Other Work in Phase I is not to be delayed while waiting for final mockup review. However, all Contractors shall be prepared for dedicated mobilization(s) or material shipment(s) to ensure this mockup is prioritized with classroom mockup.

B. BID CATEGORY NO. 2 - MASONRY

General Requirements in Paragraph 3.02.B above.

Section	01 52 60	Rubbish Container
Section	04 01 00	Maintenance of Masonry
Section	04 20 00	Unit Masonry
Section	04 43 16	Stone Fabrications
Section	07 19 00	Water Repellents
Section	07 92 00	Joint Sealants

Clarifications:

1. Contractor is responsible to clean existing brick in locations where gutter leaking occurred.
2. Contractor is responsible for spalling brick repair. Reference Detail 2 & 3 / A6-1.
3. Contractor is responsible for replacement of all brick control joints. Reference Plan Legend Notes on A6-1.
4. Contractor is responsible for dumpsters and rubbish containers for own Work.

5. One fully finished classroom in Phase I is to be completed as a mockup for all future classrooms. Other Work in Phase I is not to be delayed while waiting for final mockup review. However, all Contractors shall be prepared for dedicated mobilization(s) or material shipment(s) to ensure the classroom mockup is prioritized.
6. Masonry Contractor is responsible for all work related to recoating existing glazed masonry units. Work is to include brushing, de-glossing, recoating, priming and painting. Reference Plan Notes 12c and 12e on Exterior Elevation Drawings for additional information.
7. One full small group nook in Phase I is to be completed as a mockup for all future small group nooks. Other Work in Phase I is not to be delayed while waiting for final mockup review. However, all Contractors shall be prepared for dedicated mobilization(s) or material shipment(s) to ensure this mockup is prioritized with classroom mockup.

C. BID CATEGORY NO. 3 – METAL STUDS & DRYWALL

General Requirements in Paragraph 3.02.B above.

Section	01 52 60	Rubbish Container
Section	02 41 00	Demolition
Section	06 10 00	Rough Carpentry
Section	07 21 00	Thermal Insulation
Section	07 24 00	Exterior Insulation and Finish Systems
Section	07 92 00	Joint Sealants
Section	09 21 16	Gypsum Board Assemblies
Section	09 22 16	Non-Structural Metal Framing
Section	09 51 00	Acoustical Ceilings
Section	09 54 00	Suspended Wood Ceilings
Section	09 84 30	Sound-Absorbing Wall and Ceiling Units

Clarifications:

1. All in wall blocking is the responsibility of the Metal Studs & Drywall Contractor. "Wall blocking" is to be considered any dimensional lumber, sheathing, plywood, danbacking, or similar material.
2. All wall blocking is to be coordinated with MEP Contractors to ensure rough-in routing is maintained.
3. Contractor is responsible for demolition of existing materials and installation of fire treated blocking within wall cavity as shown in casework details.
4. All wall blocking for items such as casework, restroom accessories, furniture, electronics, etc. is to be installed following review and coordination with approved submittals and shop drawings.
5. Contractor is responsible for wood blocking noted for light pocket in Details 1 & 16 / A2-7 and shall coordinate with Electrical Contractor.
6. In locations where clips, sheathing, nailers, etc. are depicted outside of the wall line to support a finish material or product, the Contractor installing the finish material or product is also responsible for all substrate materials. Reference Detail 1 / A6-1 for example of Z-Clip.
7. Contractor is responsible for dumpsters and rubbish containers for own Work.
8. Contractor is responsible for all joint sealants for complete EIFS system.
9. Contractor to include 250 man hours by Skilled Carpenter for use at discretion of the Construction Manager.

10. Contractor to include 250 man hours by Skilled Drywall Finisher for use at discretion of the Construction Manager.
11. Contractor to include 5,000 SF ACT-1 materials and installation for use at discretion of the Construction Manager.
12. Contractor is responsible for temporary interior partitions as noted on interior phasing and/or interior logistics plans. Basis of design is finish floor to deck 3-5/8" metal stud, 5/8" drywall both sides with cavity filled with sound batt insulation. Owner occupied side of wall is to be taped. Interior Logistics Plan to be issued via Addendum.
13. One fully finished classroom in Phase I is to be completed as a mockup for all future classrooms. Other Work in Phase I is not to be delayed while waiting for final mockup review. However, all Contractors shall be prepared for dedicated mobilization(s) or material shipment(s) to ensure the classroom mockup is prioritized.
14. In locations of demolition, General Trades Contractor is responsible for patch, skim coat and refinish of masonry walls, while Metal Studs & Drywall Contractor is responsible for patch, skim coat and refinish of gypsum board walls. General Trades Contractor shall be cautious to limit excessive damage caused by demolition activity. Reference Note #11 on Architectural Floor Plan.
15. Painting Contractor is responsible for cleaning, preparing and painting existing EIFS. Metal Studs and Drywall Contractor is responsible for patching existing EIFS and installing new EIFS. Reference Exterior Elevation Plans.
16. Metal Stud and Drywall Contractor is responsible for the tile backer board at all tiling locations. Reference Specification Section 09 30 00 – Tiling for additional information, specifically paragraph 2.02 – Accessory Materials.
17. Metal Stud and Drywall Contractor is responsible for galvanized metal stud bracing at the 2" metal soffit panel system noted in Details 9 / A2-8, 4 / A4-5, 7 / A8-3 and 10 / A8-3.
18. One full small group nook in Phase I is to be completed as a mockup for all future small group nooks. Other Work in Phase I is not to be delayed while waiting for final mockup review. However, all Contractors shall be prepared for dedicated mobilization(s) or material shipment(s) to ensure this mockup is prioritized with classroom mockup.
19. In locations where Architectural Floor Plan Note #11 is applicable, it is to be assumed that wall material is gypsum board and not plaster in all locations.
20. For bidding purposes, Contractor shall plan for spray applied level five finish as noted in specifications 09 21 16 – Gypsum Board Assemblies Paragraph 3.04.C.
21. Reflected Ceiling Plan Note #29 on Drawing A2-6 is to be incorporated as part of Alternate No. 02.

D. BID CATEGORY NO. 4 – ALUMINUM STOREFRONT & GLAZING

General Requirements in Paragraph 3.02.B above.

Section	01 52 10	Construction Aids and Temporary Enclosures
Section	06 10 00	Rough Carpentry
Section	07 25 00	Weather Barriers
Section	07 92 00	Joint Sealants
Section	08 43 13	Aluminum-Frames Storefronts
Section	08 44 13	Glazed Aluminum Curtain Walls

Section	08 45 23	Fiberglass-Sandwich-Panel Assemblies
Section	08 63 00	Metal-Framed Skylights
Section	08 71 00	Door Hardware
Section	08 80 00	Glazing
Section	08 32 00	Sliding Glass Doors (ADD as part of Add 02)

Clarifications:

1. Contractor is responsible for demolition and temporary enclosure at all window openings. Intent is for Contractor to replace windows one for one in entirety to ensure building remains weather tight. Reference Construction Aids and Temporary Enclosures.
2. Contractor is responsible for shims, aluminum sill, aluminum flashing, and all interior/exterior backer rod and sealant at all window locations.
3. Contractor is responsible for treated 1x lumber below aluminum sill at all window locations per typical details.
4. Contractor is responsible for complete skylight system. Work to include, but not limited to: demolition of existing materials, new skylight system, sealants, aluminum flashings, tapes and/or waterproof membranes, 2x framing/blocking and all fasteners and/or anchors.
5. Contractor is responsible to install all aluminum door hardware furnished by the General Trades Contractor.
6. Include access control/electrified door hardware wiring internal to aluminum door frames, to accessible ceiling.
7. Contractor is responsible for interior and exterior sealant at perimeter of all aluminum frames.
8. Contractor is responsible for all membrane tape at all storefront and curtainwall locations. Reference typical details.
9. One fully finished classroom in Phase I is to be completed as a mockup for all future classrooms. Other Work in Phase I is not to be delayed while waiting for final mockup review. However, all Contractors shall be prepared for dedicated mobilization(s) or material shipment(s) to ensure the classroom mockup is prioritized.
10. Specification section 08 32 00 – Sliding Glass Doors has been added to this scope of work via Addendum 02.
11. One full small group nook in Phase I is to be completed as a mockup for all future small group nooks. Other Work in Phase I is not to be delayed while waiting for final mockup review. However, all Contractors shall be prepared for dedicated mobilization(s) or material shipment(s) to ensure this mockup is prioritized with classroom mockup.

E. BID CATEGORY NO. 5 - FLOORING

General Requirements in Paragraph 3.02.B above.

Section	07 92 00	Joint Sealants
Section	09 05 61	Common Work Results for Flooring Preparation
Section	09 30 00	Tiling
Section	09 65 00	Resilient Flooring
Section	09 68 13	Tile Carpeting

Clarifications:

1. Include 80 hours of additional floor preparation over above requirements noted in drawings and specifications.
2. Contractor is responsible to install Owner provided carpet tile for temporary classrooms.
3. One fully finished classroom in Phase I is to be completed as a mockup for all future classrooms. Other Work in Phase I is not to be delayed while waiting for final mockup review. However, all Contractors shall be prepared for dedicated mobilization(s) or material shipment(s) to ensure the classroom mockup is prioritized.
4. One full small group nook in Phase I is to be completed as a mockup for all future small group nooks. Other Work in Phase I is not to be delayed while waiting for final mockup review. However, all Contractors shall be prepared for dedicated mobilization(s) or material shipment(s) to ensure this mockup is prioritized with classroom mockup.

F. BID CATEGORY NO. 6 - PAINTING

General requirements in Paragraph 3.02.B above.

Section	05 12 00	Structural Steel Framing (DELETE as part of Add. 02)
Section	05 50 00	Metal Fabrications (DELETE as part of Add. 02)
Section	05 58 13	Metal Column Covers (DELETE as part of Add. 02)
Section	07 24 00	Exterior Insulation and Finish Systems
Section	07 92 00	Joint Sealants
Section	09 91 13	Exterior Painting
Section	09 91 23	Interior Painting
Section	09 96 00	High-Performance Coatings

Clarifications:

1. Contractor to include 400 man hours by Skilled Painter for use at discretion of the Construction Manager.
2. One fully finished classroom in Phase I is to be completed as a mockup for all future classrooms. Other Work in Phase I is not to be delayed while waiting for final mockup review. However, all Contractors shall be prepared for dedicated mobilization(s) or material shipment(s) to ensure the classroom mockup is prioritized.
3. Painting Contractor is responsible for cleaning, preparing and painting existing EIFS. Metal Studs and Drywall Contractor is responsible for patching existing EIFS and installing new EIFS. Reference Exterior Elevation Plans.
4. One full small group nook in Phase I is to be completed as a mockup for all future small group nooks. Other Work in Phase I is not to be delayed while waiting for final mockup review. However, all Contractors shall be prepared for dedicated mobilization(s) or material shipment(s) to ensure this mockup is prioritized with classroom mockup.
5. Delete specification sections 05 12 00 – Structural Steel Framing, 05 50 00 – Metal Fabrications and 05 58 13 – Metal Column Covers from this scope of work as part of Addendum 02.

G. BID CATEGORY NO. 7 - CASEWORK

General Requirements in Paragraph 3.02.B above.

Section	06 10 00	Rough Carpentry
Section	06 41 00	Architectural Wood Casework (ADD as part of Add. 01)
Section	07 92 00	Joint Sealants
Section	12 32 00	Manufactured Wood Casework

Section	12 36 00	Countertops

Clarifications:

1. Contractor to include (2) layers of 3/8" treated plywood at solid surface window sills. Reference typical window sill detail.
2. Contractor is responsible for sealant at all casework and countertop transitions to adjacent materials.
3. In locations where clips, sheathing, nailers, etc. are depicted outside of the wall line to support a finish material or product, the Contractor installing the finish material or product is also responsible for all substrate materials. Reference Detail 1 / A6-1 for example of Z-Clip.
4. Contractor is responsible for wood blocking / shims at base of all casework products.
5. One fully finished classroom in Phase I is to be completed as a mockup for all future classrooms. Other Work in Phase I is not to be delayed while waiting for final mockup review. However, all Contractors shall be prepared for dedicated mobilization(s) or material shipment(s) to ensure the classroom mockup is prioritized.
6. One full small group nook in Phase I is to be completed as a mockup for all future small group nooks. Other Work in Phase I is not to be delayed while waiting for final mockup review. However, all Contractors shall be prepared for dedicated mobilization(s) or material shipment(s) to ensure this mockup is prioritized with classroom mockup.

H. BID CATEGORY NO. 8 – FOOD SERVICE

General Requirements in Paragraph 3.02.B above.

Section	07 84 00	Firestopping
Section	07 92 00	Joint Sealants
Section	11 40 00	Food Service Equipment

Clarifications:

1. All final connections (not integral to food service equipment) shall be made by Electrical, Plumbing, HVAC or Fire Protection Contractors. Coordinate with other Trades as necessary to ensure completion of this work.
2. Provide coordinated shop drawings that indicate all MEPF requirements and accurately reflect the actual conditions and spacing of the area.
3. Obtain approvals and permits and coordinate inspections and testing with governing local and state agencies in relation to this scope of work.
4. Any equipment pads required for food service equipment are the responsibility of this Contractor.
5. One full small group nook in Phase I is to be completed as a mockup for all future small group nooks. Other Work in Phase I is not to be delayed while waiting for final mockup review. However, all Contractors shall be prepared for dedicated mobilization(s) or material shipment(s) to ensure this mockup is prioritized with classroom mockup.

I. BID CATEGORY NO. 9 – FIRE PROTECTION

General Requirements in Paragraph 3.02.B above.

Section	07 84 00	Firestopping
Section	07 92 00	Joint Sealants

Section	21 05 00	Common Work Results for Fire Suppression
Section	21 10 00	Water-Based Fire Protection Systems

Clarifications:

1. Contractor to review interior logistics and/or phasing plan and include any necessary adjustments to building system to accommodate temporary partitions.
2. Contractor is responsible for firestopping of fire protection penetrations only.
3. All wall blocking is to be coordinated with MEP Contractors to ensure rough-in routing is maintained.
4. One fully finished classroom in Phase I is to be completed as a mockup for all future classrooms. Other Work in Phase I is not to be delayed while waiting for final mockup review. However, all Contractors shall be prepared for dedicated mobilization(s) or material shipment(s) to ensure the classroom mockup is prioritized.
5. Contractor is responsible for all sleeves and joints sealants required for their own penetrations.
6. One full small group nook in Phase I is to be completed as a mockup for all future small group nooks. Other Work in Phase I is not to be delayed while waiting for final mockup review. However, all Contractors shall be prepared for dedicated mobilization(s) or material shipment(s) to ensure this mockup is prioritized with classroom mockup.

J. BID CATEGORY NO. 10 – PLUMBING

General Requirements in Paragraph 3.02.B above.

Section	01 51 50	Temporary Water
Section	02 41 00	Demolition
Section	03 30 00	Cast-In-Place Concrete
Section	07 84 00	Firestopping
Section	07 92 00	Joint Sealants
Section	22 05 00	Common Work Results for Plumbing
Section	22 05 19	Meters and Gages for Plumbing Piping
Section	22 05 23	General-Duty Valves for Plumbing Piping
Section	22 05 29	Hangers and Supports for Plumbing Piping and Equipment
Section	22 05 53	Identification for Plumbing Piping and Equipment
Section	22 07 00	Plumbing Insulation
Section	22 11 16	Domestic Water Piping
Section	22 11 19	Domestic Water Piping Specialties
Section	22 11 23	Domestic Water Pumps
Section	22 13 16	Sanitary Waste and Vent Piping
Section	22 13 19	Sanitary Waste Piping Specialties
Section	22 14 13	Storm Drainage Piping
Section	22 31 00	Domestic Water Softeners
Section	22 34 00	Fuel-Fired Water Heaters
Section	22 40 00	Plumbing Fixtures
Section	22 47 00	Drinking Fountains and Water Coolers
Section	22 85 00	Gas-Detection-System

Clarifications:

1. Contractor to include all temporary patching and sealing of roof system for their roof penetrations to ensure watertight conditions during construction.
2. Contractor is responsible for modification of existing and/or new roof curbs for equipment within scope of work.
3. Contractor is responsible for firestopping of plumbing penetrations only.
4. Contractor is responsible for own equipment pads. Where existing pads are shown to increase in size, Contractor shall plan to sawcut and demolish existing slab prior to doweling and pouring extension to equipment pad.
5. Contractor is responsible for saw cutting and demolition of concrete for plumbing rough-in. Concrete placement is by General Trades. Extent of demolition and pour back depicted on Foundation Demolition Plumbing Plans.
6. Contractor is responsible for Ground Penetrating Radar (or similar technique) to locate all existing in-wall and/or below slab utilities prior to any demolition activity.
7. Critical long-lead equipment items are to have all submittals and shop drawings submitted for review within two weeks of Notice to Proceed. Equipment includes, but not limited to: Water Heaters, Hydronic Pumps, Water Softeners, etc.
8. All wall blocking is to be coordinated with MEP Contractors to ensure rough-in routing is maintained.
9. Reference kitchen equipment drawings for plumbing requirements.
10. One fully finished classroom in Phase I is to be completed as a mockup for all future classrooms. Other Work in Phase I is not to be delayed while waiting for final mockup review. However, all Contractors shall be prepared for dedicated mobilization(s) or material shipment(s) to ensure the classroom mockup is prioritized.
11. Contractor shall disregard Note E in the "Valve Replacement Scope of Work." Contractor shall also disregard Notes E and F in the "Pipe Fitting Replacement Scope of Work."
12. Contractor is responsible for all sleeves and joints sealants required for their own penetrations.
13. One full small group nook in Phase I is to be completed as a mockup for all future small group nooks. Other Work in Phase I is not to be delayed while waiting for final mockup review. However, all Contractors shall be prepared for dedicated mobilization(s) or material shipment(s) to ensure this mockup is prioritized with classroom mockup.

K. BID CATEGORY NO. 11 – HVAC

General Requirements in Paragraph 3.02.B above.

Section	01 51 30	Temporary Heating, Ventilation and Cooling
Section	02 41 00	Demolition
Section	03 30 00	Cast-In-Place Concrete
Section	07 84 00	Firestopping
Section	07 92 00	Joint Sealants
Section	23 05 00	Common Work Results for HVAC
Section	23 05 13	Common Motor Requirements for HVAC Equipment
Section	23 05 19	Meters and Gauges for HVAC Piping
Section	23 05 23.11	Globe Valves for HVAC Piping
Section	23 05 23.12	Ball Valves for HVAC Piping
Section	23 05 23.13	Butterfly Valves for HVAC Piping
Section	23 05 23.14	Check Valves for HVAC Piping
Section	23 05 23.15	Gate Valves for HVAC Piping

Section	23 05 29	Hangers and Supports for HVAC Piping And Equipment
Section	23 05 48.13	Vibration Control for HVAC
Section	23 05 53	Identification for HVAC
Section	23 07 13	HVAC Insulation
Section	23 08 00	Commissioning of HVAC Systems
Section	23 09 23	Direct Digital Control (DDC) System for HVAC
Section	23 11 23	Natural Gas Systems
Section	23 21 13	Hydronic Piping
Section	23 21 16	Hydronic Piping Specialties
Section	23 21 23	Hydronic Pumps
Section	23 23 00	Refrigerant Piping
Section	23 25 00	HVAC Water Treatment
Section	23 31 13	Metal Ducts
Section	23 33 00	Air Duct Accessories
Section	23 34 23	HVAC Power Ventilators
Section	23 34 33	Air Curtains
Section	23 36 00	Air Terminal Units
Section	23 37 13	Diffusers, Registers, and Grilles
Section	23 37 23	HVAC Gravity Ventilators
Section	23 51 16	Breechings, Stacks, and Accessories
Section	23 52 16	Condensing Boilers
Section	23 64 16	Water-Cooled, Rotary-Screw Water Chillers
Section	23 65 14.14	Cooling Towers
Section	23 73 13.10	Modular Central-Station Air-Handling Units
Section	23 81 26	Split-System Air-Conditioners
Section	23 82 39.13	Cabinet Unit Heaters
Section	23 82 39.16	Propeller Unit Heaters

Clarifications:

1. Contractor to include all temporary patching and sealing of roof system for their roof penetrations to ensure watertight conditions during construction.
2. Contractor is responsible for modification of existing and/or new roof curbs for equipment within scope of work.
3. Contractor is responsible for firestopping penetrations required by their Work.
4. All temperature controls low voltage wiring is the responsibility of this Contractor
5. All temperature controls in wall rough-in is the responsibility of the Electrical Contractor.
6. Contractor is responsible for own equipment pads. Where existing pads are shown to increase in size, Contractor shall plan to sawcut and demolish existing slab prior to doweling and pouring extension to equipment pad.
7. Critical long-lead equipment items are to have all submittals and shop drawings submitted for review within two weeks of Notice to Proceed. Equipment includes, but not limited to: Chillers, AHUs, ACUs, Hydronic Pumps, VAVs, VFDs, etc.
8. All wall blocking is to be coordinated with MEP Contractors to ensure rough-in routing is maintained.
9. Reference kitchen equipment drawings for HVAC requirements.

10. One fully finished classroom in Phase I is to be completed as a mockup for all future classrooms. Other Work in Phase I is not to be delayed while waiting for final mockup review. However, all Contractors shall be prepared for dedicated mobilization(s) or material shipment(s) to ensure the classroom mockup is prioritized.
11. Contractor shall disregard Note E in the "Valve Replacement Scope of Work." Contractor shall also disregard Notes E and F in the "Pipe Fitting Replacement Scope of Work."
12. Contractor is responsible for all sleeves and joints sealants required for their own penetrations.
13. One full small group nook in Phase I is to be completed as a mockup for all future small group nooks. Other Work in Phase I is not to be delayed while waiting for final mockup review. However, all Contractors shall be prepared for dedicated mobilization(s) or material shipment(s) to ensure this mockup is prioritized with classroom mockup.
14. AHU's for Phase I are to be procured and ready for delivery by December 1, 2025 in order to achieve installation, startup, commissioning, testing and balance. The system servicing this area of the building shall be operation by April 1, 2026.

L. BID CATEGORY NO. 12 – ELECTRICAL

General Requirements in Paragraph 3.02.B above.

Section	01 51 10	Temporary Electricity, Lighting and Warning Systems
Section	03 30 00	Cast-In-Place Concrete
Section	07 84 00	Firestopping
Section	07 92 00	Joint Sealants
Section	26 05 00	Basic Electrical Requirements
Section	26 05 19	Low-Voltage Electrical Power Conductors and Cables
Section	26 05 23	Control-Voltage Electrical Power Cables
Section	26 05 26	Grounding and Bonding for Electrical Systems
Section	26 05 29	Hangers and Supports for Electrical Systems
Section	26 05 33.13	Conduits for Electrical Systems
Section	26 05 33.16	Boxes and Covers for Electrical Systems
Section	26 05 53	Identification for Electrical Systems
Section	26 09 23	Lighting Control Devices
Section	26 09 43.23	Relay Based Lighting Controls
Section	26 24 16	Panelboards
Section	26 27 26	Wiring Devices
Section	26 28 16	Enclosed Switches and Circuit Breakers
Section	26 29 23	Variable-Frequency Motor Controllers
Section	26 33 53	Static Uninterruptible Power System
Section	26 51 19	Led Interior Lighting
Section	26 52 13	Emergency and Exit Lighting
Section	26 56 13	Lighting Poles and Standards
Section	26 56 19	LED Exterior Lighting
Section	27 05 00	Common Work Results for Communications
Section	27 05 26	Grounding and Bonding for Communications Systems
Section	27 05 28	Pathways for Communications Systems
Section	27 05 53	Identification for Communications Systems
Section	27 11 00	Communications Equipment Room Fittings
Section	27 13 13	Communications Copper Backbone Cabling

Section	27 13 23	Communications Optical Fiber Backbone Cabling
Section	27 15 13	Communications Copper Horizontal Cabling
Section	27 41 16	Integrated Audio-Video Systems and Equipment
Section	27 51 16	Public Address Systems
Section	27 51 23	Intercommunications and Program System
Section	27 53 13	Clock System
Section	28 05 13	Conductors and Cables for Electronic Safety and Security
Section	28 05 26	Grounding and Bonding for Electronic Safety and Security
Section	28 05 28	Pathways for Electronic Safety and Security
Section	28 31 11	Digital, Addressable Fire-Alarm System

Clarifications:

1. Contractor to include all temporary patching and sealing of roof system for their roof penetrations to ensure watertight conditions during construction.
2. Contractor is responsible for Ground Penetrating Radar (or similar technique) to locate all existing in-wall and/or below slab utilities prior to any demolition activity.
3. Contractor is responsible for all in wall rough-in locations for temperature control. Low voltage wiring for temperature control is by the HVAC Contractor
4. Contractor is responsible for own equipment pads. Where existing pads are shown to increase in size, Contractor shall plan to sawcut and demolish existing slab prior to doweling and pouring extension to equipment pad.
5. Contractor is responsible for final connection of all hard-wired equipment and furnishings, either Contractor or Owner provided.
6. All wall blocking is to be coordinated with MEP Contractors to ensure rough-in routing is maintained.
7. Reference kitchen equipment drawings for electrical and technology requirements.
8. One fully finished classroom in Phase I is to be completed as a mockup for all future classrooms. Other Work in Phase I is not to be delayed while waiting for final mockup review. However, all Contractors shall be prepared for dedicated mobilization(s) or material shipment(s) to ensure the classroom mockup is prioritized.
9. Contractor is responsible for all sleeves and joints sealants required for their own penetrations.
10. One full small group nook in Phase I is to be completed as a mockup for all future small group nooks. Other Work in Phase I is not to be delayed while waiting for final mockup review. However, all Contractors shall be prepared for dedicated mobilization(s) or material shipment(s) to ensure this mockup is prioritized with classroom mockup.
11. Electrical equipment supporting HVAC equipment for Phase I are to be procured and ready for delivery by December 1, 2025 in order to achieve installation, startup, commissioning, testing and balance. The system servicing this area of the building shall be operation by April 1, 2026.

END OF SECTION 01 12 00

22SECTION 01 23 00 - ALTERNATES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including amended General Conditions and other Division 1 Specification Sections, apply to work of this Section.

1.02 PURPOSE

A. The Bids for the Alternates described herein are required in order for the Owner to obtain information necessary for the proper consideration of the Project in its entirety.

1.03 ALTERNATES

A. Definitions: Alternates are defined as alternate products, materials, equipment, installations or systems for the Work, which may, at Owner's option and under terms established by Instructions to Bidders, be selected and recorded in the Owner-Contractor Agreement to either supplement or displace corresponding basic requirements of Contract Documents. Alternates may or may not substantially change scope and general character of the Work; and must not be confused with "allowances", "unit prices", "change orders", "substitutions", and other similar provisions.

1.04 SCHEDULE OF ALTERNATES

A. ALTERNATE NO. 1: Exterior Window Replacement
Scope: Full replacement of aluminum storefront window frames and glazing. Work to include flashings, sealants, window shades, window sills, etc. at all locations.
Drawings: Multiple Architectural Drawings / Notes. Reference A6-1, A8-2, A8-3
Specifications: 02 41 00 – Demolition, 06 10 00 – Rough Carpentry, 07 92 00 – Joint Sealants, 08 43 13 – Aluminum-Framed Storefront, 08 45 23 – Fiberglass-Sandwich-Panel Assemblies – Kalwall, 12 24 00 – Window Shades, 12 36 00 - Countertops

B. ALTERNATE NO. 2: Air Handling Unit Replacement
Scope: Full replacement of Air Handling Units #04, #05 & #06. Work to include all necessary Architectural, Plumbing, Structural and Electrical alternates noted or required to support demolition and installation of these units.
Drawings: Dedicated MEP Alternate Drawings, specifically M6-1A for alternate equipment schedule. Reference Architectural drawings for ceiling locations impacted by MEP scope of work.

Specifications: 02 41 00 Demolition, 09 21 16 – Gypsum Board Assemblies, 09 51 00 – Acoustical Ceilings, 23 73 13.10 – Modular Central-Station Air-Handling Units

C. ALTERNATE NO. 3: Replacement of Gas Boilers
Scope: Replacement of (2) gas boilers and associated electrical work to support new boiler equipment.
Drawings: Dedicated MEP Alternate Drawings, specifically M6-1A for alternate equipment schedule.
Specifications: 23 52 16 – Condensing Boilers

D. ALTERNATE NO. 4: Provide Instrumentation and Controls
Base Bid: No temperature controls.
Scope: Controls for building automation.
Specifications: 23 09 23 – Direct Digital Control (DDC) System for HVAC

4a. Provide Instrumentation and Controls by Alerton – Installed by Open Control Systems.
4b. Provide Instrumentation and Controls by Johnson Controls – Installed by JCI.
4c. Provide Instrumentation and Controls by Siemens – Installed by Grantham.
4d. Provide Instrumentation and Controls by Siemens (Disego) – Installed by local Branch.
4e. Provide Instrumentation and Controls by TRANE – Installed by local Branch.

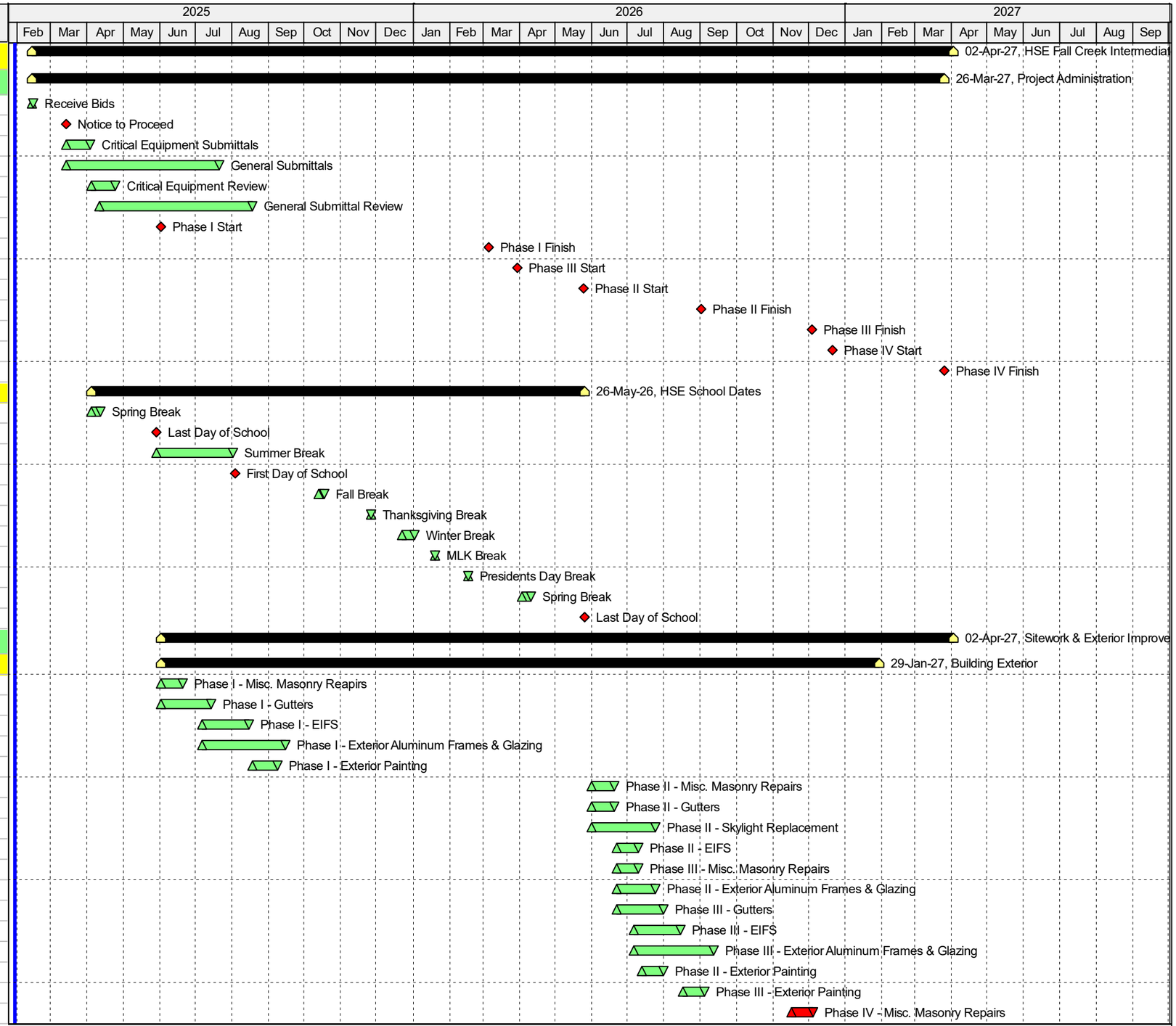
E. ALTERNATE NO. 5: Air-Handling Unit Manufacturer
Base Bid: Approved manufacturers listed in Contract Documents.
Scope: Air-Handling Unit Manufacturer.
Specifications: 23 73 13.10 – Modular Central-Station Air-Handling Units

5a. Provide add or deduct to provide Trane AHUs for base bid work
5b. Provide add or deduct to provide Trane AHUs for work in Alternate No. 02 (AHUs #04, #05, #06 & #07)

PART 2 - PRODUCTS, PART 3 - EXECUTION (Not Used)

END OF SECTION 01 23 00

Activity Name	Original Duration	Start	Finish
HSE Fall Creek Intermediate Renovation	551	13-Feb-25	02-Apr-27
Project Administration	545	13-Feb-25	26-Mar-27
Receive Bids	1	13-Feb-25*	13-Feb-25
Notice to Proceed	0	14-Mar-25*	
Critical Equipment Submittals	15	14-Mar-25*	03-Apr-25
General Submittals	90	14-Mar-25	21-Jul-25
Critical Equipment Review	15	04-Apr-25	24-Apr-25
General Submittal Review	90	11-Apr-25	18-Aug-25
Phase I Start	0	02-Jun-25*	
Phase I Finish	0		06-Mar-26*
Phase III Start	0	30-Mar-26*	
Phase II Start	0	25-May-26*	
Phase II Finish	0		01-Sep-26*
Phase III Finish	0		04-Dec-26*
Phase IV Start	0	21-Dec-26*	
Phase IV Finish	0		26-Mar-27*
HSE School Dates	291	04-Apr-25	26-May-26
Spring Break	6	04-Apr-25*	11-Apr-25
Last Day of School	0		29-May-25*
Summer Break	46	29-May-25	01-Aug-25
First Day of School	0	04-Aug-25*	
Fall Break	5	13-Oct-25*	17-Oct-25
Thanksgiving Break	1	26-Nov-25*	26-Nov-25
Winter Break	9	22-Dec-25*	02-Jan-26
MLK Break	1	19-Jan-26*	19-Jan-26
Presidents Day Break	1	16-Feb-26*	16-Feb-26
Spring Break	6	03-Apr-26*	10-Apr-26
Last Day of School	0		26-May-26*
Sitework & Exterior Improvements	475	02-Jun-25	02-Apr-27
Building Exterior	430	02-Jun-25	29-Jan-27
Phase I - Misc. Masonry Reapirs	15	02-Jun-25*	20-Jun-25
Phase I - Gutters	30	02-Jun-25	14-Jul-25
Phase I - EIFS	30	07-Jul-25	15-Aug-25
Phase I - Exterior Aluminum Frames & Glazing	50	07-Jul-25*	15-Sep-25
Phase I - Exterior Painting	15	18-Aug-25	08-Sep-25
Phase II - Misc. Masonry Repairs	15	01-Jun-26*	19-Jun-26
Phase II - Gutters	15	01-Jun-26	19-Jun-26
Phase II - Skylight Replacement	40	01-Jun-26*	24-Jul-26
Phase II - EIFS	15	22-Jun-26	10-Jul-26
Phase III - Misc. Masonry Repairs	15	22-Jun-26*	10-Jul-26
Phase II - Exterior Aluminum Frames & Glazing	25	22-Jun-26	24-Jul-26
Phase III - Gutters	30	22-Jun-26	31-Jul-26
Phase III - EIFS	30	06-Jul-26	14-Aug-26
Phase III - Exterior Aluminum Frames & Glazing	50	06-Jul-26	11-Sep-26
Phase II - Exterior Painting	15	13-Jul-26	31-Jul-26
Phase III - Exterior Painting	15	17-Aug-26	04-Sep-26
Phase IV - Misc. Masonry Repairs	15	16-Nov-26*	04-Dec-26



Actual Work
Remaining Work
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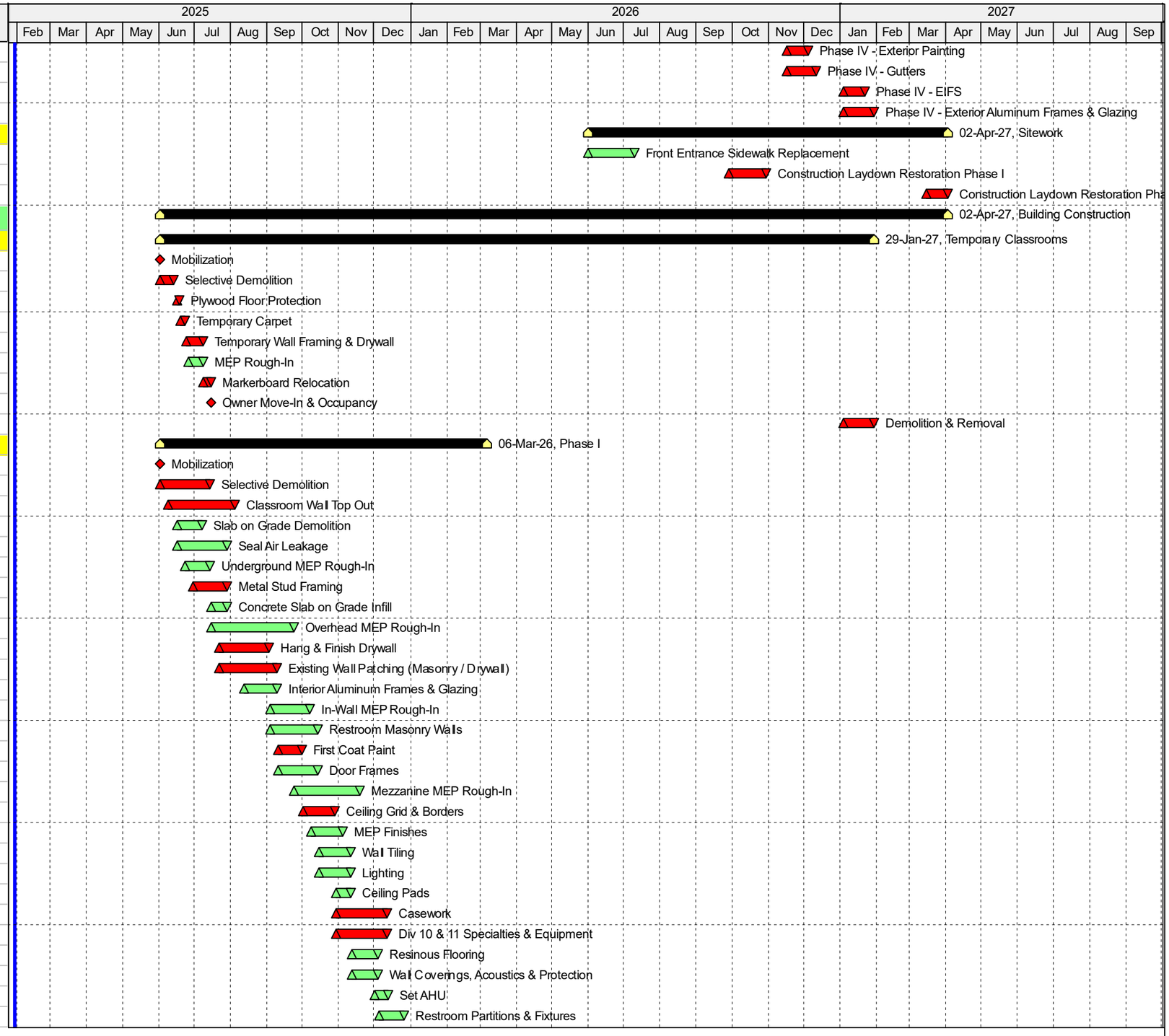
HSE Fall Creek Intermediate Renovation

Guideline Schedule

SKILLMAN

Activity Name	Original Duration	Start	Finish
Phase IV - Exterior Painting	15	16-Nov-26	04-Dec-26
Last Day of School	20	16-Nov-26	11-Dec-26
Phase IV - EIFS	15	04-Jan-27	22-Jan-27
Phase IV - Exterior Aluminum Frames & Glazing	20	04-Jan-27*	29-Jan-27
Sitework	220	01-Jun-26	02-Apr-27
Front Entrance Sidewalk Replacement	30	01-Jun-26*	10-Jul-26
Construction Laydown Restoration Phase I	25	28-Sep-26*	30-Oct-26
Construction Laydown Restoration Phase II	15	15-Mar-27*	02-Apr-27
Building Construction	475	02-Jun-25	02-Apr-27
Temporary Classrooms	430	02-Jun-25	29-Jan-27
Mobilization	0	02-Jun-25*	
Selective Demolition	10	02-Jun-25	13-Jun-25
Plywood Floor Protection	3	16-Jun-25	18-Jun-25
Temporary Carpet	3	19-Jun-25	23-Jun-25
Temporary Wall Framing & Drywall	10	24-Jun-25	08-Jul-25
MEP Rough-In	8	26-Jun-25	08-Jul-25
Markerboard Relocation	5	09-Jul-25	15-Jul-25
Owner Move-In & Occupancy	0		15-Jul-25*
Demolition & Removal	20	04-Jan-27*	29-Jan-27
Phase I	195	02-Jun-25	06-Mar-26
Mobilization	0	02-Jun-25*	
Selective Demolition	30	02-Jun-25	14-Jul-25
Classroom Wall Top Out	40	09-Jun-25	04-Aug-25
Slab on Grade Demolition	15	16-Jun-25	07-Jul-25
Seal Air Leakage	30	16-Jun-25	28-Jul-25
Underground MEP Rough-In	15	23-Jun-25	14-Jul-25
Metal Stud Framing	20	30-Jun-25	28-Jul-25
Concrete Slab on Grade Infill	10	15-Jul-25	28-Jul-25
Overhead MEP Rough-In	50	15-Jul-25	23-Sep-25
Hang & Finish Drywall	30	22-Jul-25	02-Sep-25
Existing Wall Patching (Masonry / Drywall)	35	22-Jul-25	09-Sep-25
Interior Aluminum Frames & Glazing	20	12-Aug-25	09-Sep-25
In-Wall MEP Rough-In	25	03-Sep-25	07-Oct-25
Restroom Masonry Walls	30		14-Oct-25
First Coat Paint	15	10-Sep-25	30-Sep-25
Door Frames	25	10-Sep-25	14-Oct-25
Mezzanine MEP Rough-In	40	24-Sep-25	18-Nov-25
Ceiling Grid & Borders	20	01-Oct-25	28-Oct-25
MEP Finishes	20	08-Oct-25	04-Nov-25
Wall Tiling	20	15-Oct-25	11-Nov-25
Lighting	20	15-Oct-25	11-Nov-25
Ceiling Pads	10	29-Oct-25	11-Nov-25
Casework	30	29-Oct-25	11-Dec-25
Div 10 & 11 Specialties & Equipment	30	29-Oct-25	11-Dec-25
Resinous Flooring	15	12-Nov-25	04-Dec-25
Wall Coverings, Acoustics & Protection	15	12-Nov-25	04-Dec-25
Set AHU	10	01-Dec-25*	12-Dec-25
Restroom Partitions & Fixtures	15	05-Dec-25	26-Dec-25



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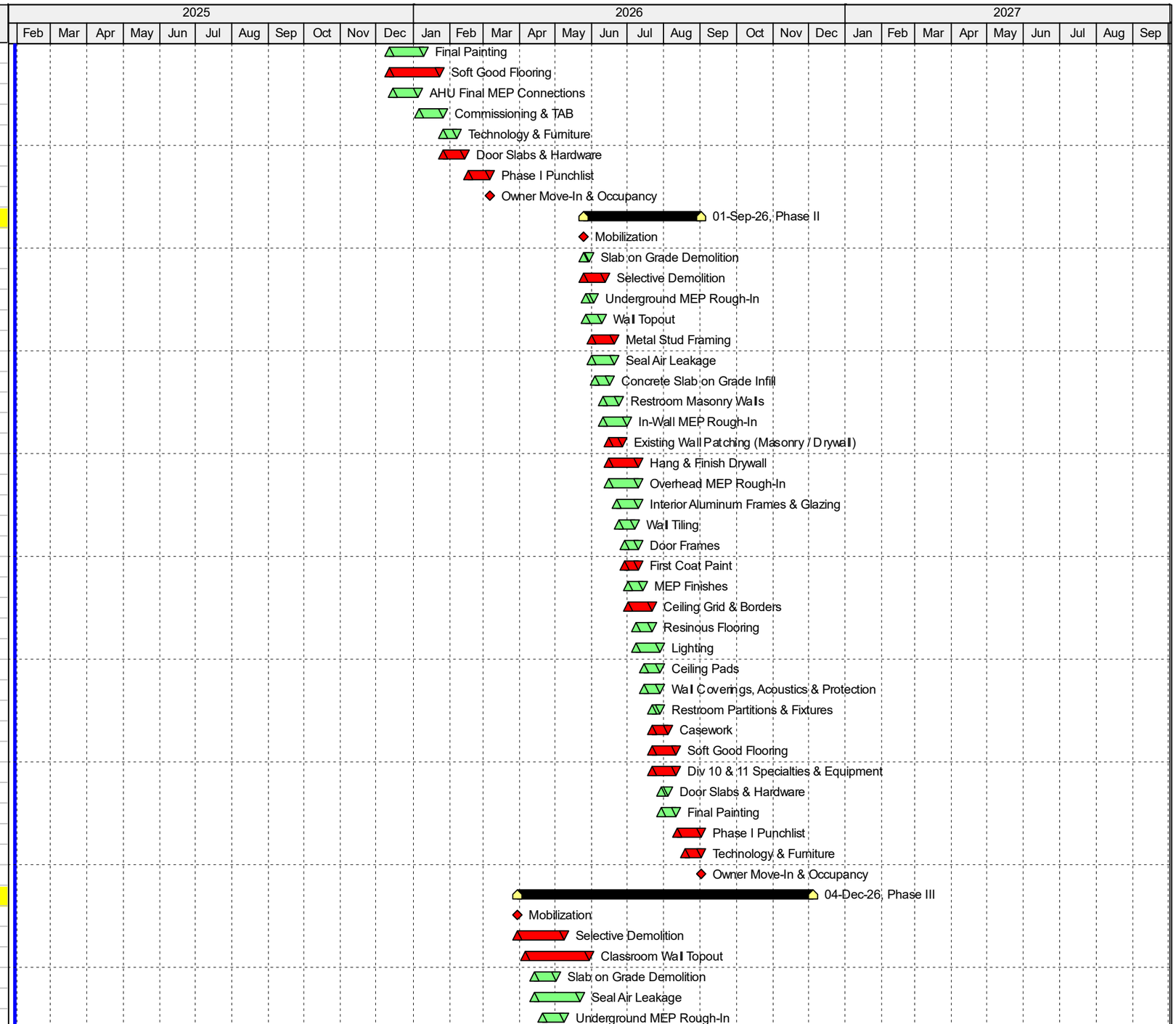
HSE Fall Creek Intermediate Renovation

Guideline Schedule

SKILLMAN

Activity Name	Original Duration	Start	Finish
Final Painting	20	12-Dec-25	09-Jan-26
Soft Good Flooring	30	12-Dec-25	23-Jan-26
AHU Final MEP Connections	15	15-Dec-25	05-Jan-26
Commissioning & TAB	15	06-Jan-26	26-Jan-26
Technology & Furniture	10	26-Jan-26	06-Feb-26
Door Slabs & Hardware	15	26-Jan-26	13-Feb-26
Phase I Punchlist	15	16-Feb-26	06-Mar-26
Owner Move-In & Occupancy	0		06-Mar-26*
Phase II	72	25-May-26	01-Sep-26
Mobilization	0	25-May-26*	
Slab on Grade Demolition	5	25-May-26	29-May-26
Selective Demolition	15	25-May-26	12-Jun-26
Underground MEP Rough-In	5	27-May-26	02-Jun-26
Wall Topout	10	27-May-26	09-Jun-26
Metal Stud Framing	15	01-Jun-26	19-Jun-26
Seal Air Leakage	15	01-Jun-26	19-Jun-26
Concrete Slab on Grade Infill	10	03-Jun-26	16-Jun-26
Restroom Masonry Walls	10	10-Jun-26	23-Jun-26
In-Wall MEP Rough-In	15	10-Jun-26	30-Jun-26
Existing Wall Patching (Masonry / Drywall)	10	15-Jun-26	26-Jun-26
Hang & Finish Drywall	20	15-Jun-26	10-Jul-26
Overhead MEP Rough-In	20	15-Jun-26	10-Jul-26
Interior Aluminum Frames & Glazing	15	22-Jun-26	10-Jul-26
Wall Tiling	10	24-Jun-26	07-Jul-26
Door Frames	10	29-Jun-26	10-Jul-26
First Coat Paint	10	29-Jun-26	10-Jul-26
MEP Finishes	10	01-Jul-26	14-Jul-26
Ceiling Grid & Borders	15	01-Jul-26	21-Jul-26
Resinous Flooring	10	08-Jul-26	21-Jul-26
Lighting	15	08-Jul-26	28-Jul-26
Ceiling Pads	10	15-Jul-26	28-Jul-26
Wall Coverings, Acoustics & Protection	10	15-Jul-26	28-Jul-26
Restroom Partitions & Fixtures	5	22-Jul-26	28-Jul-26
Casework	10	22-Jul-26	04-Aug-26
Soft Good Flooring	15	22-Jul-26	11-Aug-26
Div 10 & 11 Specialties & Equipment	15	22-Jul-26	11-Aug-26
Door Slabs & Hardware	5	29-Jul-26	04-Aug-26
Final Painting	10	29-Jul-26	11-Aug-26
Phase I Punchlist	15	12-Aug-26	01-Sep-26
Technology & Furniture	10	19-Aug-26	01-Sep-26
Owner Move-In & Occupancy	0		01-Sep-26*
Phase III	180	30-Mar-26	04-Dec-26
Mobilization	0	30-Mar-26*	
Selective Demolition	30	30-Mar-26	08-May-26
Classroom Wall Topout	40	06-Apr-26	29-May-26
Slab on Grade Demolition	15	13-Apr-26	01-May-26
Seal Air Leakage	30	13-Apr-26	22-May-26
Underground MEP Rough-In	15	20-Apr-26	08-May-26



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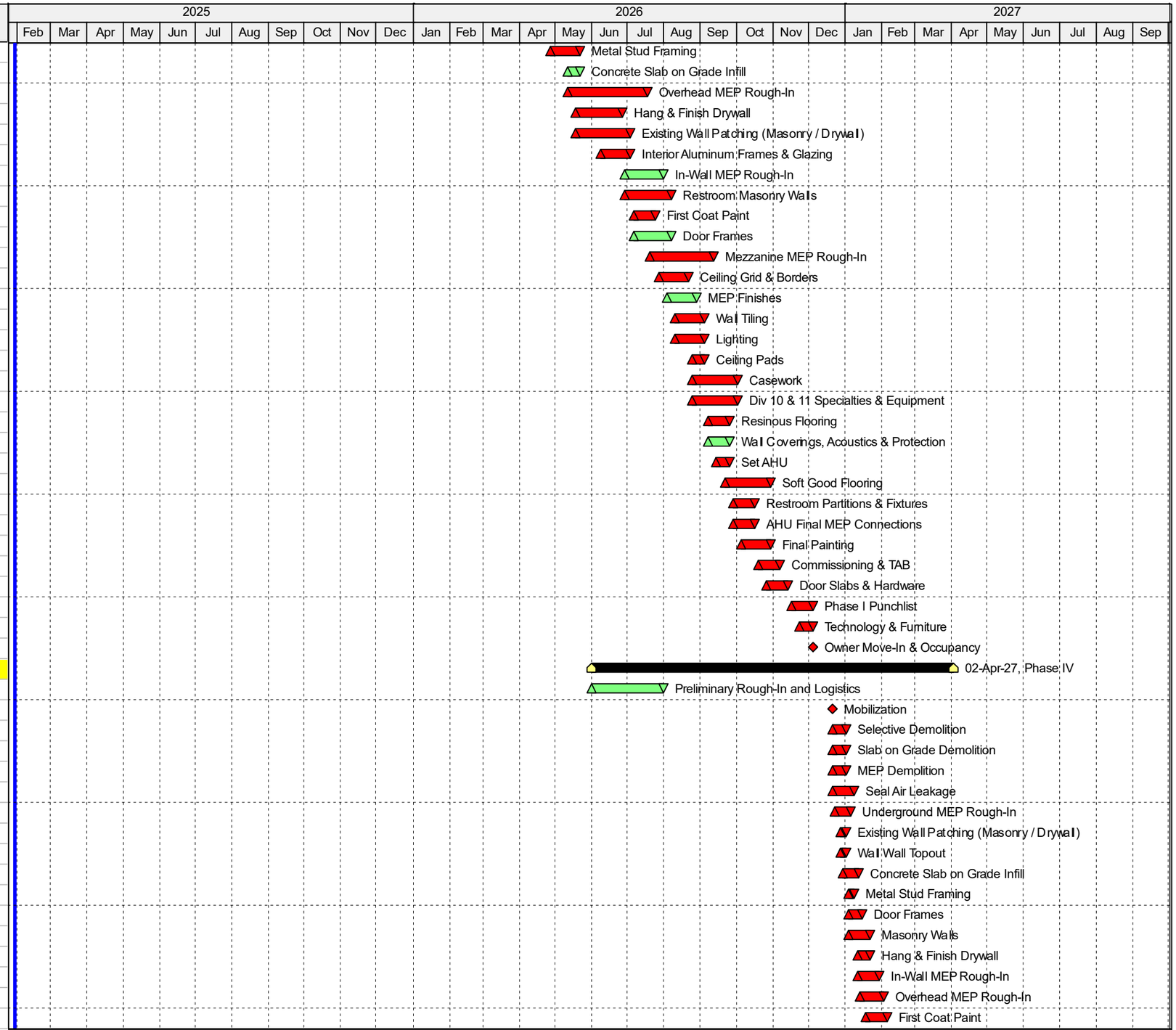
HSE Fall Creek Intermediate Renovation

Guideline Schedule

SKILLMAN

Activity Name	Original Duration	Start	Finish
Metal Stud Framing	20	27-Apr-26	22-May-26
Concrete Slab on Grade Infill	10	11-May-26	22-May-26
Overhead MEP Rough-In	50	11-May-26	17-Jul-26
Hang & Finish Drywall	30	18-May-26	26-Jun-26
Existing Wall Patching (Masonry / Drywall)	35	18-May-26	03-Jul-26
Interior Aluminum Frames & Glazing	20	08-Jun-26	03-Jul-26
In-Wall MEP Rough-In	25	29-Jun-26	31-Jul-26
Restroom Masonry Walls	30	29-Jun-26	07-Aug-26
First Coat Paint	15	06-Jul-26	24-Jul-26
Door Frames	25	06-Jul-26	07-Aug-26
Mezzanine MEP Rough-In	40	20-Jul-26	11-Sep-26
Ceiling Grid & Borders	20	27-Jul-26	21-Aug-26
MEP Finishes	20	03-Aug-26	28-Aug-26
Wall Tiling	20	10-Aug-26	04-Sep-26
Lighting	20	10-Aug-26	04-Sep-26
Ceiling Pads	10	24-Aug-26	04-Sep-26
Casework	30	24-Aug-26	02-Oct-26
Div 10 & 11 Specialties & Equipment	30	24-Aug-26	02-Oct-26
Resinous Flooring	15	07-Sep-26	25-Sep-26
Wall Coverings, Acoustics & Protection	15	07-Sep-26	25-Sep-26
Set AHU	10	14-Sep-26	25-Sep-26
Soft Good Flooring	30	21-Sep-26	30-Oct-26
Restroom Partitions & Fixtures	15	28-Sep-26	16-Oct-26
AHU Final MEP Connections	15	28-Sep-26	16-Oct-26
Final Painting	20	05-Oct-26	30-Oct-26
Commissioning & TAB	15	19-Oct-26	06-Nov-26
Door Slabs & Hardware	15	26-Oct-26	13-Nov-26
Phase I Punchlist	15	16-Nov-26	04-Dec-26
Technology & Furniture	10	23-Nov-26	04-Dec-26
Owner Move-In & Occupancy	0		04-Dec-26*
Phase IV	220	01-Jun-26	02-Apr-27
Preliminary Rough-In and Logistics	45	01-Jun-26*	31-Jul-26
Mobilization	0	21-Dec-26*	
Selective Demolition	10	21-Dec-26	01-Jan-27
Slab on Grade Demolition	10	21-Dec-26	01-Jan-27
MEP Demolition	10	21-Dec-26	01-Jan-27
Seal Air Leakage	15	21-Dec-26	08-Jan-27
Underground MEP Rough-In	10	23-Dec-26	05-Jan-27
Existing Wall Patching (Masonry / Drywall)	5	28-Dec-26	01-Jan-27
Wall Wall Topout	5	28-Dec-26	01-Jan-27
Concrete Slab on Grade Infill	10	30-Dec-26	12-Jan-27
Metal Stud Framing	5	04-Jan-27	08-Jan-27
Door Frames	10	04-Jan-27	15-Jan-27
Masonry Walls	15	04-Jan-27	22-Jan-27
Hang & Finish Drywall	10	11-Jan-27	22-Jan-27
In-Wall MEP Rough-In	15	11-Jan-27	29-Jan-27
Overhead MEP Rough-In	15	13-Jan-27	02-Feb-27
First Coat Paint	15	18-Jan-27	05-Feb-27



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HSE Fall Creek Intermediate Renovation

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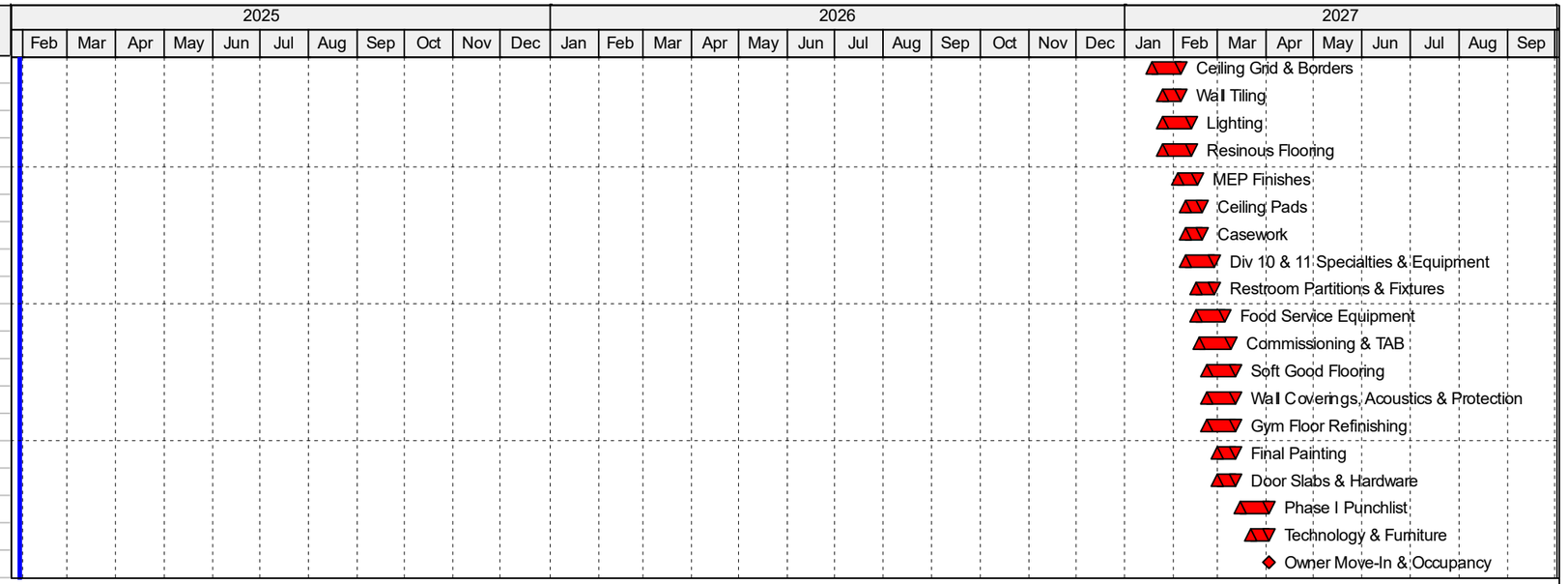
Activity Name	Original Duration	Start	Finish
Ceiling Grid & Borders	15	18-Jan-27	05-Feb-27
Wall Tiling	10	25-Jan-27	05-Feb-27
Lighting	15	25-Jan-27	12-Feb-27
Resinous Flooring	15	25-Jan-27	12-Feb-27
MEP Finishes	10	03-Feb-27	16-Feb-27
Ceiling Pads	10	08-Feb-27	19-Feb-27
Casework	10	08-Feb-27	19-Feb-27
Div 10 & 11 Specialties & Equipment	15	08-Feb-27	26-Feb-27
Restroom Partitions & Fixtures	10	15-Feb-27	26-Feb-27
Food Service Equipment	15	15-Feb-27	05-Mar-27
Commissioning & TAB	15	17-Feb-27	09-Mar-27
Soft Good Flooring	15	22-Feb-27	12-Mar-27
Wall Coverings, Acoustics & Protection	15	22-Feb-27	12-Mar-27
Gym Floor Refinishing	15	22-Feb-27	12-Mar-27
Final Painting	10	01-Mar-27	12-Mar-27
Door Slabs & Hardware	10	01-Mar-27	12-Mar-27
Phase I Punchlist	15	15-Mar-27	02-Apr-27
Technology & Furniture	10	22-Mar-27	02-Apr-27
Owner Move-In & Occupancy	0		02-Apr-27*



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Addendum #2
Hamilton Southeastern Schools
Fall Creek Intermediate School Renovations

Date: February 06, 2025
Project: Fall Creek Intermediate School Renovations
Project #: 23055
Pages: 1 of 78 pages
Bid Dates: **Thursday, February 13, 2025 at 11:00 am (prevailing local time)**

General Note:

The original Specifications and Drawings dated January 06, 2025, for the project referenced above are amended as noted in this Addendum No. 1. Receipt of this Addendum and any subsequent Addenda must be acknowledged on the Bid Form. Items changed or added by this addendum are to take precedence over the items or descriptions of the work in the project manual and the drawings. Items not mentioned in this addendum are to remain as described in the original plans and specifications.

Specifications Items:

Section 02 41 00 – SELECTIVE DEMOLITION

1. Add Part 2 Products and Add 2.01 Patching Materials
    a. New Materials: As specified in product sections, match existing products and work for patching and extending work.
    b. Type and Quality of Existing Products: Determine by inspecting and testing products where necessary, referring to existing work as a standard.
    c. Product Substitution: For any proposed change in materials, submit a request for substitution described in Section 01 60 00 - Product Requirements.
2. Change Rest of Part 2 to Part 3 Execution Add 3.05 Cutting and Patching
    a. Whenever possible, execute the work by methods that avoid cutting or patching.
    b. Perform whatever cutting and patching is necessary to:
        i. Complete the work.
        ii. Fit products together to integrate with other work.
        iii. Provide openings for penetration of mechanical, electrical, and other services.
        iv. Match work that has been cut to adjacent work.
        v. Repair areas adjacent to cuts to the required condition.
        vi. Repair new work damaged by subsequent work.
        vii. Remove samples of installed work for testing when requested.
        viii. Remove and replace defective and non-complying work.
    c. Execute work by methods that avoid damage to other work and that will provide appropriate surfaces to receive patching and finishing. In existing work, minimize damage and restore to original condition.
    d. Cut rigid materials using masonry saw or core drill. Pneumatic tools not allowed without prior approval.

e. Restore work with new products in accordance with requirements of Contract Documents.
f. Fit work air tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
g. Patching:
    i. Finish patched surfaces to match finish that existed prior to patching. On continuous surfaces, refinish to nearest intersection or natural break. For an assembly, refinish entire unit.
    ii. Match color, texture, and appearance.
    iii. Repair patched surfaces that are damaged, lifted, discolored, or showing other imperfections due to patching work. If defects are due to condition of substrate, repair substrate prior to repairing finish.

3. Add Section 3.06 Progress Cleaning
    a. Maintain areas free of waste materials, debris, and rubbish. Maintain the site in a clean and orderly condition.
    b. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces, and other closed or remote spaces, before enclosing the space.
    c. Broom and vacuum clean interior areas prior to start of surface finishing, and continue cleaning to eliminate dust.
    d. Collect and remove waste materials, debris, and trash/rubbish from site periodically and dispose off-site; do not burn or bury.

Section 02 41 19A-F – SELECTIVE DEMOLITION

1. Omit specification from scope

Section 05 58 13 - METAL COLUMN COVERS

1. Revise 2.02.A.3.f.2. Provide base gasket at all exposed column cover locations

Section 07 21 19 - FOAMED IN PLACE INSULATION

1. Revise 2.02 Materials
    a. A. Foamed-In place insulation – REMOVE words OPEN CELL, and SEMI-RIGID.
2. Revise 2.02.A.1. Regulatory Requirements: Comply with applicable code for flame and smoke, concealment and fire protection requirements.
    a. Fire Protection: Provide 15-minute thermal barrier of 1/2 inch gypsum board or equivalent material complying with the NFPA 275 test method or foamed-in-place insulation either exposed or with covering that complies with FM 4880, NFPA 286, UL 1040, or UL 1715. Must be approved for the construction type of project and location

Section 08 33 13 – COILING COUNTER DOORS

1. Add 2.01.A.3. McKeon Overhead Door; Vertical Coiling Service Counter Shutter – CS3000: https://www.mckeondoor.com/
2. Change 2.02 Coiling Counter Doors to the following:
    a. OVH003 to be Coiling Counter Metal Door, Non-Fire-Rated: Stainless Steel
        i. Mounting: Between jambs mounted
        ii. Model 651
            1. Curtain: Stainless Steel
            2. Slat: F-158
            3. Finish: #4
            4. Hood: Stainless Steel
            5. Guides: Stainless Steel
            6. Bottom Bar Stainless Steel
            7. Manual Push up
            8. Locking Devices: Cylinder Lock
    b. OVH004 Concessions to be Coiling Counter Metal Door, Painted Steel
        i. Mounting: Face of wall
        ii. Model 650
            1. Curtain: Painted Steel
            2. Slat: F-158
            3. Finish: Premium powder coat finish
            4. Hood: Premium powder coat finish
            5. Guides: Extruded Aluminum
            6. Manual Push up
            7. Locking Devices: Cylinder Lock

Section 08 33 26 – OVERHEAD COILING GRILLES

1. Add 2.01.A.3. McKeon Overhead Door; Vertical Coiling Security Grilles – SG3000: https://www.mckeondoor.com/

Section 08 44 13 – GLAZED ALUMINUM CURTAIN WALLS

1. Edit 2.01 MANUFACTURERS
    a. Glazed Aluminum Curtain Walls Manufacturers Basis of Design need to be Thermally broken:
        i. Kawneer North America; 1600UT
        ii. Tubelite, Inc; 400TU
        iii. Oldcastle: Reliance HTC

Section 08 63 00 – METAL FRAMED SKYLIGHTS

1. 2.02.A.3. Add b. Refer to drawings for location. Glazing labeled TP-1 on drawings.

Section 08 71 00 – DOOR HARDWARE

1. Revise hardware sets:

DOOR#	HWSET#
310A	27A
518A	14 ~~(37)~~
518B	14 ~~(37)~~

Section 08 80 00 – GLAZING

1. Revise 2.04.D.3. Outboard Lite: to be 1/8 inch (6.4 mm) thick, minimum.

Section 09 05 61 – COMMON WORK RESULTS FOR FLOORING PREPARATION

1. Add (Between existing line items 2 & 4) 301.B.3. Remove the remaining glue and grout. Follow ASTM C1260 – Standard Practice for Cleaning Concrete
   A. Contractor responsible for successful removal of all grout and adhesive residues without damaging concrete
   B. Methods for removing
      1. Mechanical Cleaning – Use tools like scrapers, chisels, or floor grinders to remove the material.
      2. Chemical Cleaning—Apply product-specific cleaning solutions designed for concrete surfaces to soften or dissolve the adhesive. Test a small area prior to full use.
      3. Pressure Washing – High pressure water or shot blasting concrete
2. Add 3.02.C.a. Remove existing coatings and curing agents from the surface according to recommendations of remedial coating manufacturers.
3. Add 3.02.C.b. Prepare the surface according to recommendations of the remedial coating manufacturer and according to ASTM D4259

Section 09 51 00 – ACOUSTICAL CEILINGS

1. Change A2.01.A.1 to: ASTM E1264 Classification Type A,
   a. Form A1.2,
   b. Pattern D;
   c. Fire Class A

2. Change A2.01.B.1 to: Classification: ASTM E1264 change to TYPE A
   a. Form: A2.2
   b. Pattern E
   c. Fire Class A

Drawing Set Items:

Sheet A0-1 WALL TYPES

1. Revise PARTITION TYPE M5 to include ½" Acoustical Sound Dampening Wall Board

Sheet A1-1 OVERALL ARCHITECTURAL PLAN

1. Add general note "X. CONTRACTOR IS RESPONSIBLE FOR PATCH/REPAIR OF EXISTING TO REMAIN WALLS DUE TO THE REMOVAL OF PIPING, CONDUITS, DEVICES, ETC. COORDINATE WITH ALL DIVISIONS"

Sheet A1-6 ARCHITECTURAL FLOOR PLAN – AREA F

1. Revise note 18 locations

Sheet A2-6 RCP – AREA G

1. Shower 403A and Shower 404A Change Ceiling type to 5/8" Mold and Moisture Resistant Gypsum Board. Paint with mold/ High humidity resistant paint. Color by Architect.

Sheet A8-1 DOOR/ FRAME SCHEDULES

1. Revise door schedule
2. Add note to TP-1 "Refer to 08 63 00 Metal Framed Skylights for Glazing type"

Sheet A8-2 EXTERIOR FRAME ELEVATIONS

1. Add glazing type G-2 notation in elevation 1/A8-2
2. Change glazing type to G-2 in elevation 18/A8-2

Sheet A9-1 ENLARGED FLOOR PLANS/ RESTROOM PLANS

1. Add details 29/A9-1 & 30/A9-1

Sheet A10-3 – A10-8 INTERIOR ELEVATIONS

1. Revise note 50 to read, "CASEWORK UNIT TO BE LOCKABLE, KEY ALIKE. FOR UNITS WITH MULTIPLE DOORS AND/ OR DRAWERS, EACH CASEWORK COMPONENT IS TO INCLUDE A LOCK"

Sheet A11-4 INTERIOR FINISH PLANS – AREA C

1. Revise room tags in FAC RR 124 & FAC RR 123 to be "EF-1, EF-1, EP-1"

Attachments:

1. REVISED CIVIL SHEETS
2. Sheet A0-1 WALL TYPES
3. Sheet A1-6 ARCHITECTURAL FLOOR PLAN – AREA F
4. Sheet A8-1 DOOR/ FRAME SCHEDULES
5. Sheet A9-1 ENLARGED FLOOR PLANS/ RESTROOM PLANS
6. Link to Existing Drawings:
    a. https://www.dropbox.com/scl/fo/z95o4j573c83s49oz3dsd/AHZ4Qf75KavwDs9iTvUXgQU?rlkey=0z8k12dmy4s6ocdboowejtlzk&st=4k73eq2p&dl=0
7. MEPT Cover Sheet and Attachments

END

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Fall Creek Intermediate
Addendum 2
February 5, 2025

Changes to Drawings:

Sheet C100, C102, C202, C401

1. Reduced information to only items in this scope of work.
2. Combined sheets and details in this scope of work.

Remove Drawings:

Sheet C302, C402, C403, C901

1. Relevant information is shown on the remaining plan sheets.

Addendum #2
Hamilton Southeastern School Corporation
Fall Creek Intermediate Renovations

Date: February 06, 2025
Project: FCI – Renovations
Project #: 23055
Pages: 1 of 13 pages
Bid Dates: -

General Note:

The original Specifications and Drawings dated January 06, 2025 for the project referenced above are amended as noted in this Addendum No. 2. Receipt of this Addendum and any subsequent Addenda must be acknowledged on the Bid Form. Items changed or added by this addendum are to take precedence over the items or descriptions of the work in the project manual and the drawings. Items not mentioned in this addendum are to remain as described in the original plans and specifications.

Specifications Items:

1. Specification Section 230923 – 6
    a. 1.06 Quality Assurance, 7 Acceptable Control Supplier.
        i. Add e. TRANE – Installed by local branch.
2. Specification Section 230923 - 33
    a. Section 3.02 DDC System Interface with other systems and equipment
        i. A. 2. Equipment to be connected.
            1. h. Switchboards – delete.
            2. i. Motor-control centers – delete.
            3. k. Generator – delete.
            4. l. UPS – delete.
        ii. B. Communication interface with other building systems.
            1. Remove this part entirely.

Drawing Set Items:

Sheet -

1. MP1-3 – FIRST FLOOR MECHANICAL PIPING PLAN – AREA C
    a. Added CO2 (2) sensor for media center.
2. MP1-5 – FIRST FLOOR MECHANICAL PIPING PLAN – AREA F
    a. Added CO2 sensor for cafeteria.
    b. Added CO2 sensor for orchestra.
3. MP1-6 – FIRST FLOOR MECHANICAL PIPING PLAN – AREA G
    a. Added plan note #5.
4. MP1-6A – FIRST FLOOR MECHANICAL PIPING PLAN - AREA G – ALTERNATE

   a. Added CO2 sensor for gym.

5. M4-3 – ENLARGED MECHANICAL PLANS
   a. Added plan notes #42 & 43.
6. M9-1 – TEMPERATURE CONTROL/FLOW DIAGRAMS
   a. Revised detail #2 Terminal box control schematic.
7. M9-2 – TEMPERATURE CONTROL/FLOW DIAGRAMS
   a. Revised detail #1 Chilled water system temperature control schematic.
8. M9-3 – TEMPERATURE CONTROL DIAGRAMS
   a. Revised detail #1 Ductless split system control schematic.
9. P000 – SYMBOLS AND ABBREVIAIONS
   a. Added note L to general notes.
10. T5-1 – TECHNOLOGY DETAILS
    a. Revised notes on details.
11. T5-2 – TECHNOLOGY DETAILS
    a. Revised notes on details.

Attachments:

1. MP1-3
2. MP1-5
3. MP1-6
4. MP1-6A
5. M4-3
6. M9-1
7. M9-2
8. M9-3
9. P000
10. T5-1
11. T5-2
12. 230923 – Direct Digital Control (DDC) System for HVAC

END

SECTION 23 09 23
DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

PART 1 GENERAL

1.01 SUMMARY

A. Scope:
   1. The Temperature Control Contractor (TCC) shall install, furnish, program, and turn over to client a complete operating DDC system for monitoring and controlling of MEP systems as shown in the Contract Documents.

B. Section Includes:
   1. DDC system for monitoring and controlling of MEP systems.
   2. Delivery of selected control devices to equipment and systems manufacturers for factory installation and to HVAC systems installers for field installation.

C. Scope not included in 230923:
   1. Electrical Contractor (EC) to provide all wiring to all motor starters, variable frequency drives, and motor control centers.
   2. EC to provide 120 V/60 Hz power to all direct digital controllers (DDC) that require 120 V power.
   3. Sheet Metal Contractor shall install all motorized dampers, duct mounted airflow measuring stations, thermowells (for temperature & pressure sensors), flow meters, control valves, and other accessories that are furnaced by the TCC.
   4. Mechanical Contractor shall install all temperature and pressure sensing wells and control valves furnished by the Temperature Control Contactor.

1.02 DEFINITIONS

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

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

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

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

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

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

G. COV: Changes of value.

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

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

J. DOCSIS: Data-Over Cable Service Interface Specifications.

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

L. HLC: Heavy load conditions.

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

N. LAN: Local area network.

O. LNS: LonWorks Network Services.

P. LON Specific Definitions:

1. FTT-10: Echelon Transmitter-Free Topology Transceiver.
2. LonMark: Association comprising suppliers and installers of LonTalk products. Association provides guidelines for implementing LonTalk protocol to ensure interoperability through a standard or consistent implementation.
3. LonTalk: An open standard protocol developed by the Echelon Corporation that uses a "Neuron Chip" for communication. LonTalk is a register trademark of Echelon.
4. LonWorks: Network technology developed by Echelon.
5. Node: Device that communicates using CEA-709.1-C protocol and that is connected to a CEA-709.1-C network.
6. Node Address: The logical address of a node on the network, consisting of a Domain number, Subnet number, and Node number. "Node number" portion of an address is a number assigned to device during installation, is unique within a subnet, and is not a factory-set unique Node ID.
7. Node ID: A unique 48-bit identifier assigned at factory to each CEA-709.1-C device. Sometimes called a "Neuron ID."
8. Program ID: An identifier (number) stored in a device (usually EEPROM) that identifies node manufacturer, functionality of device (application and sequence), transceiver used, and intended device usage.
9. Standard Configuration Property Type (SCPT): Pronounced "skip-it." A standard format type maintained by LonMark International for configuration properties.
10. Standard Network Variable Type (SNVT): Pronounced "snivet." A standard format type maintained by LonMark used to define data information transmitted and received by individual nodes. "SNVT" is used in two ways. It is an acronym for "Standard Network Variable Type" and is often used to indicate a network variable itself (i.e., it can mean "a network variable of a standard network variable type").
11. Subnet: Consists of a logical grouping of up to 127 nodes, where logical grouping is defined by node addressing. Each subnet is assigned a number, which is unique within a Domain. See "Node Address."
12. TP/FT-10: Free Topology Twisted Pair network defined by CEA-709.3 and is most common media type for a CEA-709.1-C control network.
13. TP/XF-1250: High-speed, 1.25-Mbps, twisted-pair, doubly terminated bus network defined by "LonMark Interoperability Guidelines" typically used only to connect multiple TP/FT-10 networks.
14. User-Defined Configuration Property Type (UCPT): Pronounced "U-Keep-It." A Configuration Property format type that is defined by device manufacturer.
15. User-Defined Network Variable Type (UNVT): Network variable format defined by device manufacturer. UNVTs create non-standard communications that other vendors' devices may not correctly interpret and may negatively impact system operation. UNVTs are not allowed.

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

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

S. MS/TP: Master-slave/token-passing, IEE 8802-3. Datalink protocol LAN option that uses twisted-pair wire for low-speed communication.
T. Network Controller: Digital controller, which supports a family of programmable application controllers and application-specific controllers, that communicates on peer-to-peer network for transmission of global data.
U. Network Repeater: Device that receives data packet from one network and rebroadcasts it to another network. No routing information is added to protocol.
V. PDA: Personal digital assistant.
W. Peer to Peer: Networking architecture that treats all network stations as equal partners.
X. RAM: Random access memory.
Y. RF: Radio frequency.
Z. Router: Device connecting two or more networks at network layer.
AA. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows. BB.
UPS: Uninterruptible power supply.
CC. USB: Universal Serial Bus.
DD. User Datagram Protocol (UDP): This protocol assumes that the IP is used as the underlying protocol.
EE. VAV: Variable air volume.
FF. WLED: White light emitting diode.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product include the following:
1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
3. Product description with complete technical data, performance curves, and product specification sheets.
4. Installation, operation and maintenance instructions including factors effecting performance.
5. Bill of materials of indicating quantity, manufacturer, and extended model number for each unique product.
6. When manufacturer's product datasheets apply to a product series rather than a specific product model, clearly indicate and highlight only applicable information.
7. Each submitted piece of product literature shall clearly cross reference specification and drawings that submittal is to cover.

B. Shop Drawings:
1. Include plans, elevations, sections, and mounting details where applicable.
2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail means of vibration isolation and show attachments to rotating equipment.
4. Plan Drawings indicating the following:
a. Screened backgrounds of walls, structural grid lines, HVAC equipment, ductwork and piping.
b. Room names and numbers with coordinated placement to avoid interference with control products indicated.
c. Each desktop operator workstation, server, gateway, router, DDC controller, control panel instrument connecting to DDC controller, and damper and valve connecting to DDC controller, if included in Project.
d. Exact placement of products in rooms, ducts, and piping to reflect proposed installed condition.

e. Network communication cable and raceway routing.
f. Proposed routing of wiring, cabling, conduit, and tubing, coordinated with building services for review before installation.

5. Schematic drawings for each controlled HVAC system indicating the following:
   a. I/O points labeled with point names shown. Indicate instrument range, normal operating set points, and alarm set points. Indicate fail position of each damper and valve, if included in Project.
   b. I/O listed in table format showing point name, type of device, manufacturer, model number, and cross-reference to product data sheet number.
   c. A graphic showing location of control I/O in proper relationship to HVAC system.
   d. Wiring diagram with each I/O point having a unique identification and indicating labels for all wiring terminals.
   e. Unique identification of each I/O that shall be consistently used between different drawings showing same point.
   f. Elementary wiring diagrams of controls for HVAC equipment motor circuits including interlocks, switches, relays and interface to DDC controllers.
   g. Narrative sequence of operation.
   h. Graphic sequence of operation, showing all inputs and output logical blocks.
6. Control panel drawings indicating the following:
   a. Panel dimensions, materials, size, and location of field cable, raceways, and tubing connections.
   b. Interior subpanel layout, drawn to scale and showing all internal components, cabling and wiring raceways, nameplates and allocated spare space.
   c. Front, rear, and side elevations and nameplate legend.
   d. Unique drawing for each panel.
7. DDC system network riser diagram indicating the following:
   a. Each device connected to network with unique identification for each.
   b. Interconnection of each different network in DDC system.
   c. For each network, indicate communication protocol, speed and physical means of interconnecting network devices, such as copper cable type, or fiber-optic cable type. Indicate raceway type and size for each.
   d. Each network port for connection of an operator workstation or other type of operator interface with unique identification for each.
8. DDC system electrical power riser diagram indicating the following:
   a. Each point of connection to field power with requirements (volts/phase//hertz/amperes/connection type) listed for each.
   b. Each control power supply including, as applicable, transformers, power-line conditioners, transient voltage suppression and high filter noise units, DC power supplies, and UPS units with unique identification for each.
   c. Each product requiring power with requirements (volts/phase//hertz/amperes/connection type) listed for each.
   d. Power wiring type and size, race type, and size for each.
9. Monitoring and control signal diagrams indicating the following:
   a. Control signal cable and wiring between controllers and I/O.
   b. Point-to-point schematic wiring diagrams for each product.
   c. Control signal tubing to sensors, switches and transmitters.
   d. Process signal tubing to sensors, switches and transmitters.

C. System Description:
1. Full description of DDC system architecture, network configuration, operator interfaces and peripherals, servers, controller types and applications, gateways, routers and other network devices, and power supplies.
2. Complete listing and description of each report, log and trend for format and timing and events which initiate generation.

3. System and product operation under each potential failure condition including, but not limited to, the following:
    a. Loss of power.
    b. Loss of network communication signal.
    c. Loss of controller signals to inputs and outpoints.
    d. Operator workstation failure.
    e. Gateway failure.
    f. Network failure
    g. Controller failure.
    h. Instrument failure.
    i. Control damper and valve actuator failure.
4. Complete bibliography of documentation and media to be delivered to Owner.
5. Description of testing plans and procedures.
6. Description of Owner training.

D. Samples:
1. For each exposed product, installed in finished space for approval of selection of aesthetic characteristics.

1.04 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plan drawings, reflected ceiling plan(s), and other details, drawn to scale and coordinated with each other, using input from installers of the items involved.

B. Qualification Data:
1. Systems Provider Qualification Data:
    a. Resume of project manager assigned to Project.
    b. Resumes of application engineering staff assigned to Project.
    c. Resumes of installation and programming technicians assigned to Project.
    d. Resumes of service technicians assigned to Project.
    e. Brief description of past project including physical address, floor area, number of floors, building system cooling and heating capacity and building's primary function.
    f. Description of past project DDC system, noting similarities to Project scope and complexity indicated.
    g. Names of staff assigned to past project that will also be assigned to execute work of this Project.
    h. Owner contact information for past project including name, phone number, and e-mail address.
    i. Contractor contact information for past project including name, phone number, and e-mail address.
    j. Architect and Engineer contact information for past project including name, phone number, and e-mail address.
2. Manufacturer's qualification data.
3. Testing agency's qualifications data.

C. Welding certificates.

D. Product Certificates:
1. Data Communications Protocol Certificates: Certifying that each proposed DDC system component complies with ASHRAE 135.

E. Product Test Reports: For each product that requires testing to be performed by manufacturer.

F. Preconstruction Test Reports: For each separate test performed.

G. Source quality-control reports.

H. Field quality-control reports.

I. Sample Warranty: For manufacturer's warranty.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For DDC system to include in emergency, operation and maintenance manuals.
1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Project Record Drawings of as-built versions of submittal Shop Drawings provided in electronic PDF format.
b. Testing and commissioning reports and checklists of completed final versions of reports, checklists, and trend logs.
c. As-built versions of submittal Product Data.
d. Names, addresses, e-mail addresses and 24-hour telephone numbers of Installer and service representatives for DDC system and products.
e. Operator's manual with procedures for operating control systems including logging on and off, handling alarms, producing point reports, trending data, overriding computer control and changing set points and variables.
f. Programming manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
g. Engineering, installation, and maintenance manuals that explain how to:
    1) Design and install new points, panels, and other hardware.
    2) Perform preventive maintenance and calibration.
    3) Debug hardware problems.
    4) Repair or replace hardware.
h. Documentation of all programs created using custom programming language including set points, tuning parameters, and object database.
i. Backup copy of graphic files, programs, and database on electronic media such as DVDs.
j. List of recommended spare parts with part numbers and suppliers.
k. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
l. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
m. Licenses, guarantees, and warranty documents.
n. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
o. Owner training materials.

1.06 QUALITY ASSURANCE

A. DDC System Manufacturer Qualifications:
1. Nationally recognized manufacturer of DDC systems and products.
2. DDC systems with similar requirements to those indicated for a continuous period of 5 years within time of bid.
3. DDC systems and products that have been successfully tested and in use on at least 3 past projects.
4. Having complete published catalog literature, installation, operation and maintenance manuals for all products intended for use.
5. Having full-time in-house employees for the following:
    a. Product research and development.
    b. Product and application engineering.
    c. Product manufacturing, testing and quality control.
    d. Technical support for DDC system installation training, commissioning and troubleshooting of installations.
    e. Owner operator training.
6. TCC to provide controllers as required.
7. Acceptable Control Supplier:
    a. Open Control Systems.
    b. Johnson Controls – Installed by JCI.
    c. Siemens – Installed by Grantham.
    d. Siemens (Desigo) – Installed by local Branch.
    e. Trane - Installed by local Branch.

B. DDC System Provider Qualifications:
   1. Authorized representative of, and trained by, DDC system manufacturer.
   2. In-place facility located within 150 miles of Project and be capable of to respond on-site within 4 hours of notice.
   3. Staffing resources of competent and experienced full-time employees that are assigned to execute work according to schedule.
   4. Service and maintenance staff assigned to support Project during warranty period.
   5. Product parts inventory to support on-going DDC system operation for a period of not less than 5 years after Substantial Completion.
   6. DDC system manufacturer's backing to take over execution of Work if necessary to comply with requirements indicated. Include Project-specific written letter, signed by manufacturer's corporate officer, if requested.

C. Testing Agency Qualifications: Member company of NETA or an NRTL.
   1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

D. Welding Qualifications: Qualify procedures and personnel according to the following:
   1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
   3. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
   4. AWS D1.4/D1.4M, "Structural Welding Code - Reinforcing Steel."

E. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

1.07 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace products that fail in materials or workmanship within specified warranty period at no cost to client.
   1. Failures shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner.
   2. Include updates or upgrades to software and firmware if necessary to resolve deficiencies.
      a. Install updates only after receiving Owner's written authorization.
   3. Warranty service shall occur during normal business hours and commence within 24 hours of Owner's warranty service request.
   4. Warranty Period: 3 years from date of Substantial Completion. Warranty shall cover labor, material, replacement, and repairs for work performed during warranty period.

PART 2 PRODUCTS

2.01 DDC SYSTEM DESCRIPTION

A. Microprocessor-based monitoring and control including analog/digital conversion and program logic. A control loop or subsystem in which digital and analog information is received and processed by a microprocessor, and digital control signals are generated based on control algorithms and transmitted to field devices to achieve a set of predefined conditions.
   1. DDC system shall consist of a high-speed, peer-to-peer network of distributed DDC controllers, other network devices, operator interfaces, and software.

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

2.02 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional to design DDC system to satisfy requirements indicated.
   1. System Performance Objectives:
      a. DDC system shall manage HVAC systems.

b. DDC system control shall operate HVAC systems to achieve optimum operating costs while using least possible energy and maintaining specified performance.
c. DDC system shall respond to power failures, HVAC equipment failures, and adverse and emergency conditions encountered through connected I/O points.
d. DDC system shall operate while unattended by an operator and through operator interaction.
e. DDC system shall record & store trends and transaction of events and produce report information such as performance, energy, occupancies, and equipment operation.

B. Surface-Burning Characteristics: Products installed in ducts, equipment, and return-air paths shall comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

C. DDC System Data Storage:
1. Include server(s) with disk drive data storage to archive not less than 24 consecutive months of historical data for all I/O points connected to system, including alarms, event histories, transaction logs, trends and other information indicated.
2. When logged onto a server, operator shall be able to also interact with any DDC controller connected to DDC system as required for functional operation of DDC system.
3. Server(s) shall be used for application configuration; for archiving, reporting and trending of data; for operator transaction archiving and reporting; for network information management; for alarm annunciation; and for operator interface tasks and controls application management.
4. Server(s) shall use IT industry-standard database platforms such as Microsoft SQL Server and Microsoft Data Engine (MSDE).

D. Future Expandability:
1. DDC system size shall be expandable to an ultimate capacity of at least 125% times total I/O points indicated.
2. Additional DDC controllers, I/O and associated wiring shall be all that is needed to achieve ultimate capacity. Initial network infrastructure shall be designed and installed to support ultimate capacity.
3. Operator interfaces installed initially shall not require hardware and software additions and revisions for ultimate capacity.

E. Environmental Conditions for Controllers, Gateways, and Routers:
1. Products shall operate without performance degradation under ambient environmental temperature, pressure and humidity conditions encountered for installed location.
a. If product alone cannot comply with requirement, install product in a protective enclosure that is isolated and protected from conditions impacting performance. Enclosure shall be internally insulated, electrically heated, cooled and ventilated as required by product and application.
2. Products shall be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Products not available with integral enclosures complying with requirements indicated shall be housed in protective secondary enclosures. Installed location shall dictate the following NEMA 250 enclosure requirements:
a. Outdoors, Protected: Type 4.
b. Outdoors, Unprotected: Type 4.
c. Indoors, Heated with Filtered Ventilation: Type 2.
d. Indoors, Heated with Non-Filtered Ventilation: Type 2.
e. Indoors, Heated and Air Conditioned: Type 2.
f. Mechanical Equipment Rooms:
1) Chiller and Boiler Rooms: Type 4.
2) Air-Moving Equipment Rooms: Type 4.
g. Localized Areas Exposed to Washdown: Type 4.

h. Within Duct Systems and Air-Moving Equipment Not Exposed to Possible Condensation: Type 3.
i. Within Duct Systems and Air-Moving Equipment Exposed to Possible Condensation: Type 4.
j. Hazardous Locations: Explosion-proof rating for condition.

F. Environmental Conditions for Instruments and Actuators:
1. Instruments and actuators shall operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.
a. If instruments and actuators alone cannot comply with requirement, install instruments and actuators in protective enclosures that are isolated and protected from conditions impacting performance. Enclosure shall be internally insulated, electrically heated and ventilated as required by instrument and application.
2. Instruments, actuators and accessories shall be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Instruments and actuators not available with integral enclosures complying with requirements indicated shall be housed in protective secondary enclosures. Installed location shall dictate the following NEMA 250 enclosure requirements:
a. Outdoors, Protected: Type 4.
b. Outdoors, Unprotected: Type 4.
c. Indoors, Heated with Filtered Ventilation: Type 2.
d. Indoors, Heated with Non-Filtered Ventilation: Type 2.
e. Indoors, Heated and Air Conditioned: Type 2.
f. Mechanical Equipment Rooms:
1) Chiller and Boiler Rooms: Type 4.
2) Air-Moving Equipment Rooms: Type 4.
g. Localized Areas Exposed to Washdown: Type 4.
h. Within Duct Systems and Air-Moving Equipment Not Exposed to Possible Condensation: Type 3.
i. Within Duct Systems and Air-Moving Equipment Exposed to Possible Condensation: Type 4.
j. Hazardous Locations: Explosion-proof rating for condition.

G. Electric Power Quality:
1. Power-Line Surges:
a. Protect DDC system products connected to ac power circuits from power-line surges to comply with requirements of IEEE C62.41.
b. Do not use fuses for surge protection.
c. Test protection in the normal mode and in the common mode, using the following two waveforms:
1) 10-by-1000-mic.sec. waveform with a peak voltage of 1500 V and a peak current of 60 A.
2) 8-by-20-mic.sec. waveform with a peak voltage of 1000 V and a peak current of 500 A.
2. Power Conditioning:
a. Protect DDC system products connected to ac power circuits from irregularities and noise rejection. Characteristics of power-line conditioner shall be as follows:
1) At 85 percent load, output voltage shall not deviate by more than plus or minus 1 percent of nominal when input voltage fluctuates between minus 20 percent to plus 10 percent of nominal.
2) During load changes from zero to full load, output voltage shall not deviate by more than plus or minus 3 percent of nominal.
3) Accomplish full correction of load switching disturbances within five cycles, and 95 percent correction within two cycles of onset of disturbance.
4) Total harmonic distortion shall not exceed 3-1/2 percent at full load.

3. Ground Fault: Protect products from ground fault by providing suitable grounding. Products shall not fail due to ground fault condition.

H. Backup Power Source:
   1. HVAC systems and equipment served by a backup power source shall have associated DDC system products that control such systems and equipment also served from a backup power source.

I. UPS:
   1. DDC system products powered by UPS units shall include the following:
      a. Desktop operator workstations.
      b. Printers.
      c. Servers.
      d. Gateways.
      e. DDC controllers.
   2. DDC system instruments and actuators powered by UPS units shall be defined in the documents.

J. Continuity of Operation after Electric Power Interruption:
   1. Equipment and associated factory-installed controls, field-installed controls, electrical equipment, and power supply connected to building normal and backup power systems shall automatically return equipment and associated controls to operating state occurring immediately before loss of normal power, without need for manual intervention by operator when power is restored either through backup power source or through normal power if restored before backup power is brought online.

2.03 SYSTEM ARCHITECTURE

A. System architecture shall consist of no more than 3 levels of LANs.
   1. Level one LAN shall connect network controllers and operator workstations.
   2. Level two LAN shall connect programmable application controllers to other programmable application controllers, and to network controllers.
   3. Level three LAN shall connect application-specific controllers to programmable application controllers and network controllers.
   4. Level three LAN shall connect application-specific controllers to application-specific controllers.

B. DDC system shall consist of dedicated and/or separated LANs that are not shared with other building systems and tenant data and communication networks.

C. System architecture shall be modular and have inherent ability to expand to not less than 3 times system size indicated with no impact to performance indicated.

D. System architecture shall perform modifications without having to remove and replace existing network equipment.

E. Number of LANs and associated communication shall be transparent to operator. All I/O points residing on any LAN shall be capable of global sharing between all system LANs.

F. System design shall eliminate dependence on any single device for system alarm reporting and control execution. Each controller shall operate independently by performing its' own control, alarm management and historical data collection.

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

2.04 DDC SYSTEM OPERATOR INTERFACES

A. Operator Means of System Access: Operator shall be able to access entire DDC system through any of multiple means, including, but not limited to, the following:
   1. Desktop and portable operator workstation with hardwired connection through LAN port.
   2. Portable operator terminal with hardwired connection through LAN port.
   3. Portable operator workstation with wireless connection through LAN router.
   4. Remote connection using outside of system personal computer or through Web access.

5. Remote connection using portable operator workstation and internet connection.
6. Mobile device.

B. Access to system, regardless of operator means used, shall be transparent to operator.

C. Desktop Workstations:
1. Connect to DDC system Level one LAN through a communications port directly on LAN or through a communications port on a DDC controller.
2. Able to communicate with any device located on any DDC system LAN.
3. Able to communicate, with modems, remotely with any device connected to any DDC system LAN.
4. Communication via a modem shall not interfere with LAN activity and LAN activity shall not prevent workstation from handling incoming calls.

D. Critical Alarm Reporting:
1. Operator-selected critical alarms shall be sent by DDC system to notify operator of critical alarms that require immediate attention.
2. DDC system shall send alarm notification to multiple recipients that are assigned for each alarm.
3. DDC system shall notify recipients by any or all means, including e-mail, text message, and prerecorded phone message to mobile and landline phone numbers.

E. Simultaneous Operator Use: Capable of accommodating up to 10 simultaneous operators that are accessing DDC system through any one of operator interfaces indicated.

2.05 NETWORK COMMUNICATION PROTOCOL

A. Network communication protocol(s) used throughout entire DDC system shall be open to public and available to other companies for use in making future modifications to DDC system.

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

2.06 DESKTOP OPERATOR WORKSTATIONS

A. Performance Requirements:
1. Performance requirements may dictate equipment exceeding minimum requirements indicated.
2. Energy Star compliant.

B. Computer Workstation:
1. Shall include computer, monitor(s), mouse, and keyboard.
a. Computer shall support all building automation operations, email, include all Microsoft Office suit programs, and pdf viewer and edit program.
1) Shall be a minimum i5 processor with 16 GB RAM and 3.6 GHz processor. 2) 64-bit.
3) Capable of expanding ram to 32 GB.
4) 1 TB hard drive.
5) 4 USB ports, no optical drive required.
6) Graphics card suitable for BAS requirements.
7) Sound card.
8) Network card and built in wireless.
9) Windows 10 or newer.

2.07 ASHRAE 135 GATEWAYS

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

B. Include gateways to connect BACnet to legacy systems, existing non-BACnet devices, and existing non-BACnet DDC-controlled equipment, only when specifically requested and approved by Owner.

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

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

2.08 DDC CONTROLLERS

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

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

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

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

E. Environment Requirements:
   1. Controller hardware shall be suitable for the anticipated ambient conditions.
   2. Controllers located in conditioned space shall be rated for operation at 32 to 120 deg F.
   3. Controllers located outdoors shall be rated for operation at 40 to 150 deg F.

F. Power and Noise Immunity:
   1. Controller shall operate at 90 to 110 percent of nominal voltage rating and shall perform an orderly shutdown below 80 percent of nominal voltage.
   2. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios with up to 5 W of power located within 36 inches of enclosure.

G. DDC Controller Spare Processing Capacity:
   1. Include spare processing memory for each controller. RAM, PROM, or EEPROM will implement requirements indicated with the following spare memory:
      a. Network Controllers: 50 percent.
      b. Programmable Application Controllers: Not less than 60 percent.
      c. Application-Specific Controllers: Not less than 70 percent.
   2. Memory shall support DDC controller's operating system and database and shall include the following:
      a. Monitoring and control.
      b. Energy management, operation and optimization applications.
      c. Alarm management.
      d. Historical trend data of all connected I/O points.

e. Maintenance applications.
f. Operator interfaces.
g. Monitoring of manual overrides.

H. Maintenance and Support: Include the following features to facilitate maintenance and support:
1. Mount microprocessor components on circuit cards for ease of removal and replacement.
2. Means to quickly and easily disconnect controller from network.
3. Means to quickly and easily access connect to field test equipment.
4. Visual indication that controller electric power is on, of communication fault or trouble, and that controller is receiving and sending signals to network.

I. Input and Output Point Interface:
1. Hardwired input and output points shall connect to network, programmable application and application-specific controllers.
2. Input and output points shall be protected so shorting of point to itself, to another point, or to ground will not damage controller.
3. Input and output points shall be protected from voltage up to 24 V of any duration so that contact will not damage controller.
4. AIs:
a. AIs shall include monitoring of low-voltage (zero- to 10-V dc), current (4 to 20 mA) and resistance signals from thermistor and RTD sensors.
b. AIs shall be compatible with, and field configurable to, sensor and transmitters installed.
c. Controller AIs shall perform analog-to-digital (A-to-D) conversion with a minimum resolution of 12 bits or better to comply with accuracy requirements indicated.
d. Signal conditioning including transient rejection shall be provided for each AI.
e. Capable of being individually calibrated for zero and span.
f. Incorporate common-mode noise rejection of at least 50 dB from zero to 100 Hz for differential inputs, and normal-mode noise rejection of at least 20 dB at 60 Hz from a source impedance of 10000 ohms.
5. AOs:
a. Controller AOs shall perform analog-to-digital (A-to-D) conversion with a minimum resolution of 12 bits or better to comply with accuracy requirements indicated.
b. Output signals shall have a range of 4 to 20 mA dc or zero- to 10-V dc as required to include proper control of output device.
c. Capable of being individually calibrated for zero and span.
d. AOs shall not exhibit a drift of greater than 0.4 percent of range per year.
6. BIs:
a. Controller BIs shall accept contact closures and shall ignore transients of less than 5-ms duration.
b. Isolation and protection against an applied steady-state voltage of up to 180-V ac peak.
c. BIs shall include a wetting current of at least 12 mA to be compatible with commonly available control devices and shall be protected against effects of contact bounce and noise.
d. BIs shall sense "dry contact" closure without external power (other than that provided by the controller) being applied.
e. Pulse accumulation input points shall comply with all requirements of BIs and accept up to 10 pulses per second for pulse accumulation. Buffer shall be provided to totalize pulses. Pulse accumulator shall accept rates of at least 20 pulses per second. The totalized value shall be reset to zero on operator's command.
7. BOs:
a. Controller BOs shall include relay contact closures or triac outputs for momentary and maintained operation of output devices.
1) Relay contact closures shall have a minimum duration of 0.1 second. Relays shall include at least 180 V of isolation. Electromagnetic interference suppression

shall be provided on all output lines to limit transients to non-damaging levels. Minimum contact rating shall be 1 A at 24-V ac.

2) Triac outputs shall include at least 180 V of isolation. Minimum contact rating shall be 1 A at 24-V ac.

b. BOs shall include for two-state operation or a pulsed low-voltage signal for pulse- width modulation control.

c. BOs shall be selectable for either normally open or normally closed operation.

d. Include tristate outputs (two coordinated BOs) for control of three-point floating-type electronic actuators without feedback.

e. Limit use of three-point floating devices to VAV terminal unit control applications, and other applications indicated on Drawings, Control algorithms shall operate actuator to one end of its stroke once every 24 hours for verification of operator tracking.

2.09 NETWORK CONTROLLERS

A. General Network Controller Requirements:

1. Include adequate number of controllers to achieve performance indicated.
2. System shall consist of one or more independent, standalone, microprocessor-based network controllers to manage global strategies indicated.
3. Controller shall have enough memory to support its operating system, database, and programming requirements.
4. Data shall be shared between networked controllers and other network devices.
5. Operating system of controller shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
6. Controllers that perform scheduling shall have a real-time clock.
7. Controller shall continually check status of its processor and memory circuits. If an abnormal operation is detected, controller shall assume a predetermined failure mode and generate an alarm notification.
8. Controllers shall be fully programmable.

B. Communication:

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

C. Operator Interface:

1. Controller shall be equipped with a service communications port for connection to a portable operator's workstation.
2. Local Keypad and Display:
   a. Equip controller with local keypad and digital display for interrogating and editing data.
   b. Use of keypad and display shall require security password.

D. Serviceability:

1. Controller shall be equipped with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
2. Wiring and cable connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
3. Controller shall maintain BIOS and programming information in event of a power loss for at least 72 hours.

2.10 PROGRAMMABLE APPLICATION CONTROLLERS

A. General Programmable Application Controller Requirements:

1. Include adequate number of controllers to achieve performance indicated.
2. Controller shall have enough memory to support its operating system, database, and programming requirements.
3. Data shall be shared between networked controllers and other network devices.
4. Operating system of controller shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms.

5. Controllers that perform scheduling shall have a real-time clock.
6. Controller shall continually check status of its processor and memory circuits. If an abnormal operation is detected, controller shall assume a predetermined failure mode and generate an alarm notification.
7. Controllers shall be fully programmable.

B. Communication:
1. Programmable application controllers shall communicate with other devices on network.

C. Operator Interface:
1. Controller shall be equipped with a service communications port for connection to a portable operator's workstation.
2. Local Keypad and Display:
a. Equip controller with local keypad and digital display for interrogating and editing data.
b. Use of keypad and display shall require security password.

D. Serviceability:
1. Controller shall be equipped with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
2. Wiring and cable connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
3. Controller shall maintain BIOS and programming information in event of a power loss for at least 72 hours.

2.11 APPLICATION-SPECIFIC CONTROLLERS

A. Description: Microprocessor-based controllers, which through hardware or firmware design are dedicated to control a specific piece of equipment. Controllers are not fully user-programmable but are configurable and customizable for operation of equipment they are designed to control.
1. Capable of standalone operation and shall continue to include control functions without being connected to network.
2. Data shall be shared between networked controllers and other network devices.

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

C. Operator Interface: Controller shall be equipped with a service communications port for connection to a portable operator's workstation. Connection shall extend to port on space temperature sensor that is connected to controller.

D. Serviceability:
1. Controller shall be equipped with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
2. Wiring and cable connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
3. Controller shall use nonvolatile memory and maintain all BIOS and programming information in event of power loss.

2.12 CONTROLLER SOFTWARE

A. General Controller Software Requirements:
1. Software applications shall reside and operate in controllers. Editing of applications shall occur at operator workstations.
2. I/O points shall be identified by a character point name. Same names shall be used at operator workstations.
3. Control functions shall be executed within controllers using DDC algorithms.
4. Controllers shall be configured to use stored default values to ensure fail-safe operation. Default values shall be used when there is a failure of a connected input instrument or loss of communication of a global point value.

B. Security:
1. Operator access shall be secured using individual security passwords and user names.
2. Passwords shall restrict operator to points, applications, and system functions as assigned by system manager.

3. Operator log-on and log-off attempts shall be recorded.
4. System shall protect itself from unauthorized use by automatically logging off after last keystroke. The delay time shall be operator-definable.

C. Scheduling: Include capability to schedule each point or group of points in system. Each schedule shall consist of the following:
1. Weekly Schedule:
a. Include separate schedules for each day of week.
b. Each schedule should include the capability for start, stop, optimal start, optimal stop, and night economizer.
c. Each schedule may consist of up to 10 events.
d. When a group of objects are scheduled together, include capability to adjust start and stop times for each member.
2. Exception Schedules:
a. Include ability for operator to designate any day of the year as an exception schedule.
b. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed, it will be discarded and replaced by regular schedule for that day of week.
3. Holiday Schedules:
a. Include capability for operator to define up to 99 special or holiday schedules.
b. Schedules may be placed on scheduling calendar and will be repeated each year.
c. Operator shall be able to define length of each holiday period.

D. System Coordination:
1. Include standard application for proper coordination of equipment.
2. Application shall include operator with a method of grouping together equipment based on function and location.
3. Group may then be used for scheduling and other applications.

E. Binary Alarms:
1. Each binary point shall be set to alarm based on operator-specified state.
2. Include capability to automatically and manually disable alarming.

F. Analog Alarms:
1. Each analog object shall have both high and low alarm limits.
2. Alarming shall be able to be automatically and manually disabled.

G. Alarm Reporting:
1. Operator shall be able to determine action to be taken in event of an alarm.
2. Alarms shall be routed to appropriate operator workstations based on time and other conditions.
3. Alarm shall be able to start programs, print, be logged in event log, generate custom messages, and display graphics.

H. Remote Communication:
1. System shall have ability to dial out in the event of an alarm.

I. Control Loops:
1. Support any of the following control loops, as applicable to control required:
a. Two-position (on/off, open/close, slow/fast) control.
b. Proportional control.
c. Proportional plus integral (PI) control.
d. Proportional plus integral plus derivative (PID) control.
1) Include PID algorithms with direct or reverse action and anti-windup.
2) Algorithm shall calculate a time-varying analog value used to position an output or stage a series of outputs.
3) Controlled variable, set point, and PID gains shall be operator-selectable.
e. Adaptive (automatic tuning).

J. Staggered Start: Application shall prevent all controlled equipment from simultaneously restarting after a power outage. Order which equipment (or groups of equipment) is started, along with the time delay between starts, shall be operator-selectable.

K. Anti-Short Cycling:
   1. BO points shall be protected from short cycling.
   2. Feature shall allow minimum on-time and off-time to be selected.

L. On and Off Control with Differential:
   1. Include an algorithm that allows a BO to be cycled based on a controlled variable and set point.
   2. Algorithm shall be direct- or reverse-acting and incorporate an adjustable differential.

M. Run-Time Totalization:
   1. Include software to totalize run-times for all BI and BO points.
   2. A high run-time alarm shall be assigned, if required, by operator.

2.13 ENCLOSURES

A. General Enclosure Requirements:
   1. House each controller and associated control accessories in a enclosure. Enclosure shall serve as central tie-in point for control devices such as switches, transmitters, transducers, power supplies and transformers.
   2. Do not house more than one controller in a single enclosure.
   3. Include enclosure door with key locking mechanism. Key locks alike for all enclosures and include one pair of keys per enclosure.
   4. Equip doors of enclosures housing controllers and components with analog or digital displays with windows to allow visual observation of displays without opening enclosure door.
   5. Individual wall-mounted single-door enclosures shall not exceed 36 inches wide and 48 inches high.
   6. Individual wall-mounted double-door enclosures shall not exceed 60 inches wide and 36 inches high.
   7. Include wall-mounted enclosures with brackets suitable for mounting enclosures to wall or freestanding support stand as indicated.
   8. Supply each enclosure with a complete set of as-built schematics, tubing, and wiring diagrams and product literature located in a pocket on inside of door.

B. Internal Arrangement:
   1. Internal layout of enclosure shall group and protect pneumatic, electric, and electronic components associated with a controller, but not an integral part of controller.
   2. Arrange layout to group similar products together.
   3. Include a barrier between line-voltage and low-voltage electrical and electronic products.
   4. Factory or shop install products, tubing, cabling and wiring complying with requirements and standards indicated.
   5. Terminate field cable and wire using heavy-duty terminal blocks.
   6. Include spare terminals, equal to not less than 25 percent of used terminals.
   7. Include spade lugs for stranded cable and wire.
   8. Install a maximum of two wires on each side of a terminal.
   9. Include enclosure field power supply with a toggle-type switch located at entrance inside enclosure to disconnect power.
   10. Include enclosure with a line-voltage nominal 20-A GFCI duplex receptacle for service and testing tools. Wire receptacle on hot side of enclosure disconnect switch and include with a 5-A circuit breaker.
   11. Mount products within enclosure on removable internal panel(s).
   12. Include products mounted in enclosures with engraved, laminated phenolic nameplates (black letters on a white background). The nameplates shall have at least 1/4-inch-high lettering.
   13. Route tubing cable and wire located inside enclosure within a raceway with a continuous removable cover.
   14. Label each end of cable, wire and tubing in enclosure following an approved identification system that extends from field I/O connection and all intermediate connections throughout length to controller connection.

15. Size enclosure internal panel to include at least 25 percent spare area on face of panel.

C. Environmental Requirements:
   1. Evaluate temperature and humidity requirements of each product to be installed within each enclosure.
   2. Calculate enclosure internal operating temperature considering heat dissipation of all products installed within enclosure and ambient effects (solar, conduction and wind) on enclosure.
   3. Where required by application, include temperature-controlled electrical heat to maintain inside of enclosure above minimum operating temperature of product with most stringent requirement.
   4. Where required by application, include temperature-controlled ventilation fans with filtered louver(s) to maintain inside of enclosure below maximum operating temperature of product with most stringent requirement.

D. Wall-Mounted, NEMA 250, Type 1:
   1. Enclosure shall be NRTL listed according to UL 50 or UL 50E.
   2. Construct enclosure of steel.
   3. Finish enclosure inside and out with polyester powder coating that is electrostatically applied and then baked to bond to substrate.
      a. Exterior color shall be NSF/ANSI 61 gray or manufacturer's standard.
      b. Interior color shall be NSF/ANSI 61 gray or manufacturer's standard.
   4. Hinged door full size of front face of enclosure and supported using:
      a. Enclosures sizes less than 36 in. tall: Multiple butt hinges.
      b. Enclosures sizes 36 in. tall and larger: Continuous piano hinges.
   5. Removable internal panel with a white polyester powder coating that is electrostatically applied and then baked to bond to substrate.
   6. Internal panel mounting hardware, grounding hardware and sealing washers.
   7. Grounding stud on enclosure body.
   8. Thermoplastic pocket on inside of door for record Drawings and Product Data.

E. Wall Mounted NEMA 250, Types 4 and 12:
   1. Enclosure shall be NRTL listed according to UL 508A.
   2. Seam and joints are continuously welded and ground smooth.
   3. Where recessed enclosures are indicated, include enclosures with face flange for flush mounting.
   4. Externally formed body flange around perimeter of enclosure face for continuous perimeter seamless gasket door seal.
   5. Single-door enclosure sizes up to 60 inches tall by 36 inches wide.
   6. Double-door enclosure sizes up to 36 inches tall by 60 inches wide.
   7. Construct enclosure of steel.
   8. Finish enclosure with polyester powder coating that is electrostatically applied and then baked to bond to substrate.
      a. Exterior color shall be NSF/ANSI 61 gray or manufacturer's standard.
      b. Interior color shall be NSF/ANSI 61 gray or manufacturer's standard.
   9. Corner-formed door, full size of enclosure face, supported using multiple concealed hinges with easily removable hinge pins.
      a. Sizes through 24 Inches Tall: Two hinges.
      b. Sizes between 24 Inches through 48 Inches Tall: Three hinges.
      c. Sizes Larger 48 Inches Tall: Four hinges.
   10. Double-door enclosures with overlapping door design to include unobstructed full-width access.
      a. Single-door enclosures 48 inches and taller, and all double-door enclosures, with three-point (top, middle and bottom) latch system.
   11. Removable internal panel with a white polyester powder coating that is electrostatically applied and then baked to bond to substrate.
   12. Internal panel mounting studs with hardware, grounding hardware, and sealing washers.

13. Grounding stud on enclosure body.
14. Thermoplastic pocket on inside of door for record Drawings and Product Data.

F. Accessories:
1. Electric Heater:
a. Aluminum housing with brushed finish.
b. Thermostatic control with adjustable set point from zero to 100 deg F.
c. Capacity: 100, 200, 400, and 800 W as required by application.
d. Fan draws cool air from bottom of enclosure and passes air across thermostat and heating elements before being released into enclosure cavity. Heated air is discharged through the top of heater.
2. Ventilation Fans, Filtered Intake and Exhaust Grilles:
a. Number and size of fans, filters and grilles as required by application.
b. Compact cooling fans engineered for 50,000 hours of continuous operation without lubrication or service.
c. Fans capable of being installed on any surface and in any position within enclosure for spot cooling or air circulation.
d. Thermostatic control with adjustable set point from 32 to 140 deg F.
e. Airflow Capacity at Zero Pressure:
1) 4-Inch Fan: 100 cfm.
2) 6-Inch Fan: 240 cfm.
3) 10-Inch Fan: 560 cfm.
f. Maximum operating temperature of 158 deg F.
g. 4-inch fan thermally protected and provided with permanently lubricated ball-bearings.
h. 6- and 10-inch fans with ball-bearing construction and split capacitor motors thermally protected to avoid premature failure.
i. Dynamically balanced impellers molded from polycarbonate material.
j. Fan furnished with power cord and polarized plug for power connection.
k. Fan brackets, finger guards and mounting hardware provided with fans to complete installation.
l. Removable Intake and Exhaust Grilles: Stainless steel of size to match fan size and suitable for NEMA 250, Types 1 and 12 enclosures.
m. Filters for NEMA 250, Type 1 Enclosures: Washable aluminum, of a size to match intake grille.
n. Filters for NEMA 250, Type 12 Enclosures: Disposable, of a size to match intake grille.
3. Bar handle with keyed cylinder lock set.

2.14 RELAYS

A. General-Purpose Relays:
1. Relays shall be heavy duty and rated for at least 10 A at 250-V ac and 60 Hz.
2. Relays shall be either double pole double throw (DPDT) or three-pole double throw, depending on the control application.
3. Use a plug-in-style relay with an eight-pin octal plug for DPDT relays and an 11-pin octal plug for three-pole double-throw relays.
4. Construct the contacts of either silver cadmium oxide or gold.
5. Enclose the relay in a clear transparent polycarbonate dust-tight cover.
6. Relays shall have LED indication and a manual reset and push-to-test button.
7. Equip relays with coil transient suppression to limit transients to non-damaging levels.
8. Plug each relay into an industry-standard, 35-mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
9. Relay socket shall have screw terminals. Mold into the socket the coincident screw terminal numbers and associated octal pin numbers.

B. Multifunction Time-Delay Relays:
1. Relays shall be continuous duty and rated for at least 10 A at 240-V ac and 60 Hz.

2. Relays shall be DPDT relay with up to eight programmable functions to provide on/off delay, interval and recycle timing functions.
3. Use a plug-in-style relay with either an 8- or 11-pin octal plug.
4. Construct the contacts of either silver cadmium oxide or gold.
5. Enclose the relay in a dust-tight cover.
6. Include knob and dial scale for setting delay time.
7. Equip relays with coil transient suppression to limit transients to non-damaging levels.
8. Plug each relay into an industry-standard, 35-mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
9. Relay socket shall have screw terminals. Mold into the socket the coincident screw terminal numbers and associated octal pin numbers.

C. Latching Relays:
1. Relays shall be continuous duty and rated for at least 10 A at 250-V ac and 60 Hz.
2. Relays shall be either DPDT or three-pole double throw, depending on the control application.
3. Use a plug-in-style relay with a multibladed plug.
4. Construct the contacts of either silver cadmium oxide or gold.
5. Enclose the relay in a clear transparent polycarbonate dust-tight cover.
6. Equip relays with coil transient suppression to limit transients to non-damaging levels.
7. Plug each relay into an industry-standard, 35-mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
8. Relay socket shall have screw terminals. Mold into the socket the coincident screw terminal numbers and associated octal pin numbers.

D. Current Sensing Relay:
1. Monitors ac current.
2. Independent adjustable controls for pickup and dropout current.
3. Energized when supply voltage is present and current is above pickup setting.
4. De-energizes when monitored current is below dropout current.
5. Dropout current is adjustable from 50 to 95 percent of pickup current.
6. Include a current transformer, if required for application.
7. House current sensing relay and current transformer in its own enclosure. Use NEMA 250, Type 12 enclosure for indoors and NEMA 250, Type 4 for outdoors.

E. Combination On-Off Status Sensor and On-Off Relay:
1. Description:
   a. On-off control and status indication in a single device.
   b. LED status indication of activated relay and current trigger.
   c. Closed-Open-Auto override switch located on the load side of the relay.
2. Performance:
   a. Ambient Temperature: Minus 30 to 140 deg F.
   b. Voltage Rating: Single-phase loads rated for 300-V ac. Three-phase loads rated for 600-V ac.
3. Status Indication:
   a. Current Sensor: Integral sensing for single-phase loads up to 20 A and external solid or split sensing ring for three-phase loads up to 150 A.
   b. Current Sensor Range: As required by application.
   c. Current Set Point: Fixed or adjustable as required by application.
   d. Current Sensor Output:
      1) Solid-state, single-pole double-throw contact rated for 30-V ac and dc and for 0.4 A.
      2) Solid-state, single-pole double-throw contact rated for 120-V ac and 1.0 A.
      3) Analog, zero- to 5- or 10-V dc.
      4) Analog, 4 to 20 mA, loop powered.
4. Relay: Single-pole double-throw, continuous-duty coil; rated for 10-million mechanical cycles.

5. Enclosure: NEMA 250, Type 1 enclosure.

2.15 ELECTRICAL POWER DEVICES

A. Transformers:
   1. Transformer shall be sized for the total connected load, plus an additional 25 percent of connected load.
   2. Transformer shall be at least 100 VA.
   3. Transformer shall have both primary and secondary fuses.

B. DC Power Supply:
   1. Plug-in style suitable for mating with a standard eight-pin octal socket. Include the power supply with a mating mounting socket.
   2. Enclose circuitry in a housing.
   3. Include both line and load regulation to ensure a stable output. To protect both the power supply and the load, power supply shall have an automatic current limiting circuit.
   4. Performance:
      a. Output voltage nominally 25-V dc within 5 percent.
      b. Output current up to 100 mA.
      c. Input voltage nominally 120-V ac, 60 Hz.
      d. Load regulation within 0.5 percent from zero- to 100-mA load.
      e. Line regulation within 0.5 percent at a 100-mA load for a 10 percent line change.
      f. Stability within 0.1 percent of rated volts for 24 hours after a 20-minute warmup.

2.16 UNINTERRUPTABLE POWER SUPPLY (UPS) UNITS

A. 250 through 1000 VA:
   1. UPS units shall provide continuous, regulated output power without using their batteries during brown-out, surge, and spike conditions.
   2. Load served shall not exceed 75 percent of UPS rated capacity, including power factor of connected loads.
      a. Larger-capacity units shall be provided for systems with larger connected loads.
      b. UPS shall provide 5 minutes of battery power.
   3. Performance:
      a. Input Voltage: Single phase, 120- or 230-V ac, compatible with field power source.
      b. Load Power Factor Range (Crest Factor): 0.65 to 1.0.
      c. Output Voltage: 101- to 132-V ac, while input voltage varies between 89 and 152- V ac.
      d. On Battery Output Voltage: Sine wave.
      e. Inverter overload capacity shall be minimum 150 percent for 30 seconds.
      f. Recharge time shall be a maximum of six hours to 90 percent capacity after full discharge to cutoff.
      g. Transfer Time: 6 ms.
      h. Surge Voltage Withstand Capacity: IEEE C62.41, Categories A and B; 6 kV/200 and 500 A; 100-kHz ringwave.
   4. UPS shall be automatic during fault or overload conditions.
   5. Unit with integral line-interactive, power condition topology to eliminate all power contaminants.
   6. Include front panel with power switch and visual indication of power, battery, fault and temperature.
   7. Unit shall include an audible alarm of faults and front panel silence feature.
   8. Unit with four NEMA WD 1, NEMA WD 6 Configuration 5-15R receptacles.
   9. UPS shall include dry contacts (digital output points) for low battery condition and battery- on (primary utility power failure) and connect the points to the DDC system.
   10. Batteries shall be sealed lead-acid type and be maintenance free. Battery replacement shall be front accessible by user without dropping load.
   11. Include tower models installed in ventilated cabinets to the particular installation location.

B. 1000 through 3000 VA:

1. UPS units shall provide continuous, regulated output power without using their batteries during brown-out, surge, and spike conditions.
2. Load served shall not exceed 75 percent of UPS rated capacity, including power factor of connected loads.
    a. Larger-capacity units, or multiple units, shall be provided for systems with larger connected loads.
    b. UPS shall provide 5 minutes of battery power.
3. Performance:
    a. Input Voltage: Single phase, 120-V ac, plus 20 to minus 30 percent.
    b. Power Factor: Minimum 0.97 at full load.
    c. Output Voltage: Single phase, 120-V ac, within 3 percent, steady state with rated output current of 10.0 A, 30.0-A peak.
    d. Inverter overload capacity shall be minimum 150 percent for 30 seconds.
    e. Recharge time shall be a maximum of eight hours to 90 percent capacity.
4. UPS bypass shall be automatic during fault or overload conditions.
5. UPS shall include dry contacts (digital output points) for low battery condition and battery- on (primary utility power failure) and connect the points to the DDC system.
6. Batteries shall be sealed lead-acid type and be maintenance free.
7. Include tower models installed in ventilated cabinets or rack models installed on matching racks, as applicable to the particular installation location and space availability/configuration.

2.17 CONTROL WIRE AND CABLE

A. Wire: Single conductor control wiring above 24 V.
    1. Wire size shall be at least No. 14 AWG or sized per length of run.
    2. Conductor shall be 7/24 soft annealed copper strand with 2- to 2.5-inch lay.
    3. Conductor insulation shall be 600 V, Type THWN or Type THHN, and 90 deg C according to UL 83.
    4. Conductor colors shall be black (hot), white (neutral), and green (ground).
    5. Furnish wire on spools.
B. Single Twisted Shielded Instrumentation Cable above 24 V:
    1. Wire size shall be a minimum No. 18 AWG or sized per length of run.
    2. Conductors shall be a twisted, 7/24 soft annealed copper strand with a 2- to 2.5-inch lay.
    3. Conductor insulation shall have a Type THHN/THWN or Type TFN rating.
    4. Shielding shall be 100 percent type, 0.35/0.5-mil aluminum/Mylar tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
    5. Outer jacket insulation shall have a 600-V, 90-deg C rating and shall be Type TC cable.
    6. For twisted pair, conductor colors shall be black and white. For twisted triad, conductor colors shall be black, red and white.
    7. Furnish wire on spools.
C. Single Twisted Shielded Instrumentation Cable 24 V and Less:
    1. Wire size shall be a minimum No. 18 AWG or sized per length of run.
    2. Conductors shall be a twisted, 7/24 soft annealed copper stranding with a 2- to 2.5-inch lay.
    3. Conductor insulation shall have a nominal 15-mil thickness, constructed from flame-retardant PVC.
    4. Shielding shall be 100 percent type, 1.35-mil aluminum/polymer tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
    5. Outer jacket insulation shall have a 300-V, 105-deg C rating and shall be Type PLTC cable.
    6. For twisted pair, conductor colors shall be black and white. For twisted triad, conductor colors shall be black, red and white.
    7. Furnish wire on spools.
D. LAN and Communication Cable: Comply with DDC system manufacturer requirements for network being installed.

1. Cable shall be plenum rated.
2. Cable shall comply with NFPA 70.
3. Cable shall have a unique color that is different from other cables used on Project.
4. Copper Cable for Ethernet Network:
    a. 100BASE-TX, 1000BASE-T, or 1000BASE-TX.
    b. TIA/EIA 586, Category 6.
    c. Minimum No. 22 AWG solid or sized per length of run.
    d. Shielded Twisted Pair (STP).
    e. Thermoplastic insulated conductors, enclosed in a thermoplastic outer jacket, Class CMP as plenum rated.

2.18 RACEWAYS FOR CONTROL WIRING, CABLING, AND TUBING

A. Metal Conduits, Tubing, and Fittings:
1. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. EMT: Comply with NEMA ANSI C80.3 and UL 797.
3. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.19 CONTROL POWER WIRING AND RACEWAYS

A. Installation minimum requirements:
1. Mechanical spaces, services spaces, and areas without ceiling: All wiring including cables in EMT.
2. Space sensors and alarms: All wiring cables in EMT within wall construction.
3. Ducted ceiling return: Approved non-plenum cable.
4. Non-ducted return ceiling plenum: Approved plenum rated cable.
5. Non-accessible ceilings: EMT or code compliant equal solid conduit.
6. Inside air handling units: All wiring including cables in EMT or code compliant solid conduit.
7. Note the use of cable is limited to low voltage service with less than 24 volt only.
8. Do not lay cables on ceiling grids.
9. Conduit junctions and terminations shall utilize compression fittings.

B. All control wiring that is stated to be routed in EMT shall be separate from any power wiring.

2.20 FIELD EQUIPMENT

A. Space Sensors:
1. See space sensor schedule on drawings.
2. Set-point adjustment to be a maximum plus and minus 5 degrees from the null setpoint programmed through the DDC system.
3. Space sensors may be (RTD) 1,000 Ohm platinum with an accuracy of ±0.5 deg F or 10,000 OHM thermistor with accuracy of ±0.5 deg. F for all spaces.
4. Space sensor shall be manufacture's standard color.
5. Provide insulating bases for all sensors located on exterior walls and on exterior column wraps. Foam seal cavity and junction box prior to installing insulating base.
6. Space sensors with occupant set-point adjustment shall be adjustable from the operator's workstation as to the deadband of adjustability allowed to the occupants.

B. Temperature Sensors:
1. Duct sensors for critical spaces shall utilize averaging elements, 1000 OHM platinum Resistance Temperature Detectors (RTD) having an accuracy of ±0.5 deg F.
2. Duct sensors for non-critical spaces may utilize 10,000 OHM or 20,000 OHM thermistor having an accuracy of ±1.0 deg F. 1000 OHM RTDs are also acceptable for non-critical applications.
3. Immersion sensors to be furnished with companion wells separable stainless steel. Well pressure rating shall be consistent with and extend the system pressure it will be immersed in. Wells shall withstand pipe design flow velocities.

C. Low limit thermostats:

1. Low limit safety thermostats shall be manually reset, line voltage with maximum 23'-0" flexible sensing elements responsible to lowest temperature along entire length. Furnish minimum two (2) wired in series on the discharge side of the first hydronic coils (i.e., a 4-section coil requires eight low limit thermostats wired in series). Contractor to note that the operating head of such instruments shall be shielded from conditions whereby it could be activated by low temperature.
2. All flexible averaging sensors shall be attached by wire ties to a suspended wire or insulated cable to prevent sensor contact with metal or other unit components.
3. Install flexible sensors across all coils at a maximum of 6” from the bottom of the bottom coil and a minimum of 7” diameter to turn the sensor. Install the detector with a maximum free distance of 12” between each pass.
4. Staggered coils (if applicable) shall utilize multiple sensors. Each sensor shall cover one section of the staggered coil. Sensing elements shall be a minimum of 17’ long.
5. All flexible sensors shall be protected at point of penetration of unit via a section of poly tubing to prevent contact of the sensor and the unit.
6. Mount detector within 6” of the face of the coil unless noted otherwise. For staggered coil banks, this requirement applies for each half of the bank
7. TCC to note that when any low limit controls are above an elevation 7'-0" above floor level or otherwise inaccessible, they shall employ automatic reset and shall be wired to an auxiliary control panel of a 5'-0" elevation. The control panel with piano hinged door shall utilize a latching reset relay for each individual low limit control which ensures that the fan is de-energized even as the low limit resets automatically. The panel face shall utilize a red alarm pilot light that remains lit until the 10 second time delay reset relay momentary contact switch is activated. An LED inside the panel shall indicate which of low limits has signaled the alarm.

D. Electronic Actuators:
1. Manufactured, brand labeled or distributed by Belimo or Johnson Controls, Inc. or Siemens.
2. Size for torque required for damper seal at load conditions.
3. Coupling: V-bolt dual nut clamp with a V-shaped, toothed cradle.
4. Mounting: Actuators shall be direct shaft mount type. Actuators shall be capable of being mechanically and electrically paralleled to increase torque if required.
5. Overload protected electronically throughout rotation.
6. Fail safe operation: Mechanical, spring return mechanism.
7. Power requirements (spring return): 24 VAC.
8. Proportional actuators shall be fully programmable through an EEPROM without the use of actuator mounted switches.
9. Temperature rating: -22 deg. F to +122 deg. F.
10. Housing: Minimum requirement NEMA Type 2/IP54 mounted in any orientation. NEMA 4/4X (IP67) required for outdoor applications.
11. Agency listings: ISO 9001 or UL.
12. The manufacturer shall warrant all components for a period of 5 years from the date of production with the first two years unconditional.
13. All damper actuators used on equipment introducing outdoor air shall be furnished with mechanical spring return mechanism as indicated in “fail safe operation” above.
14. All actuators shall have external adjustable stops to limit the travel in either direction and a gear release to allow manual positioning.
15. Actuators shall be provided with position feedback signal (2-10 VDC or 4-20 mA) where indicated on control drawings. Feedback signal shall be independent of the input signal and shall provide true position indication.

E. Dampers:
1. All automatic dampers furnished by this Contractor for modulating control shall be of the proportioning type with opposed or parallel blades depending on the application or as shown on the drawings. Dampers for two position action shall be of the opposed blade type for all applications except those located immediately at the inlet of fans and as noted

otherwise on the drawings. Dampers for generator radiator fan exhaust shall be opposed blade type.

2. All dampers for outdoor air service and exhaust air service to be equivalent to TAMCO Series 9000 aluminum and have the following features:
   a. Frames shall be 4” deep X 1” and no less than .080” in thickness, mill finish extruded aluminum 6063-T5 with mounting flanges on both sides of the frame. Frame to be assembled using plated steel mounting fasteners.
   b. Entire frame shall be thermally broken by means of two polyurethane resin pockets complete with thermal cuts.
   c. Blades shall be extruded aluminum 6063-T5, mill finish air foil profiles, internally insulated with expanded polyurethane foam and shall be thermally broken.
   d. Blade and frame seals shall be of extruded silicone and shall be secured in an integral slot within the aluminum extrusions. Blade and frame seals are to be mechanically fastened to eliminate shrinkage and movement over the life of the damper. Adhesive or clip on type blade seals shall not be approved. Jamb seals shall be silicone.
   e. Maintenance free bearings are to be composed of an inner bearing fixed to a 7/16” aluminum hexagon blade pivot pin, rotating within a polycarbonate outer bearing inserted into the frame. There shall be no metal-to-metal or metal-to-plastic contact.
   f. Adjustable 7/16” hexagonal drive rod, U-bolt fastener and hexagonal retaining nuts shall be corrosion resistant, zinc plated steel to provide positive connection to blades and linkage.
   g. Linkage hardware shall be installed in the frame side. All linkage crank arm and rod hardware parts shall be constructed of mill finished aluminum, complete with corrosion resistant, zinc plated trunnions and cup point trunnion screws for a slip-proof grip.
   h. Dampers are to be designed for operation in temperatures ranging between -40 deg. F (-40 deg. C) and 212 deg. F (100 deg. C).
   i. Dampers shall be rated Leakage Class 1A at 1 in. w.g. (0.25 kPa) static pressure differential. Standard air leakage data shall be certified under the AMCA Certified Ratings Program.
   j. Dampers shall be made to size required without blanking off free area.
   k. Dampers shall be available as “flanged to duct” mounting type.
   l. Installation of dampers must be in accordance with manufacturer’s installation guidelines provided with each damper shipment.
   m. Intermediate or tubular steel structural support is required to resist applied pressure loads for dampers that consist of two or more sections in both height and width. (See manufacturer’s installation guidelines).
3. Dampers for all other applications to be equal to TAMCO Series 1500 Ultra Low Leakage Air Foil Aluminum and have the following features:
   a. Frames shall be 4” deep X 1” and no less than .080” in thickness, mill finish extruded aluminum 6063-T5 with mounting flanges on both sides of the frame. Frame to be assembled using plated steel mounting fasteners.
   b. Entire frame shall be thermally broken by means of two polyurethane resin pockets complete with thermal cuts.
   c. Blades shall be extruded aluminum 6063-T5, mill finish air foil profiles, internally insulated with expanded polyurethane foam and shall be thermally broken.
   d. Blade and frame seals shall be of extruded silicone and shall be secured in an integral slot within the aluminum extrusions. Blade and frame seals are to be mechanically fastened to eliminate shrinkage and movement over the life of the damper. Adhesive or clip on type blade seals shall not be approved.
   e. Maintenance free bearings are to be composed of an inner bearing fixed to a 7/16” aluminum hexagon blade pivot pin, rotating within a polycarbonate outer bearing inserted into the frame. There shall be no metal-to-metal or metal-to-plastic contact.
   f. Adjustable 7/16” hexagonal drive rod, U-bolt fastener and hexagonal retaining nuts shall be corrosion resistant, zinc plated steel to provide positive connection to blades and linkage.

g. Linkage hardware shall be installed in the frame side. All linkage crank arm and rod hardware parts shall be constructed of mill finished aluminum, complete with corrosion resistant, zinc plated trunnions and cup point trunnion screws for a slip-proof grip.
h. Dampers are to be designed for operation in temperatures ranging between -40 deg. F (-40 deg. C) and 212 deg. F (100 deg. C).
i. Dampers shall be rated Leakage Class 1A at 1 in. w.g. (0.25 kPa) static pressure differential. Standard air leakage data shall be certified under the AMCA Certified Ratings Program.
j. Dampers shall be made to size required without blanking off free area.
k. Dampers shall be available with either opposed blade action or parallel blade action.
l. Dampers shall be available as “flanged to duct” mounting type.
m. Installation of dampers must be in accordance with manufacturer’s installation guidelines provided with each damper shipment.
n. Intermediate or tubular steel structural support is required to resist applied pressure loads for dampers that consist of two or more sections in both height and width. (See manufacturer’s installation guidelines).

4. Automatic dampers (modulating) shall be designed for face velocity that varies from 1,200 fpm to 2,000 fpm in most cases as approved by the design engineer. Dampers to be selected by the supplier with blade shaft lengths that prevent torsion that will create a leakage of more than 2 percent of the rated leakage capacity. Beyond that point, the dampers shall be broken into multiple sections. Field supplied mullions are required on large dampers exceeding 200 square feet.
5. Individual damper section actuators are preferred unless access to actuators is difficult and then jack shafting is acceptable. TCC to note that drive shafts between dampers of different air paths (i.e., outdoor air and return air or return air and exhaust air) is not acceptable. Jack shafting between sections is permitted when such shafting is designed to accommodate and eliminate the effects of torsion.
6. TCC to note that free access to all actuators is the responsibility of the TCC.
7. Each damper shall be equipped with an individual damper operator of the size and style required for the service intended.
8. Actuators to be designed for modulating control with spring return to the fail "safe" position. Actuators to be low voltage with 100% surplus torque (submittals to incorporate calculations to prove 100 percent closure under 4.0" wg status pressure differential for modulating service and 2.0" wg for two position application).
9. Terminal box/AFCV damper actuators to be low voltage, non-spring return and incremental control with 200 percent torque. All control actuators to utilize auto zero program to insure total accuracy of damper actuator. The feature to be activated during periods of low or no occupancy.

F. Insertion Turbine Flow Meters for Closed Loop Condenser Water:
1. Provide dual turbine flow meter complete with all installation hardware necessary to enable insertion and removal of the meter without system shutdown. The flow meter shall be hand insertable up to 400 psi. The flow meter shall have two contra-rotating axial turbines, with electronic impedance-based sensing and an averaging circuit to reduce measurement errors due to swirl and flow profile distortion.
2. The flow meter shall be installed in accordance with the manufacturer’s installation guide including meter orientation and straight pipe recommendations.
3. Wetted metal components shall be nickel-plated brass for applications operating below 250 degrees F, 316L SS construction for DW applications, HTHW applications operating over 250 degrees F, and for any application in non-metallic pipe. The maximum operating temperature shall be 280 degrees F, 300 F peak.
4. Each flow meter shall be individually wet-calibrated against a primary volumetric standard that is accurate to within 0.1% and traceable to NIST. The manufacturer’s certificate of calibration shall be provided with each flow meter.

5. Accuracy shall be within ± 0.5% of rate at the calibrated velocity, within ± 1% of rate over a 10:1 turndown (3.0 to 30 ft/s) and within ± 2% of rate over a 50:1 turndown (from 0.4 to 20 ft/s).
6. The flow meter shall include integral analog output(s), 4-20 mA, 0-10V, or 0-5V, and a high resolution frequency output for use with peripheral devices (remote display or BTU Meter). FB-1210 for Bi-directional applications shall include an isolated contact closure output for direction.
7. The flow meter shall be covered by the manufacturer's three-year warranty.
8. Turbine meter shall be ONICON Incorporated Model F-1210 Dual Turbine, or equivalent as approved by the Engineer.

G. Energy BTU Measurement System:
1. The entire energy BTU measurement system shall be built and calibrated by a single manufacturer and shall consist of a flow meter, two temperature sensors, a BTU meter, temperature thermowells, and all required mechanical installation hardware. The BTU meter and associated sensors and flow meter shall be installed in accordance with the manufacturer's installation guide.
2. The BTU meter shall provide the following points both at the integral LCD and as outputs to the building control system: Energy total, Energy rate, flow rate, supply temperature and return temperature. Output signals shall be either serial network (protocol conforming to BACnet® MS/TP, JCI-N2, MODBUS RTU, MODBUS TCP, or Siemens-P1) and/or via individual analog and pulse outputs.
3. Each BTU meter shall be factory programmed and tagged for its specific application, and shall be re-programmable using the front panel keypad (no special interface device or computer required).
4. Temperature sensors shall be loop-powered current based (mA) sensors and shall be bath-calibrated and matched (NIST traceable) for the specific temperature range for each application. The calculated differential temperature used in the energy calculation shall be accurate to within $\pm$0.15˚F (including the error from individual temperature sensors, sensor matching, input offsets, and calculations).
5. A certificate of NIST traceable calibration shall be provided with each system.
6. Flow meter shall be in accordance with paragraph A, B, C, or D, refer to meter schedule for specific flow meter type.
7. All equipment shall be covered by the manufacturer's three-year warranty.
8. Energy BTU measurement system shall be ONICON Incorporated System-10 BTU Meter, or equivalent as approved by the Engineer.

H. Differential Pressure Transmitter:
1. Liquid: Furnish field mounted differential pressure transmitters as indicated on plans for measuring differential pressure and transmitting an isolated 4 to 20 mA DC output linear differential pressure signal.
    a. The unit shall be accurate to ±0.20% of calibrated span. It shall withstand static pressures of 1000 psig with negligible change in output. The flanges shall be made of stainless steel with stainless steel wetted sensing components, wetted parts all stainless steel and a silicone fill fluid. A brass or stainless 3 valve bypass manifold and bracket mounting kit shall be utilized for easier on-site equalization and calibration. Unit shall be protected against radio frequency interference and shall have a water-tight (NEMA Type 4) electrical enclosure with 1/2" NPT conduit connection. An LCD display is not required.
        1) The Type A transmitter shall be a standard process grade loop powered transmitter as manufactured by:
            a) Rosemount Model 3051C.
            b) Foxboro Model IDP10.
            c) Yokogawa Model EJA110A.
2. Air: Furnish field mounted differential pressure transmitters using a 4-20 mA (or 0-10 VDC) output linear with measured differential pressure. Accuracy shall be ±0.8% of calibrated

span. Response time shall be 250 milliseconds. Transmitter shall be in a standard grade transmitter manufactured by Ashcroft or Setra.

I. Airflow Measuring Stations:
   1. All air flow measuring stations to be furnished under this contract as shown on control schematics and as scheduled.
      a. Approved manufacturers are Tek-Air Systems, Air Monitor, Paragon, Ebtron, Farr, and Airflow Wing.
   2. Duct-mounted stations shall be installed by the Sheet Metal Contractor while fan inlet station installation responsibility shall be by this Contractor.
   3. Sizing and physical location of stations shall be the responsibility of this Contractor. TCC to ensure that sufficient distance is available both upstream and downstream such that turbulence is not a factor in the velocity pressure measurement. Sizing shall insure that the minimum velocity across the station affords accuracy of measurement and the design engineer shall be notified within 30 days of contract award if any modifications are required to the field ductwork.
   4. TCC to ensure that a proper access door upstream of the station is provided in the ductwork such that the inlet face of the unit may be cleaned as necessary.
   5. Duct-mounted air flow measuring stations:
      a. Furnish and install air flow measuring stations constructed of 16 gage sheet metal casing and a copper velocity pressure traverse section.
      b. The velocity pressure traverse section shall consist of air straightening tubes, total pressure sensors and static pressure sensors, all interconnected to form a traverse by copper manifolds which shall equalize and integrate each type sensor measurement into one (1) total pressure and one (1) static pressure metering port. There shall be one static pressure sensor for each total pressure sensor.
      c. A minimum of one static and one total pressure sensor shall be used for every 16 square feet in cross section. For larger ducts, a minimum of one static and one total pressure sensor shall be used for every 36" of duct cross sectional area up to a maximum as recommended by ASHRAE guide for traverse measurement.
      d. Identification: Each air flow measuring station shall have a nameplate with the following information:
         1) Unit size.
         2) Unit designation.
         3) Design air quantity.
         4) Direction of air flow.
         5) Design air velocity.
   6. Fan inlet air flow sensing (non-intrusive piezometer type):
      a. Accuracy: Within 2% throughout the velocity range of 600 fpm and over, when installed in accordance with published recommendations
      b. Temperature: 350 deg F continuous operation; 400 deg F intermittent operation
      c. Humidity: 0-100% continuous operation
      d. Corrosion resistance: Good salt air and mild acid resistance, excellent solvent and aromatic hydrocarbon resistance
      e. Material: 6063-T5 anodized aluminum, galvanized mounting brackets

J. Thermal Dispersion Air Flow Measurement:
   1. Air volume measurement system to consist of multiple sensors designed to average velocity using thermal dispersion principles. System to be designed to be totally independent of temperature, density, and humidity. Tek-Air or Ebtron.
   2. The quantity of sensing tubes shall conform to manufacturer’s requirements for spacing based on the specified accuracy and the actual inlet and outlet conditions.
   3. Unit to be accurate to 1.5% between 50 fpm and 6000 fpm. Output to be 4-20 mA.

K. VAV/CAV Terminal Unit Control Components (DDC Control):

Component	Furnished By	Installed By	Wired By
Disconnect Switch	Manufacturer	Manufacturer	Manufacturer
Transformer	TCC	Manufacturer	Manufacturer
Damper Actuator	TCC	Manufacturer	Manufacturer
Flow Controller	TCC	Manufacturer	Manufacturer
Flow Sensing	Manufacturer	Manufacturer	Manufacturer
Misc Accessories	TCC	TCC	TCC

L. Gas Instruments:
   1. Dual Carbon Monoxide (CO) & Nitrogen Dioxide (No2) Sensor and Controller.
      a. Comply with UL 61010-1.
      b. Wall mounted.
      c. 24 VAC power.
      d. BACnet MS/TP protocol.
      e. Programmable fan and alarm relays.
      f. Integrated display with LED indicators for status and adjustable parameters for warning and alarm setpoints.
      g. Audible alarm.
      h. 2 analog outputs.
      i. Field replaceable sensing elements with a 7-year minimum life expectancy on each element.
      j. Standard water/dust tight, corrosion resistant drip proof enclosure.
      k. Carbon Monoxide accuracy to be plus or minus 5% between 0-100 ppm and cover up to 7500 SF.
      l. Nitrogen Dioxide accuracy to be plus or minus 5% between 0-10 ppm and cover up to 7500 SF.
      m. Include standard 7-year warranty on sensor electronics and 2-year warranty on replaceable elements.
      n. Similar or equivalent to Senva TG Series.
   2. Carbon Monoxide (CO) Sensor and Controller.
      a. Comply with UL 61010-1.
      b. Wall mounted.
      c. 24 VAC power.
      d. BACnet MS/TP protocol.
      e. Programmable fan and alarm relays.
      f. Integrated display with LED indicators for status and adjustable parameters for warning and alarm setpoints.
      g. Audible alarm.
      h. 2 analog outputs.
      i. Field replaceable sensing elements with a 7-year minimum life expectancy on each element.
      j. Standard water/dust tight, corrosion resistant drip proof enclosure.
      k. Carbon Monoxide accuracy to be plus or minus 5% between 0-100 ppm and cover up to 7500 SF.
      l. Include standard 7-year warranty on sensor electronics and 2-year warranty on replaceable elements.
      m. Similar or equivalent to Senva TG Series.
      n. Application
         1) Locate in any mechanical room with condensing boilers.

M. Control Valves:
   1. Source Limitations: Obtain valves from single manufacturer.
   2. Selection Criteria:
      a. Control valves shall be suitable for operation at following conditions:
         1) Refer to specification section 232113 – Hydronic Piping for system pressures.
      b. Fail positions unless otherwise indicated:

1) Condenser Water: Open.

c. In water systems, select modulating control valves for a design Cv based on a pressure drop of:
   1) 1 psig for two-position unless otherwise indicated.
   2) 5 psig for two way modulating unless otherwise indicated.
   3) 5 psig for three way modulating unless otherwise indicated.

d. Actuators:
   1) Actuators for Steam Control Valves: Shutoff against 1.5 times design pressure.

2.21 BALL-STYLE CONTROL VALVES

A. Ball Valves with Single Port and Characterized Disk:
   1. Pressure Rating for NPS 1 and Smaller: Nominal 600 WOG.
   2. Pressure Rating for NPS 1-1/2 through NPS 2: Nominal 400 WOG.
   3. Close-off Pressure: 200 psig.
   4. Process Temperature Range: Zero to 212 deg F.
   5. Body and Tail Piece: Cast bronze ASTM B 61, ASTM B 62, ASTM B 584, or forged brass with nickel plating.
   6. End Connections: Threaded (NPT) ends.
   7. Ball: 300 series stainless steel.
   8. Stem and Stem Extension:
      a. Material to match ball.
      b. Blowout-proof design.
      c. Sleeve or other approved means to allow valve to be opened and closed without damaging the insulation or the vapor barrier seal.
   9. Ball Seats: Reinforced PTFE.
   10. Stem Seal: Reinforced PTFE packing ring with a threaded packing ring follower to retain the packing ring under design pressure with the linkage removed. Alternative means, such as EPDM O-rings, are acceptable if an equivalent cycle endurance can be demonstrated by testing.
   11. Flow Characteristic: Equal percentage.

B. Ball Valves with Two Ports and Characterized Disk:
   1. Pressure Rating for NPS 1 and Smaller: Nominal 600 WOG.
   2. Pressure Rating for NPS 1-1/2 through NPS 2: Nominal 400 WOG.
   3. Close-off Pressure: 200 psig.
   4. Process Temperature Range: Zero to 212 deg F.
   5. Body and Tail Piece: Cast bronze ASTM B 61, ASTM B 62, ASTM B 584, or forged brass with nickel plating.
   6. End Connections: Threaded (NPT) ends.
   7. Ball: 300 series stainless steel.
   8. Stem and Stem Extension:
      a. Material to match ball.
      b. Blowout-proof design.
      c. Sleeve or other approved means to allow valve to be opened and closed without damaging the insulation or the vapor barrier seal.
   9. Ball Seats: Reinforced PTFE.
   10. Stem Seal: Reinforced PTFE packing ring with a threaded packing ring follower to retain the packing ring under design pressure with the linkage removed. Alternative means, such as EPDM O-rings, are acceptable if an equivalent cycle endurance can be demonstrated by testing.
   11. Flow Characteristics for A-Port: Equal percentage.
   12. Flow Characteristics for B-Port: Modified for constant common port flow.

2.22 GLOBE-STYLE CONTROL VALVES

A. General Globe-Style Valve Requirements:
   1. Globe-style control valve body dimensions shall comply with ISA 75.08.01.
   2. Construct the valves to be serviceable from the top.

3. For cage guided valves, trim shall be field interchangeable for different valve flow characteristics, such as equal percentage, linear, and quick opening.
4. Reduced trim for one nominal size smaller shall be available for industrial valves NPS 1 and larger.
5. Replaceable seats and plugs.
6. Furnish each control valve with a corrosion-resistant nameplate indicating the following:
   a. Manufacturer's name, model number, and serial number.
   b. Body and trim size.
   c. Arrow indicating direction of flow.

B. Two-Way Globe Valves NPS 2 and Smaller:
1. Globe Style: Single port.
2. Body: Cast bronze or forged brass with ASME B16.5, Class 250 rating.
3. End Connections: Threaded.
4. Bonnet: Screwed.
5. Packing: PTFE V-ring.
6. Plug: Top guided.
7. Plug, Seat, and Stem: stainless steel.
8. Process Temperature Range: 35 to 248 deg F.
9. Ambient Operating Temperature: 35 to 150 deg F.
10. Leakage: FCI 70-2, Class IV.
11. Rangeability: 25 to 1.
12. Equal percentage flow characteristic.

C. Three-Way Globe Valves NPS 2 and Smaller:
1. Globe Style: Mix flow pattern.
2. Body: Cast bronze or forged brass with ASME B16.5, Class 250 rating.
3. End Connections: Threaded.
4. Bonnet: Screwed.
5. Packing: PTFE V-ring.
6. Plug: Top guided.
7. Plug, Seat, and Stem: stainless steel.
8. Process Temperature Range: 35 to 248 deg F.
9. Ambient Operating Temperature: 35 to 150 deg F.
10. Leakage: FCI 70-2, Class IV.
11. Rangeability: 25 to 1.
12. Linear flow characteristic.

D. Two-Way Globe Valves NPS 2-1/2 to NPS 6:
1. Globe Style: Single port.
2. Body: Cast iron complying with ASME B61.1, Class 125.
3. End Connections: Flanged, suitable for mating to ASME B16.5, Class 150 flanges.
4. Bonnet: Bolted.
5. Packing: PTFE cone-ring.
6. Plug: Top or bottom guided.
7. Plug, Seat, and Stem: Brass or stainless steel.
8. Process Temperature Rating: 35 to 281 deg F.
9. Leakage: 0.1 percent of maximum flow.
10. Rangeability: Varies with valve size between 6 and 10 to 1.
11. Modified linear flow characteristic.

2.23 ACCESSORIES

A. Damper Blade Limit Switches:
1. Sense positive open and/or closed position of the damper blades.
2. NEMA 250, Type 13, oil-tight construction.
3. Arrange for the mounting application.
4. Additional waterproof enclosure when required by its environment.
5. Arrange to prevent "over-center" operation.

2.24 IDENTIFICATION

A. Instrument Air Pipe and Tubing:
   1. Engraved tag shall bear the following information:
      a. Service (Example): "Instrument Air."
      b. Pressure Range (Example): 0 to 30 psig.
   2. Letter size shall be a minimum of 0.25 inch high.
   3. Tag shall consist of white lettering on blue background.
   4. Tag shall be engraved phenolic consisting of three layers of rigid laminate. Top and bottom layers are color-coded blue with contrasting white center exposed by engraving through outer layer.
   5. Include tag with a brass grommet, chain and S-hook.

B. Control Equipment, Instruments, and Control Devices:
   1. Engraved tag bearing unique identification.
      a. Include instruments with unique identification identified by equipment being controlled or monitored, followed by point identification.
   2. Letter size shall be as follows:
      a. Operator Workstations: Minimum of 0.5 inch high.
      b. Printers: Minimum of 0.5 inch high.
      c. DDC Controllers: Minimum of 0.5 inch high.
      d. Gateways: Minimum of 0.5 inch high.
      e. Repeaters: Minimum of 0.5 inch high.
      f. Enclosures: Minimum of 0.5 inch high.
      g. Electrical Power Devices: Minimum of 0.25 inch high.
      h. UPS units: Minimum of 0.5 inch high.
      i. Accessories: Minimum of 0.25 inch high.
      j. Instruments: Minimum of 0.25 inch high.
      k. Control Damper and Valve Actuators: Minimum of 0.25 inch high.
   3. Tag shall consist of white lettering on black background.
   4. Tag shall be engraved phenolic consisting of three layers of rigid laminate. Top and bottom layers are color-coded black with contrasting white center exposed by engraving through outer layer.
   5. Tag shall be fastened with drive pins.
   6. Instruments, control devices and actuators with Project-specific identification tags having unique identification numbers following requirements indicated and provided by original manufacturer do not require an additional tag.

C. Valve Tags:
   1. Brass tags and brass chains attached to valve.
   2. Tags shall be at least 1.5 inches diameter.
   3. Include tag with unique valve identification indicating control influence such as flow, level, pressure, or temperature; followed by location of valve, and followed by three-digit sequential number. For example: TV-1.001.
   4. Valves with Project-specific identification tags having unique identification numbers following requirements indicated and provided by original manufacturer do not require an additional tag.

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

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

2.25 SOURCE QUALITY CONTROL

A. Product(s) and material(s) will be considered defective if they do not pass tests and inspections.
B. Prepare test and inspection reports.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
   1. Verify compatibility with and suitability of substrates.
B. Examine roughing-in for products to verify actual locations of connections before installation.
   1. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.
   2. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.
C. Examine walls, floors, roofs, and ceilings for suitable conditions where product will be installed.
D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 DDC SYSTEM INTERFACE WITH OTHER SYSTEMS AND EQUIPMENT

A. Communication Interface to Equipment with Integral Controls:
   1. DDC system shall have communication interface with equipment having integral controls and having a communication interface for remote monitoring or control.
   2. Equipment to Be Connected:
      a. Air-terminal units specified in Section 233600 "Air Terminal Units."
      b. Boilers specified in Section 235216 "Condensing Boilers."
      c. Chillers specified in Section 236416 “Centrifugal Water Chillers.”
      d. Cooling towers specified in Section 236514.14 "Cooling Towers."
      e. Air-handling units specified in Section 237313 "Modular Indoor Central-Station Air-Handling Units."
      f. Ductless Splits in Section 238126 “Split-System Air-Conditioners.”
      g. Refrigerator and Freezer/Coolers – see KEC plans.
      h. Variable-frequency controllers specified in Section 262923 "Variable-Frequency Motor Controllers."
      i. Refrigerant monitoring.

3.03 GENERAL INSTALLATION REQUIREMENTS

A. Install products to satisfy more stringent of all requirements indicated.
B. Install products level, plumb, parallel, and perpendicular with building construction.
C. Support products, tubing, piping wiring and raceways. Brace products to prevent lateral movement and sway or a break in attachment when subjected to a force.
D. If codes and referenced standards are more stringent than requirements indicated, comply with requirements in codes and referenced standards.
E. Fabricate openings and install sleeves in ceilings, floors, roof, and walls required by installation of products. Before proceeding with drilling, punching, and cutting, check for concealed work to avoid damage. Patch, flash, grout, seal, and refinish openings to match adjacent condition.
F. Firestop penetrations made in fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."
G. Seal penetrations made in acoustically rated assemblies. Comply with requirements in Section

079200 "Joint Sealants."

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

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

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

K. Corrosive Environments:
   1. Avoid or limit use of materials in corrosive airstreams and environments, including, but not limited to, the following:
      a. Laboratory exhaust-air streams.
      b. Process exhaust-air streams.
   2. When conduit is in contact with a corrosive airstream and environment, use Type 316 stainless-steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment. Comply with requirements for installation of raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
   3. Where instruments are located in a corrosive airstream and are not corrosive resistant from manufacturer, field install products in NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

3.04 OPERATOR WORKSTATION INSTALLATION

A. Desktop Operator Workstations Installation:
   1. Install operator workstation(s) at location(s) directed by Owner.
   2. Install multiple-receptacle power strip with cord for use in connecting multiple workstation components to a single duplex electrical power receptacle.

3. Install software on workstation(s) and verify software functions properly.
4. Develop Project-specific graphics, trends, reports, logs and historical database.
5. Power workstation through a UPS unit. Locate UPS adjacent to workstation.

B. Portable Operator Workstations Installation:
1. Turn over portable operator workstations to Owner at Substantial Completion.
2. Install software on workstation(s) and verify software functions properly.

C. Color Graphics Application:
1. Use system schematics indicated as starting point to create graphics.
2. Develop Project-specific library of symbols for representing system equipment and products.
3. Incorporate digital images of Project-completed installation into graphics where beneficial to enhance effect.
4. Submit sketch of graphic layout with description of all text for each graphic for Owner's review before creating graphic using graphics software.
5. Seek Owner input in graphics development once using graphics software.
6. Final editing shall be done on-site with Owner's review and feedback.
7. Refine graphics as necessary for Owner acceptance.
8. On receiving Owner acceptance, print a hard copy for inclusion in operation and maintenance manual. Prepare a scanned copy PDF file of each graphic and include with softcopy of DDC system operation and maintenance manual.

3.05 GATEWAY INSTALLATION

A. Install gateways if required for DDC system communication interface requirements indicated.
1. Install gateway(s) required to suit indicated requirements.

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

3.06 ROUTER INSTALLATION

A. Install routers if required for DDC system communication interface requirements indicated.
1. Install router(s) required to suit indicated requirements.

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

3.07 CONTROLLER INSTALLATION

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

B. Connect controllers to field power supply.

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

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

E. Installation of Network Controllers:
1. Quantity and location of network controllers shall be determined by DDC system manufacturer to satisfy requirements indicated.
2. Install controllers in a protected location that is easily accessible by operators.
3. Top of controller shall be within 72 inches of finished floor.

F. Installation of Programmable Application Controllers:
1. Quantity and location of programmable application controllers shall be determined by DDC system manufacturer to satisfy requirements indicated.
2. Install controllers in a protected location that is easily accessible by operators.
3. Top of controller shall be within 72 inches of finished floor.

G. Application-Specific Controllers:
1. Quantity and location of application-specific controllers shall be determined by DDC system manufacturer to satisfy requirements indicated.
2. For controllers not mounted directly on equipment being controlled, install controllers in a protected location that is easily accessible by operators.

3.08 ENCLOSURES INSTALLATION

A. Install the following items in enclosures, to comply with indicated requirements:
1. Gateways.
2. Routers.

3. Controllers.
4. Electrical power devices.
5. UPS units.
6. Relays.
7. Accessories.
8. Instruments.
9. Actuators

B. Attach wall-mounted enclosures to wall using the following types of steel struts:
1. For NEMA 250, Type 1 Enclosures: Use galvanized-steel strut and hardware.
2. For NEMA 250, Type 4 Enclosures and Enclosures Located Outdoors: Use stainless-steel strut and hardware.
3. Install plastic caps on exposed cut edges of strut.

C. Align top of adjacent enclosures of like size.

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

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

3.09 ELECTRIC POWER CONNECTIONS

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

B. Design of electrical power to products not indicated with electric power is delegated to DDC system provider and installing trade. Work shall comply with NFPA 70 and other requirements indicated.

C. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers" for electrical power circuit breakers.

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

E. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for electrical power raceways and boxes.

3.10 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements in Section 260553 "Identification for Electrical Systems" for identification products and installation.

B. Install engraved phenolic nameplate with unique identification on face for each of the following:
1. Operator workstation.
2. Printer.
3. Gateway.
4. Router.
5. DDC controller.
6. Enclosure.
7. Electrical power device.
8. UPS unit.
9. Accessory.

C. Install engraved phenolic nameplate with unique instrument identification on face of each instrument connected to a DDC controller.

D. Install engraved phenolic nameplate with identification on face of each control damper and valve actuator connected to a DDC controller.

E. Where product is installed above accessible tile ceiling, also install matching engraved phenolic nameplate with identification on face of ceiling grid located directly below.

F. Where product is installed above an inaccessible ceiling, also install engraved phenolic nameplate with identification on face of access door directly below.

G. Warning Labels:
1. Shall be permanently attached to equipment that can be automatically started by DDC control system.
2. Shall be located in highly visible location near power service entry points.

3.11 NETWORK INSTALLATION

A. Install copper cable when connecting between the following network devices located in same building:
   1. Operator workstations.
   2. Operator workstations and network controllers.
   3. Network controllers.

B. Install copper cable when connecting between the following:
   1. Gateways.
   2. Gateways and network controllers or programmable application controllers.
   3. Routers.
   4. Routers and network controllers or programmable application controllers.
   5. Network controllers and programmable application controllers.
   6. Programmable application controllers.
   7. Programmable application controllers and application-specific controllers.
   8. Application-specific controllers.

C. Install network cable in continuous raceway.
   1. Where indicated on Drawings, cable trays may be used for copper cable in lieu of conduit.

3.12 NETWORK NAMING AND NUMBERING

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

B. ASHRAE 135 Networks:
   1. MAC Address:
      a. Every network device shall have an assigned and documented MAC address unique to its network.
      b. Ethernet Networks: Document MAC address assigned at its creation.
      c. ARCNET or MS/TP networks: Assign from 00 to 64.
   2. Network Numbering:
      a. Assign unique numbers to each new network.
      b. Provide ability for changing network number through device switches or operator interface.
      c. DDC system, with all possible connected LANs, can contain up to 65,534 unique networks.
   3. Device Object Identifier Property Number:
      a. Assign unique device object identifier property numbers or device instances for each device network.
      b. Provide for future modification of device instance number by device switches or operator interface.
      c. LAN shall support up to 4,194,302 unique devices.
   4. Device Object Name Property Text:
      a. Device object name property field shall support 32 minimum printable characters.
      b. Assign unique device "Object Name" property names with plain-English descriptive names for each device.
         1) Example 1: Device object name for device controlling boiler plant at Building 1000 would be "HW System B1000."
         2) Example 2: Device object name for a VAV terminal unit controller could be "VAV unit 102".
   5. Object Name Property Text for Other Than Device Objects:
      a. Object name property field shall support 32 minimum printable characters.
      b. Assign object name properties with plain-English names descriptive of application.
         1) Example 1: "Zone 1 Temperature."
         2) Example 2 "Fan Start and Stop."
   6. Object Identifier Property Number for Other Than Device Objects:
      a. Assign object identifier property numbers according to Drawings indicated.

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

3.13 CONTROL WIRE, CABLE AND RACEWAYS INSTALLATION

A. Comply with NECA 1.
B. Comply with TIA 568-C.1.
C. Wiring Method: Install cables in raceways and cable trays except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.
   1. Install plenum cable in environmental air spaces, including plenum ceilings.
   2. Comply with requirements for cable trays specified in Section 260536 "Cable Trays for Electrical Systems."
   3. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
D. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
E. Field Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
F. Conduit Installation:
   1. Install conduit expansion joints where conduit runs exceed 200 feet, and conduit crosses building expansion joints.
   2. Coordinate conduit routing with other trades to avoid conflicts with ducts, pipes and equipment and service clearance.
   3. Maintain at least 3-inch separation where conduits run axially above or below ducts and pipes.
   4. Limit above-grade conduit runs to 100 feet without pull or junction box.
   5. Do not install raceways or electrical items on any "explosion-relief" walls, or rotating equipment.
   6. Do not fasten conduits onto the bottom side of a metal deck roof.
   7. Flexible conduit is permitted only where flexibility and vibration control is required.
   8. Limit flexible conduit to 3 feet long.
   9. Conduit shall be continuous from outlet to outlet, from outlet to enclosures, pull and junction boxes, and shall be secured to boxes in such manner that each system shall be electrically continuous throughout.
   10. Direct bury conduits underground or install in concrete-encased duct bank where indicated.
      a. Use rigid, nonmetallic, Schedule 80 PVC.
      b. Provide a burial depth according to NFPA 70, but not less than 24 inches.
   11. Secure threaded conduit entering an instrument enclosure, cabinet, box, and trough, with a locknut on outside and inside, such that conduit system is electrically continuous throughout. Provide a metal bushing on inside with insulated throats. Locknuts shall be the type designed to bite into the metal or, on inside of enclosure, shall have a grounding wedge lug under locknut.
   12. Conduit box-type connectors for conduit entering enclosures shall have an insulated throat.
   13. Connect conduit entering enclosures in wet locations with box-type connectors or with watertight sealing locknuts or other fittings.
   14. Offset conduits where entering surface-mounted equipment.
   15. Seal conduit runs used by sealing fittings to prevent the circulation of air for the following:
      a. Conduit extending from interior to exterior of building.
      b. Conduit extending into pressurized duct and equipment.
      c. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
G. Wire and Cable Installation:

1. Cables serving a common system may be grouped in a common raceway. Install control wiring and cable in separate raceway from power wiring. Do not group conductors from different systems or different voltages.
2. Install cables with protective sheathing that is waterproof and capable of withstanding continuous temperatures of 90 deg C with no measurable effect on physical and electrical properties of cable.
    a. Provide shielding to prevent interference and distortion from adjacent cables and equipment.
3. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
4. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
5. UTP Cable Installation:
    a. Comply with TIA 568-C.2.
    b. Do not untwist UTP cables more than 1/2 inch from the point of termination, to maintain cable geometry.
6. Installation of Cable Routed Exposed under Raised Floors:
    a. Install plenum-rated cable only.
    b. Install cabling after the flooring system has been installed in raised floor areas.
    c. Coil cable 6 feet long not less than 12 inches in diameter below each feed point.
7. Identify each wire on each end and at each terminal with a number-coded identification tag. Each wire shall have a unique tag.
8. Provide strain relief.
9. Terminate wiring in a junction box.
    a. Clamp cable over jacket in junction box.
    b. Individual conductors in the stripped section of the cable shall be slack between the clamping point and terminal block.
10. Terminate field wiring and cable not directly connected to instruments and control devices having integral wiring terminals using terminal blocks.
11. Install signal transmission components according to IEEE C2, REA Form 511a, NFPA 70, and as indicated.
12. Keep runs short. Allow extra length for connecting to terminal boards. Do not bend flexible coaxial cables in a radius less than 10 times the cable OD. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.
13. Ground wire shall be copper and grounding methods shall comply with IEEE C2. Demonstrate ground resistance.
14. Wire and cable shall be continuous from terminal to terminal without splices.
15. Use insulated spade lugs for wire and cable connection to screw terminals.
16. Use shielded cable to transmitters.
17. Use shielded cable to temperature sensors.
18. Perform continuity and meager testing on wire and cable after installation.
19. Do not install bruised, kinked, scored, deformed, or abraded wire and cable. Remove and discard wire and cable if damaged during installation, and replace it with new cable.
20. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
21. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
22. Protection from Electro-Magnetic Interference (EMI): Provide installation free of (EMI). As a minimum, comply with the following requirements:
    a. Comply with BICSI TDMM and TIA 569-C for separating unshielded cable from potential EMI sources, including electrical power lines and equipment.
    b. Separation between open cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

1) Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
3) Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

c. Separation between cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
1) Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
3) Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

d. Separation between cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
1) Electrical Equipment Rating Less Than 2 kVA: No requirement.
2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
3) Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

e. Separation between Cables and Electrical Motors and Transformers, 5 kVA or 5 HP and Larger: A minimum of 48 inches.

f. Separation between Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.14 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 installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Testing of Pneumatic and Air-Signal Tubing:
a. Test for leaks and obstructions.
b. Disconnect each pipe and tubing line before a test is performed, and blowout dust, dirt, trash, condensate and other foreign materials with compressed air. Use commercially pure compressed air or nitrogen as distributed in gas cylinders. Air from an oil-free compressor with an air dryer is an acceptable alternative for the test.
c. After foreign matter is expelled and line is free from obstructions, plug far end of tubing run.
d. Connect a pressure source to near end of run with a needle valve between air supply and tubing run.
e. Connect a pressure gage accurate to within 0.5 percent of test between the shutoff needle valve and tubing run under test.
f. For system pressures above 30 psig, apply a pressure of 1.5 times operating pressure. Record pressure in tubing run every 10 minutes for one hour. Allowable drop in pressure in one-hour period shall not exceed 1 psig.
g. For system pressures 30 psig and below, apply a pressure of 2.0 times operating pressure to piping and tubing run. Record pressure in tubing run every 5 minutes for one hour. Allowable drop in pressure in one-hour period shall not exceed 0.5 psig.

D. Testing:
1. Perform preinstallation, in-progress, and final tests, supplemented by additional tests, as necessary.
2. Preinstallation Cable Verification: Verify integrity and serviceability for new cable lengths before installation. This assurance may be provided by using vendor verification documents, testing, or other methods. As a minimum, furnish evidence of verification for cable attenuation and bandwidth parameters.
3. In-Progress Testing: Perform standard tests for correct pair identification and termination during installation to ensure proper installation and cable placement. Perform tests in addition to those specified if there is any reason to question condition of material furnished

and installed. Testing accomplished is to be documented by agency conducting tests. Submit test results for Project record.

4. Final Testing: Perform final test of installed system to demonstrate acceptability as installed. Testing shall be performed according to a test plan supplied by DDC system manufacturer. Defective Work or material shall be corrected and retested. As a minimum, final testing for cable system, including spare cable, shall verify conformance of attenuation, length, and bandwidth parameters with performance indicated.
5. Test Equipment: Use a fiber-optic time domain reflectometer for testing of length and optical connectivity.
6. Test Results: Record test results and submit copy of test results for Project record.

3.15 DDC SYSTEM I/O CHECKOUT PROCEDURES

A. Check installed products before continuity tests, leak tests and calibration.
B. Check instruments for proper location and accessibility.
C. Check instruments for proper installation on direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.
D. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material and support.
E. For pneumatic products, verify that air supply for each product is properly installed.
F. Control Damper Checkout:
   1. Verify that control dampers are installed correctly for flow direction.
   2. Verify that proper blade alignment, either parallel or opposed, has been provided.
   3. Verify that damper frame attachment is properly secured and sealed.
   4. Verify that damper actuator and linkage attachment is secure.
   5. Verify that actuator wiring is complete, enclosed and connected to correct power source.
   6. Verify that damper blade travel is unobstructed.
G. Control Valve Checkout:
   1. For pneumatic valves, verify that pressure gages are provided in each air line to valve actuator and positioner.
   2. Verify that control valves are installed correctly for flow direction.
   3. Verify that valve body attachment is properly secured and sealed.
   4. Verify that valve actuator and linkage attachment is secure.
   5. Verify that actuator wiring is complete, enclosed and connected to correct power source.
   6. Verify that valve ball, disc or plug travel is unobstructed.
   7. After piping systems have been tested and put into service, but before insulating and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks. Replace the valve if leaks persist.
H. Instrument Checkout:
   1. Verify that instrument is correctly installed for location, orientation, direction and operating clearances.
   2. Verify that attachment is properly secured and sealed.
   3. Verify that conduit connections are properly secured and sealed.
   4. Verify that wiring is properly labeled with unique identification, correct type and size and is securely attached to proper terminals.
   5. Inspect instrument tag against approved submittal.
   6. For instruments with tubing connections, verify that tubing attachment is secure and isolation valves have been provided.
   7. For flow instruments, verify that recommended upstream and downstream distances have been maintained.
   8. For temperature instruments:
      a. Verify sensing element type and proper material.
      b. Verify length and insertion.

3.16 DDC SYSTEM I/O ADJUSTMENT, CALIBRATION AND TESTING:

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

B. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
C. For each analog instrument, make a three-point test of calibration for both linearity and accuracy.
D. Equipment and procedures used for calibration shall comply with instrument manufacturer's written instructions.
E. Provide diagnostic and test equipment for calibration and adjustment.
F. Field instruments and equipment used to test and calibrate installed instruments shall have accuracy at least twice the instrument accuracy being calibrated. An installed instrument with an accuracy of 1 percent shall be checked by an instrument with an accuracy of 0.5 percent.
G. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
H. If after calibration indicated performance cannot be achieved, replace out-of-tolerance instruments.
I. Comply with field testing requirements and procedures indicated by ASHRAE's Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements, and to supplement requirements indicated.
J. Analog Signals:
    1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
    2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.
    3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistant source.
K. Digital Signals:
    1. Check digital signals using a jumper wire.
    2. Check digital signals using an ohmmeter to test for contact making or breaking.
L. Control Dampers:
    1. Stroke and adjust control dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.
    2. Stroke control dampers with pilot positioners. Adjust damper and positioner following manufacturer's recommended procedure, so damper is 100 percent closed, 50 percent closed and 100 percent open at proper air pressure.
    3. Check and document open and close cycle times for applications with a cycle time less than 30 seconds.
    4. For control dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.
M. Control Valves:
    1. Stroke and adjust control valves following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.
    2. Stroke control valves with pilot positioners. Adjust valve and positioner following manufacturer's recommended procedure, so valve is 100 percent closed, 50 percent closed and 100 percent open at proper air pressures.
    3. Check and document open and close cycle times for applications with a cycle time less than 30 seconds.
    4. For control valves equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.
N. Meters: Check sensors at zero, 50, and 100 percent of Project design values.
O. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.
P. Switches: Calibrate switches to make or break contact at set points indicated.
Q. Transmitters:
    1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.
    2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistant source.

3.17 DDC SYSTEM CONTROLLER CHECKOUT

A. Verify power supply.
    1. Verify voltage, phase and hertz.

2. Verify that protection from power surges is installed and functioning.
3. Verify that ground fault protection is installed.
4. If applicable, verify if connected to UPS unit.
5. If applicable, verify if connected to a backup power source.
6. If applicable, verify that power conditioning units, transient voltage suppression and high-frequency noise filter units are installed.

B. Verify that wire and cabling is properly secured to terminals and labeled with unique identification.
C. Verify that spare I/O capacity is provided.

3.18 DDC CONTROLLER I/O CONTROL LOOP TESTS

A. Testing:
1. Test every I/O point connected to DDC controller to verify that safety and operating control set points are as indicated and as required to operate controlled system safely and at optimum performance.
2. Test every I/O point throughout its full operating range.
3. Test every control loop to verify operation is stable and accurate.
4. Adjust control loop proportional, integral and derivative settings to achieve optimum performance while complying with performance requirements indicated. Document testing of each control loop's precision and stability via trend logs.
5. Test and adjust every control loop for proper operation according to sequence of operation.
6. Test software and hardware interlocks for proper operation. Correct deficiencies.
7. Operate each analog point at the following:
   a. Upper quarter of range.
   b. Lower quarter of range.
   c. At midpoint of range.
8. Exercise each binary point.
9. For every I/O point in DDC system, read and record each value at operator workstation, at DDC controller and at field instrument simultaneously. Value displayed at operator workstation, at DDC controller and at field instrument shall match.
10. Prepare and submit a report documenting results for each I/O point in DDC system and include in each I/O point a description of corrective measures and adjustments made to achieve desire results.

3.19 DDC SYSTEM VALIDATION TESTS

A. Perform validation tests before requesting final review of system. Before beginning testing, first submit Pretest Checklist and Test Plan.
B. After approval of Test Plan, execute all tests and procedures indicated in plan.
C. After testing is complete, submit completed test checklist.
D. Pretest Checklist: Submit the following list with items checked off once verified:
1. Detailed explanation for any items that are not completed or verified.
2. Required mechanical installation work is successfully completed and HVAC equipment is working correctly.
3. HVAC equipment motors operate below full-load amperage ratings.
4. Required DDC system components, wiring, and accessories are installed.
5. Installed DDC system architecture matches approved Drawings.
6. Control electric power circuits operate at proper voltage and are free from faults.
7. Required surge protection is installed.
8. DDC system network communications function properly, including uploading and downloading programming changes.
9. Using BACnet protocol analyzer, verify that communications are error free.
10. Each controller's programming is backed up.
11. Equipment, products, tubing, wiring cable and conduits are properly labeled.
12. All I/O points are programmed into controllers.
13. Testing, adjusting and balancing work affecting controls is complete.
14. Dampers and actuators zero and span adjustments are set properly.

15. Each control damper and actuator goes to failed position on loss of power.
16. Valves and actuators zero and span adjustments are set properly.
17. Each control valve and actuator goes to failed position on loss of power.
18. Meter, sensor and transmitter readings are accurate and calibrated.
19. Control loops are tuned for smooth and stable operation.
20. View trend data where applicable.
21. Each controller works properly in standalone mode.
22. Safety controls and devices function properly.
23. Interfaces with fire-alarm system function properly.
24. Electrical interlocks function properly.
25. Operator workstations and other interfaces are delivered, all system and database software is installed, and graphic are created.
26. Record Drawings are completed.

E. Test Plan:
1. Prepare and submit a validation test plan including test procedures for performance validation tests.
2. Test plan shall address all specified functions of DDC system and sequences of operation.
3. Explain detailed actions and expected results to demonstrate compliance with requirements indicated.
4. Explain method for simulating necessary conditions of operation used to demonstrate performance.
5. Include a test checklist to be used to check and initial that each test has been successfully completed.
6. Submit test plan documentation 10 business days before start of tests.

F. Validation Test:
1. Verify operating performance of each I/O point in DDC system.
   a. Verify analog I/O points at operating value.
   b. Make adjustments to out-of-tolerance I/O points.
      1) Identify I/O points for future reference.
      2) Simulate abnormal conditions to demonstrate proper function of safety devices.
      3) Replace instruments and controllers that cannot maintain performance indicated after adjustments.
2. Simulate conditions to demonstrate proper sequence of control.
3. Readjust settings to design values and observe ability of DDC system to establish desired conditions.
4. After 24 Hours following Initial Validation Test:
   a. Re-check I/O points that required corrections during initial test.
   b. Identify I/O points that still require additional correction and make corrections necessary to achieve desired results.
5. After 24 Hours of Second Validation Test:
   a. Re-check I/O points that required corrections during second test.
   b. Continue validation testing until I/O point is normal on two consecutive tests.
6. Completely check out, calibrate, and test all connected hardware and software to ensure that DDC system performs according to requirements indicated.
7. After validation testing is complete, prepare and submit a report indicating all I/O points that required correction and how many validation re-tests it took to pass. Identify adjustments made for each test and indicate instruments that were replaced.

G. DDC System Response Time Test:
1. Simulate HLC.
   a. Heavy load shall be an occurrence of 50 percent of total connected binary COV, one-half of which represent an "alarm" condition, and 50 percent of total connected analog COV, one-half of which represent an "alarm" condition, that are initiated simultaneously on a one-time basis.

2. Initiate 10 successive occurrences of HLC and measure response time to typical alarms and status changes.
3. Measure with a timer having at least 0.1-second resolution and 0.01 percent accuracy.
4. Purpose of test is to demonstrate DDC system, as follows:
   a. Reaction to COV and alarm conditions during HLC.
   b. Ability to update DDC system database during HLC.
5. Passing test is contingent on the following:
   a. Alarm reporting at printer beginning no more than two seconds after the initiation (time zero) of HLC.
   b. All alarms, both binary and analog, are reported and printed; none are lost.
   c. Compliance with response times specified.
6. Prepare and submit a report documenting HLC tested and results of test including time stamp and print out of all alarms.

H. DDC System Network Bandwidth Test:
1. Test network bandwidth usage on all DDC system networks to demonstrate bandwidth usage under DDC system normal operating conditions and under simulated HLC.
2. To pass, none of DDC system networks shall use more than 70 percent of available bandwidth under normal and HLC operation.

3.20 FINAL REVIEW

A. Submit written request to Architect and Construction Manager when DDC system is ready for final review. Written request shall state the following:
1. DDC system has been thoroughly inspected for compliance with contract documents and found to be in full compliance.
2. DDC system has been calibrated, adjusted and tested and found to comply with requirements of operational stability, accuracy, speed and other performance requirements indicated.
3. DDC system monitoring and control of HVAC systems results in operation according to sequences of operation indicated.
4. DDC system is complete and ready for final review.

B. Review by Architect and Construction Manager shall be made after receipt of written request. A field report shall be issued to document observations and deficiencies.

C. Take prompt action to remedy deficiencies indicated in field report and submit a second written request when all deficiencies have been corrected. Repeat process until no deficiencies are reported.

D. Should more than two reviews be required, DDC system manufacturer and Installer shall compensate entity performing review for total costs, labor and expenses, associated with third and subsequent reviews. Estimated cost of each review shall be submitted and approved by DDC system manufacturer and Installer before making the review.

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

F. A part of DDC system final review shall include a demonstration to parties participating in final review.
1. Provide staff familiar with DDC system installed to demonstrate operation of DDC system during final review.
2. Provide testing equipment to demonstrate accuracy and other performance requirements of DDC system that is requested by reviewers during final review.
3. Demonstration shall include, but not be limited to, the following:
   a. Accuracy and calibration of 10 I/O points randomly selected by reviewers. If review finds that some I/O points are not properly calibrated and not satisfying performance requirements indicated, additional I/O points may be selected by reviewers until total I/O points being reviewed that satisfy requirements equals quantity indicated.
   b. HVAC equipment and system hardwired and software safeties and life-safety functions are operating according to sequence of operation. Up to 10 I/O points shall be randomly selected by reviewers. Additional I/O points may be selected by reviewers to discover problems with operation.

c. Correct sequence of operation after electrical power interruption and resumption after electrical power is restored for randomly selected HVAC systems.
d. Operation of randomly selected dampers and valves in normal-on, normal-off and failed positions.
e. Reporting of alarm conditions for randomly selected alarms, including different classes of alarms, to ensure that alarms are properly received by operators and operator workstations.
f. Trends, summaries, logs and reports set-up for Project.
g. For up to three HVAC systems randomly selected by reviewers, use graph trends to show that sequence of operation is executed in correct manner and that HVAC systems operate properly through complete sequence of operation including different modes of operations indicated. Show that control loops are stable and operating at set points and respond to changes in set point of 20 percent or more.
h. Software's ability to communicate with controllers, operator workstations, uploading and downloading of control programs.
i. Software's ability to edit control programs off-line.
j. Data entry to show Project-specific customizing capability including parameter changes.
k. Step through penetration tree, display all graphics, demonstrate dynamic update, and direct access to graphics.
l. Execution of digital and analog commands in graphic mode.
m. Spreadsheet and curve plot software and its integration with database.
n. Online user guide and help functions.
o. Multitasking by showing different operations occurring simultaneously on four quadrants of split screen.
p. System speed of response compared to requirements indicated.
q. For Each Network and Programmable Application Controller:
    1) Memory: Programmed data, parameters, trend and alarm history collected during normal operation is not lost during power failure.
    2) Operator Interface: Ability to connect directly to each type of digital controller with a portable operator workstation and PDA. Show that maintenance personnel interface tools perform as indicated in manufacturer's technical literature.
    3) Standalone Ability: Demonstrate that controllers provide stable and reliable standalone operation using default values or other method for values normally read over network.
    4) Electric Power: Ability to disconnect any controller safely from its power source.
    5) Wiring Labels: Match control drawings.
    6) Network Communication: Ability to locate a controller's location on network and communication architecture matches Shop Drawings.
    7) Nameplates and Tags: Accurate and permanently attached to control panel doors, instrument, actuators and devices.
r. For Each Operator Workstation:
    1) I/O points lists agree with naming conventions.
    2) Graphics are complete.
    3) UPS unit, if applicable, operates.
s. Communications and Interoperability: Demonstrate proper interoperability of data sharing, alarm and event management, trending, scheduling, and device and network management. Use ASHRAE 135 protocol analyzer to help identify devices, view network traffic, and verify interoperability. Requirements must be met even if only one manufacturer's equipment is installed.
    1) Data Presentation: On each operator workstation, demonstrate graphic display capabilities.
    2) Reading of Any Property: Demonstrate ability to read and display any used readable object property of any device on network.

3) Set Point and Parameter Modifications: Show ability to modify set points and tuning parameters indicated. Modifications are made with messages and write services initiated by an operator using workstation graphics, or by completing a field in a menu with instructional text.
4) Peer-to-Peer Data Exchange: Network devices are installed and configured to perform without need for operator intervention to implement Project sequence of operation and to share global data.
5) Alarm and Event Management: Alarms and events are installed and prioritized according to Owner. Demonstrate that time delays and other logic are set up to avoid nuisance tripping. Show that operators with sufficient privileges are permitted.
6) Schedule Lists: Schedules are configured for start and stop, mode change, occupant overrides, and night setback as defined in sequence of operations.
7) Schedule Display and Modification: Ability to display any schedule with start and stop times for calendar year. Show that all calendar entries and schedules are modifiable from any connected operator workstation by an operator with sufficient privilege.
8) Archival Storage of Data: Data archiving is handled by operator workstation and server and local trend archiving and display is accomplished.
9) Modification of Trend Log Object Parameters: Operator with sufficient privilege can change logged data points, sampling rate, and trend duration.
10) Device and Network Management:
    a) Display of network device status.
    b) Display of BACnet Object Information.
    c) Silencing devices transmitting erroneous data.
    d) Time synchronization.
    e) Remote device re-initialization.
    f) Backup and restore network device programming and master database(s).
    g) Configuration management of routers.

3.21 ADJUSTING

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

3.22 MAINTENANCE SERVICE

A. Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12-month full maintenance by DDC system manufacturer's authorized service representative. Include quarterly preventive maintenance, repair or replacement of worn or defective components, cleaning, calibration and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.23 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for one year(s).
B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within one year from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
    1. Upgrade Notice: At least 30 days to allow Owner to schedule and access system and to upgrade computer equipment if necessary.

3.24 DEMONSTRATION

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

1. Base extent of training on scope and complexity of DDC system indicated and training requirements indicated. Provide extent of training required to satisfy requirements indicated even if more than minimum training requirements are indicated.
2. Inform Owner of anticipated training requirements if more than minimum training requirements are indicated.
3. Minimum Training Requirements:
    a. Provide not less than 24 hours of training total.
    b. Stagger training over multiple training classes to accommodate Owner's requirements. All training shall occur before end of warranty period.
    c. Total days of training shall be broken into not more than five separate training classes. Coordinate with owner.

C. Training Schedule:
1. Schedule training with Owner 20 business days before expected Substantial Completion.
2. Schedule training to provide Owner with at least 15 business days of notice in advance of training.
3. Training shall occur within normal business hours at a mutually agreed on time. Unless otherwise agreed to, training shall occur Monday through Friday, except on U.S. Federal holidays, with two morning sessions and two afternoon sessions. Each morning session and afternoon session shall be split in half with 15 minute break between sessions. Morning and afternoon sessions shall be separated by 60 minute lunch period. Training, including breaks and excluding lunch period, shall not exceed eight hours per day.
4. Provide staggered training schedule as requested by Owner.

D. Training Attendee List and Sign-in Sheet:
1. Request from Owner in advance of training a proposed attendee list with name, phone number and e-mail address.
2. Provide a preprinted sign-in sheet for each training session with proposed attendees listed and no fewer than six blank spaces to add additional attendees.
3. Preprinted sign-in sheet shall include training session number, date and time, instructor name, phone number and e-mail address, and brief description of content to be covered during session. List attendees with columns for name, phone number, e-mail address and a column for attendee signature or initials.
4. Circulate sign-in sheet at beginning of each session and solicit attendees to sign or initial in applicable location.
5. At end of each training day, send Owner an e-mail with an attachment of scanned copy (PDF) of circulated sign-in sheet for each session.

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

F. Organization of Training Sessions:
1. Organize training sessions into logical groupings of technical content and to reflect different levels of operators having access to system. Plan training sessions to accommodate the following three levels of operators:
    a. Daily operators.
    b. Advanced operators.
    c. System managers and administrators.
2. Plan and organize training sessions to group training content to protect DDC system security. Some attendees may be restricted to some training sessions that cover restricted content for purposes of maintaining DDC system security.

G. Training Outline:

1. Submit training outline for Owner review at least 10 business day before scheduling training.
2. Outline shall include a detailed agenda for each training day that is broken down into each of four training sessions that day, training objectives for each training session and synopses for each lesson planned.

H. On-Site Training:
1. Owner will provide conditioned classroom or workspace with ample desks or tables, chairs, power and data connectivity for instructor and each attendee.
2. Instructor shall provide training materials, projector and other audiovisual equipment used in training.
3. Provide as much of training located on-site as deemed feasible and practical by Owner.
4. On-site training shall include regular walk-through tours, as required, to observe each unique product type installed with hands-on review of operation, calibration and service requirements.
5. Operator workstation provided with DDC system shall be used in training. If operator workstation is not indicated, provide a temporary workstation to convey training content.

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

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

25. Demonstrating the following for HVAC systems and equipment controlled by DDC system:
    a. Operation of HVAC equipment in normal-off, -on and failed conditions while observing individual equipment, dampers and valves for correct position under each condition.
    b. For HVAC equipment with factory-installed software, show that integration into DDC system is able to communicate with DDC controllers or gateways, as applicable.
    c. Using graphed trends, show that sequence of operation is executed in correct manner, and HVAC systems operate properly through complete sequence of operation including seasonal change, occupied and unoccupied modes, warm-up and cool-down cycles and other modes of operation indicated.
    d. Hardware interlocks and safeties function properly and DDC system performs correct sequence of operation after electrical power interruption and resumption after power is restored.
    e. Reporting of alarm conditions for each alarm, and confirm that alarms are received at assigned locations, including operator workstations.
    f. Each control loop responds to set point adjustment and stabilizes within time period indicated.
    g. Sharing of previously graphed trends of all control loops to demonstrate that each control loop is stable and set points are being maintained.

K. Training Content for Advanced Operators:
1. Making and changing workstation graphics.
2. Creating, deleting and modifying alarms including annunciation and routing.
3. Creating, deleting and modifying point trend logs including graphing and printing on an ad-hoc basis and operator-defined time intervals.
4. Creating, deleting and modifying reports.
5. Creating, deleting and modifying points.
6. Creating, deleting and modifying programming including ability to edit control programs off-line.
7. Creating, deleting and modifying system graphics and other types of displays.
8. Adding DDC controllers and other network communication devices such as gateways and routers.
9. Adding operator workstations.
10. Performing DDC system checkout and diagnostic procedures.
11. Performing DDC controllers operation and maintenance procedures.
12. Performing operator workstation operation and maintenance procedures.
13. Configuring DDC system hardware including controllers, workstations, communication devices and I/O points.
14. Maintaining, calibrating, troubleshooting, diagnosing and repairing hardware.
15. Adjusting, calibrating and replacing DDC system components.

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

M. Video of Training Sessions:
1. Provide a digital video and audio recording of each training session. Create a separate recording file for each session.
2. Stamp each recording file with training session number, session name and date.
3. Provide Owner with two copies of digital files on DVDs or flash drives for later reference and for use in future training.

4. Owner retains right to make additional copies for intended training purposes without having to pay royalties.

END OF SECTION