Clark Co. Courthouse Boiler Replacement

517 Court Street, Neillsville, WI 54456

APEX PROJECT NUMBER: 22101

OCTOBER, 2023

APEX Engineering
Eau Claire, Wisconsin
www.apexengineering.biz

ARCHITECTS
L&P
ENGINEERS
LIEN & PETERSON ARCHITECTS, INC
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SECTION 00 01 02
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DIVISION 26 - ELECTRICAL

All specification information is on the plan set.

DRAWINGS BOUND SEPARATELY

END OF TABLE OF CONTENTS

DOCUMENT 00 11 16
INVITATION TO BID

PROJECT INFORMATION

Notice to Bidders: Bidders are invited to submit bids for Project as described in this Document.

Project Identification: **Boiler Replacement, Clark County Courthouse**
Project Location: **517 Court Street, Neillsville, WI 54456**
Designer: **Apex Engineering, 110 E Grand Avenue, Eau Claire, WI 54701**
Designer Project Number: **22101**

Project Description:

The project consists of the replacement of two (2) steam boilers that serve air handling units and terminal devices throughout portions of the facility. There are four (4) steam to hot water converters that will be replaced and piped to the new hot water boiler systems. The existing system will be split into two (2) new separate boiler plants with equal output of the removed boilers. Twelve (12) circulating pumps will be replaced as part of the project and replaced with five (5) new circulating pumps. Controls are provided by Owner's T.C.C. (Complete Control, Inc.). Gas piping will need to be provided including a new meter and coordination with Owner's utility (XCEL Energy) for at least one (1) of the new boiler plants. Electrical disconnect and reconnect coordination also required for new work.

This project has less than a 30-day bid advertisement period.

Pre-bid Tour: A mandatory pre-bid walk through will be conducted on **Wednesday, November 1st, at 10:30 AM.** All participants shall meet at the project site at door B103 on the North side of the building along 6th Street.

BID SUBMITTAL AND OPENING

The Owner will receive bids as indicated below:

Bid Date: Tuesday, November 14, 2023.
Bid Opening: 2:00 p.m., local time, all bids must be submitted before 2:00 p.m.
Location: Clark County Courthouse, Room 307, 517 Court Street, Neillsville, WI 54456
Bids will be thereafter **publicly** opened.

All questions are due Friday, November 3, 2023. An addenda will be issued the following week.
Direct all question to Apex Engineering, landonj@apexengineering.biz.

Bids can be mailed or hand delivered to: 517 Court Street, Room 200, Neillsville, WI 54456
Bids can also be emailed to: timothy.thompson@co.clark.wi.us

DOCUMENTS

Bid Documents can be obtain after October 19, 2023 through any of the following site(s): La Crosse Builders Exchange, Northwest Regional Builders Exchange, and Lien and Peterson Architects

TIME OF COMPLETION

Bidders shall begin the Work on receipt of the Notice to Proceed.

BIDDER'S QUALIFICATIONS

Bidders must be properly licensed under the laws governing their respective trades and be able to obtain insurance and bonds required for the Work.

INTERPRETATION

No verbal explanation or instructions will be given in regard to the meaning of the drawings or specifications during the bid period. Bidders shall bring inadequacies, omissions, or conflicts to the Architect/Engineer's attention at least ten (10) business days before the date set for bid opening. Prompt clarification will be supplied to all bidders of record by addendum.

Failure to so request clarification or interpretation of the drawings and specifications will not relieve the successful Bidder of responsibility. Signing of the contract will be considered as implicitly denoting that the Contractor has thorough understanding of the scope of work and comprehension of the contract documents.

END OF SECTION

SECTION 00 21 00
INSTRUCTIONS TO BIDDERS

DEFINITIONS

Bidding Documents include the Bidding Requirements and the Proposed Contract Documents. The Bidding Requirements consist of the invitation to bid, Instructions to Bidders, the bid form, and any other bidding forms. The Proposed Contract Documents consist of the unexecuted form of Agreement between the Owner and Contractor and that Agreement's Exhibits, Conditions of the Contract (General, Supplementary and other Conditions), Drawings, Specifications, and all Addenda.

Addenda are written or graphic instruments issued prior to Bid Deadline which modify or interpret the bidding documents, including Drawings and Specifications, by addition, deletion, clarification and/or correction. Addenda become part of the Contract Documents.

A Bidder is a person or entity who submits a Bid and who meets the requirements set forth in the Bidding Documents.

A Sub-bidder is a person or entity who submits a bid to a Bidder for materials, equipment, or labor for a portion of the Work.

The terms, Architect and A/E shall mean Lien & Peterson Architects, Inc.

BIDDERS REPRESENTATION

Each bidder by making his bid represents that he has read and understands the bidding documents and that he has visited the site and familiarized himself with the local conditions under which the Work is to be performed.

BIDDING PROCEDURES

All bids must be prepared on the form provided in this Project Manual and submitted in accordance with the Instructions to Bidders. **REMOVE FORM FROM PROJECT MANUAL**. Do not submit entire project manual. Submit only one Bid Form. Bid shall be completed in accordance with the requirements stated in this section. Place bid in an opaque envelope and seal. No other information shall be included with the Bid Form except any required bond or information requested herein or by Addendum. Mark the exterior of the envelope as follows:

CONTRACTORS PROPOSAL
(Give Project Name)
(State Portion of the Work Bid Upon)
(Contractor's Name and Address)

No bidder shall modify, withdraw, or cancel his bid or any part thereof for thirty (30) days after the Bid Deadline.

A bid is invalid if it has not been deposited at the designated location prior to the Bid Deadline. Such a bid will not be opened and will be returned to the bidder.

Bids will be received for contracts as provided in the Bid/Proposal form.

ADDENDA

Addenda will be made available through the same online platform as the Bid Documents.

EXAMINATION OF BIDDING DOCUMENTS

Each bidder shall examine the bidding documents carefully and, not later than seven (7) days prior to the date for receipt of bids, shall make requests to the A/E for interpretation or correction of any ambiguity, inconsistency or error therein. Any interpretation or correction will be issued as an Addendum. Only a written interpretation or correction by Addendum shall be binding. No bidder shall rely upon any interpretation or correction given by any other method.

BID GUARANTEE

Provide a certified check, a cashier's check, or a bid bond, payable to the owner in an amount not less than five percent (5%) of the maximum bid with each bid as a guarantee. If the bid is accepted, the bidder will execute and deliver the proposed contract and bonds within ten (10) days after being notified in writing to do so.

If the successful bidder executes and delivers the contract and bond, the bid guarantee will be returned to him. If the bidder fails to furnish such contract and bond, the bid guarantee shall be forfeited to the owner as liquidated damages.

The company issuing the bid bond shall be licensed to do business in the State of Wisconsin. Bid Bond may be submitted on AIA document A310, Bid Bond, latest edition.

INSURANCE REQUIREMENTS

The Contractor shall purchase and maintain property insurance upon the entire Work at the site to the full insurable value thereof. This insurance shall include the interests of the Owner, the Contractor, Subcontractors and Sub-subcontractors in the Work and shall insure against the perils of fire and extended coverage and shall include "all risk" insurance for physical loss or damage including, without duplication coverage, theft, vandalism and malicious mischief.

SUBSTITUTIONS

Each bidder represents that his bid is based upon the materials and equipment described in the bidding documents.

No substitution will be considered unless written request has been submitted to the A/E for approval at least ten (10) days prior to the date for receipt of bids. Each such request shall include a complete description of the proposed substituted, drawings, cuts, performance and test data and any other data or information necessary for a complete evaluation. Approval of substitutions will be set forth by Addendum.

Approval by the A/E of a manufacturer for specified items shall not be deemed as approval of all products or models that the manufacturer can furnish but only the single product which most closely duplicates the item originally specified.

The responsibility for all revisions to the work required by substitutions shall be borne solely by the Contractor who utilizes the substitution, including the following:

- Additional work by other Contractors.
- Changes to the building structure or room sizes.
- Additional associated devices, connections, wiring, etc.
- Properly notifying other contractors as to the effect of such substitutions on their contract.

PRODUCT OR MATERIAL AVAILABILITY

Prior to the receipt of bids, verify that all specified items, products, materials, etc., will be available for timely inclusion in the work. Should any item not be available, notify the A/E. Extra costs resulting from delays caused by failure to determine availability of specified items shall be borne by the Contractor.

QUALIFICATION OF BIDDERS

Before the award of any contract, the owner shall be satisfied that the bidder, (1) maintains a permanent place of business, (2) has adequate equipment to do the work properly, (3) has a suitable financial status to meet obligations incident to the work, (4) has appropriate technical experience, and (5) has satisfactorily completed contracts of similar nature and magnitude.

AWARD OR REJECTION OF BIDS

Review the Bid Form for procedures to be followed should the bid be accepted by the Owner. Notice that prompt delivery of the required documents is required. The bidder acknowledges the right of the Owner to reject any or all bids and to waive any informality or irregularity in any bid received. In addition, the bidder recognizes the right of the Owner to reject a bid if the bidder failed to furnish any required bid security, or to submit the data required by the bidding documents, or if the bid is in any way incomplete or irregular.

SUBMISSION OF POST-BID INFORMATION

Upon request by the A/E, the selected bidder shall within seven (7) days thereafter submit the following:

A statement of costs for each major item of Work included in the bid.
A designation of the Work to be performed by the bidder with his own forces.
A list of names of the Subcontractors or other persons or organizations (including those who are to furnish materials or equipment fabricated to a special design) proposed for the principal portions of the Work.

PERFORMANCE BOND AND PAYMENT BOND

The Bidder who is awarded the work shall furnish and pay for bonds covering the faithful performance of the Contract and the payment of all obligations arising thereunder in such form as the Owner may prescribe and with such sureties secured through the bidder's usual sources as may be agreeable to the parties. The amount of each bond shall be 100% of the Contract Amount. Bonds shall be dated not later than the date of execution of the Contract. The attorney-in-fact who executes the required bonds on behalf of the surety shall affix thereto a certified and current copy of his power-of-attorney indicating the limit of such power.

Bond form shall be AIA Document WIS. A311, latest edition, "Private Improvement Performance Bond" and "Private Improvement Labor and Material Payment Bond."

ALTERNATE BIDS

If alternate bids are requested, bidder shall state the amount to be added to or deducted from the base bid for making the changes required under each alternate. The stated sum stated sum shall include all incidental work and adjustments as may be necessary or required to fully complete the alternate work. Refer to Section 01 23 00 Alternates. Space is provided on the bid form for alternates. If there is no price change, the bidder shall state "NO CHANGE".

UNIT PRICES

Unit prices requested on the Bid Form shall be given and, if included in the Contract, will be used for additions to or deductions from amount of work required under the Contract. Unit prices shall include all costs of materials, labor, insurance, taxes, overhead and profit. The Owner reserves the right to reject any unit prices as given in the bid if they are considered excessive or unreasonable, or to accept any or all of the unit prices that may be considered fair and reasonable.

RETAINAGE

Retainage will be accumulated at 10% of the amount due until 50% completion. Upon substantial completion, payments shall be increased to 98% of the amount due, less allowance for incomplete and unsatisfactory work.

END OF SECTION

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SECTION 00 41 13
BID FORM - STIPULATED SUM (SINGLE-PRIME CONTRACT)

BID INFORMATION

Bidder: _____.
Project Identification: **Boiler Replacement, Clark County**
Project Location: **517 Court Street, Neillsville, WI 54456**
Designer: **Apex Engineering, 110 E Grand Avenue, Eau Claire, WI 54701**
Designer Project Number: **22101**

CERTIFICATIONS AND BASE BID

Base Bid, Single-Prime (All Trades) Contract: The undersigned Bidder, having carefully examined the Procurement and Contracting Requirements, Conditions of the Contract, Drawings, Specifications, and all subsequent Addenda, as prepared by Apex Engineering and consultants, having visited the site, and being familiar with all conditions and requirements of the Work, hereby agrees to furnish all material, labor, equipment and services, including all scheduled allowances, necessary to complete the construction of the above-named project, according to the requirements of the Procurement and Contracting Documents, for the stipulated sum of:

_____ Dollars ($_____).

BID GUARANTEE

The undersigned Bidder agrees to execute a contract for this Work in the above amount and to furnish surety as specified within 10 days after a written Notice of Award, if offered within 60 days after receipt of bids, and on failure to do so agrees to forfeit to Owner the attached cash, cashier's check, certified check, U.S. money order, or bid bond, as liquidated damages for such failure, in the following amount constituting five percent (5%) of the Base Bid amount above:

_____ Dollars ($_____).

In the event Owner does not offer Notice of Award within the time limits stated above, Owner will return to the undersigned the cash, cashier's check, certified check, U.S. money order, or bid bond.

CONTRACTORS & SUBCONTRACTORS

The following companies shall execute contracts or subcontracts for the portions of Work indicated:

General Work: _____.

Mechanical Work: _____.

Electrical Work: _____.

TIME OF COMPLETION

Bidders shall begin mobilizing after received the Notice to Proceed. Demolition and Construction is anticipated to begin Spring of 2024.

ACKNOWLEDGMENT OF ADDENDA

The undersigned Bidder acknowledges receipt of and use of the following Addenda in the preparation of this Bid:

Addendum No. 1, dated _____.

Addendum No. 2, dated _____.

Addendum No. 3, dated _____.

Addendum No. 4, dated _____.

CONTRACTOR'S LICENSE

The undersigned further states that it is a duly licensed contractor, for the type of work proposed, and that all fees, permits, etc., pursuant to submitting this proposal have been paid in full.

SUBMISSION OF BID

Respectfully submitted this _____ day of _____, 2023.

Submitted By:_____(Name of bidding firm or corporation).

Authorized Signature:_____(Handwritten signature).

Signed By:_____(Type or print name).

Title:_____(Owner/Partner/President/Vice President).

Witnessed By:_____(Handwritten signature).

Attest:_____(Handwritten signature).

By:_____(Type or print name).

Title:_____(Corporate Secretary or Assistant Secretary).

Street Address:_____.

City, State, Zip:_____.

Phone:_____.

License No.:_____.

Federal ID No.:_____(Affix Corporate Seal Here).

END OF DOCUMENT

SECTION 00 43 23
ALTERNATES FORM

BID INFORMATION

Bidder: _____.

Prime Contract: _____.
Project Identification: **Boiler Replacement, Clark County**
Project Location: **517 Court Street, Neillsville, WI 54456**
Designer: **Apex Engineering, 110 E Grand Avenue, Eau Claire, WI 54701**
Designer Project Number: **22101**

BID FORM SUPPLEMENT
This form is required to be attached to the Bid Form.

DESCRIPTION
The undersigned Bidder proposes the amount below be added to or deducted from the Base Bid if particular alternates are accepted by Owner. Amounts listed for each alternate include costs of related coordination, modification, or adjustment.

Cost-Plus-Fee Contract: Alternate price given below includes adjustment to Contractor's Fee.

If the alternate does not affect the Contract Sum, the Bidder shall indicate "NO CHANGE."

If the alternate does not affect the Work of this Contract, the Bidder shall indicate "NOT APPLICABLE."

The Bidder shall be responsible for determining from the Contract Documents the affects of each alternate on the Contract Time and the Contract Sum.

Owner reserves the right to accept or reject any alternate, in any order, and to award or amend the Contract accordingly within [**60**] days of the Notice of Award unless otherwise indicated in the Contract Documents.

Acceptance or non-acceptance of any alternates by the Owner shall have no affect on the Contract Time unless the "Schedule of Alternates" Article below provides a formatted space for the adjustment of the Contract Time.

SCHEDULE OF ALTERNATES
Alternate No. 1: Remove all piping during demolition as noted on plan sheets M100, M101, M102, M103

ADD____ DEDUCT____ NO CHANGE____ NOT APPLICABLE_____.

_____ Dollars ($_____).

ADD_____ DEDUCT_____ calendar days to adjust the Contract Time for this alternate.

Alternate No. 2: Remove condensate receiver and pump complete, including strainers, steam traps, control and accessories, during demolition as noted on plan sheet M100.

ADD____ DEDUCT____ NO CHANGE____ NOT APPLICABLE_____.

_____ Dollars ($_____).

ADD_____ DEDUCT_____ calendar days to adjust the Contract Time for this alternate.

SUBMISSION OF BID SUPPLEMENT

Respectfully submitted this _____ day of _____, 2023.

Submitted By:_____(Name of bidding firm or corporation).

Authorized Signature:_____(Handwritten signature).

Signed By:_____(Type or print name).

Title:_____(Owner/Partner/President/Vice President).

END OF DOCUMENT

SECTION 01 10 00
SUMMARY

PART 1 - GENERAL

SUMMARY

Section Includes:

- Project information.
- Work covered by Contract Documents.
- Work under separate contracts.
- Access to site.
- Coordination with occupants.
- Work restrictions.
- Specification and Drawing conventions.

Related Requirements:

- Section 01 50 00 "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Owner's facilities.

PROJECT INFORMATION

Project Identification: **Boiler Replacement, Clark County**
Project Location: **517 Court Street, Neillsville, WI 54456**
Designer: **Apex Engineering, 110 E Grand Avenue, Eau Claire, WI 54701**
Designer Project Number: **22101**

WORK COVERED BY CONTRACT DOCUMENTS

The Work of Project is defined by the Contract Documents and consists of the following:

In general, the project consists of the replacement of two (2) steam boilers that serve air handling units and terminal devices throughout portions of the facility. There are four (4) steam to hot water converters that will be replaced and piped to the new hot water boiler systems. The existing system will be split into two (2) new separate boiler plants with equal output of the removed boilers. Twelve (12) circulating pumps will be replaced as part of the project and replaced with five (5) new circulating pumps. Controls are provided by Owner's T.C.C. (Complete Control, Inc.). Gas piping will need to be provided including a new meter and coordination with Owner's utility (XCEL Energy) for at least one (1) of the new boiler plants. Electrical disconnect and reconnect coordination also required for new work.

ACCESS TO SITE

General: Each Contractor shall have full use of Project site for construction operations during construction period. Contractor's use of Project site is limited only by Owner's right to perform work or to retain other contractors on portions of Project.

Use of Site: Limit use of Project site to Work in areas indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.

Driveways, Walkways, and Entrances: Keep driveways and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or for storage of materials.

COORDINATION WITH OCCUPANTS

Partial Owner Occupancy: Owner will occupy adjacent building on the premises during the construction period.

WORK RESTRICTIONS

Work Restrictions, General: Comply with restrictions on construction operations.

Comply with limitations on use of public streets and with other requirements of authorities having jurisdiction.

On-Site Work Hours:

Limit work to normal business working hours, as governed by local ordinances, Monday through Friday, unless otherwise indicated.

Existing Utility Interruptions:

Notify Construction Manager, Owner not less than two days in advance of proposed utility interruptions.

Restricted Substances: Use of tobacco products and other controlled substances within the existing building on Project site is not permitted.

SPECIFICATION AND DRAWING CONVENTIONS

Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:

Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.

Specification requirements are to be performed by Contractor unless specifically stated otherwise.

Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 01 29 00
PAYMENT PROCEDURES

PART 1 - GENERAL

SUMMARY

Section includes administrative and procedural requirements necessary to prepare and process Applications for Payment.

SCHEDULE OF VALUES

Coordination: Coordinate preparation of the schedule of values with preparation of Contractor's construction schedule.

- Coordinate line items in the schedule of values with items required to be indicated as separate activities in Contractor's construction schedule.
- Submit the schedule of values to Designer at earliest possible date, but no later than seven days before the date scheduled for submittal of initial Applications for Payment.

Format and Content: Use Project Manual table of contents as a guide to establish line items for the schedule of values. Provide at least one line item for each Specification Section.

- Arrange schedule of values consistent with format of AIA Document G703.
- Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Provide multiple line items for principal subcontract amounts in excess of five percent of the Contract Sum.

APPLICATIONS FOR PAYMENT

Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments as certified by Designer and paid for by Owner.

Application for Payment Forms: Use AIA Document G702 and AIA Document G703 as form for Applications for Payment. Other form can be used if approved by Owner and Designer.

Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. Designer will return incomplete applications without action.

- Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
- Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
- Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.

Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following if not already provided:

- List of subcontractors.
- Schedule of values.
- Contractor's construction schedule (preliminary if not final).
- List of Contractor's principal consultants.
- Copies of building permits.
- Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.
- Certificates of insurance and insurance policies.
- Performance and payment bonds.

Application for Payment at Substantial Completion: After Designer issues the Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion for portion of the Work claimed as substantially complete.

Final Payment Application: After completing Project closeout requirements, submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:

- Evidence of completion of Project closeout requirements.
- Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
- Updated final statement, accounting for final changes to the Contract Sum.
- AIA Document G706.
- AIA Document G706A.
- AIA Document G707.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 01 31 00
PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

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

SUMMARY
Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:

- General coordination procedures.
- Coordination drawings.
- RFIs.
- Digital project management procedures.
- Project meetings.

DEFINITIONS
BIM: Building Information Modeling.

RFI: Request for Information. Request from Owner, Architect, or Contractor seeking information required by or clarifications of the Contract Documents.

INFORMATIONAL SUBMITTALS
Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:

- Name, address, telephone number, and email address of entity performing subcontract or supplying products.
- Number and title of related Specification Section(s) covered by subcontract.
- Drawing number and detail references, as appropriate, covered by subcontract.

GENERAL COORDINATION PROCEDURES
Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations included in different Sections that depend on each other for proper installation, connection, and operation.

- Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
- Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
- Make adequate provisions to accommodate items scheduled for later installation.

Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and scheduled activities of other contractors to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:

- Preparation of Contractor's construction schedule.
- Preparation of the schedule of values.
- Installation and removal of temporary facilities and controls.
- Delivery and processing of submittals.

Progress meetings.
Pre-installation conferences.
Project closeout activities.
Startup and adjustment of systems.

COORDINATION DRAWINGS

Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, and additionally where installation is not completely indicated on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.

Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:

Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
Indicate dimensions shown on Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternative sketches to Architect indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

Coordination Drawing Organization: Organize coordination drawings as follows:

Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements, and mechanical, plumbing, fire-protection, fire-alarm, and electrical Work. Show locations of visible ceiling-mounted devices relative to acoustical ceiling grid. Supplement plan drawings with section drawings where required to adequately represent the Work.
Mechanical Rooms: Provide coordination drawings for mechanical rooms showing plans and elevations of mechanical, plumbing, fire-protection, fire-alarm, and electrical equipment.
Structural Penetrations: Indicate penetrations and openings required for all disciplines.
Slab Edge and Embedded Items: Indicate slab edge locations and sizes and locations of embedded items for metal fabrications, sleeves, anchor bolts, bearing plates, angles, door floor closers, slab depressions for floor finishes, curbs and housekeeping pads, and similar items.
Review: Architect will review coordination drawings to confirm that in general the Work is being coordinated, but not for the details of the coordination, which are Contractor's responsibility.

REQUEST FOR INFORMATION (RFI)

General: Immediately on discovery of the need for additional information, clarification, or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.

All RFI’s shall be submitted to the Construction Manager for initial processing. Architect will return without response those RFIs submitted to Architect by entities other than the Construction Manager.
Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.

Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:

Project name.
Project number.
Date.
Name of Contractor.
Name of Architect.
RFI number, numbered sequentially.

RFI subject.
Specification Section number and title and related paragraphs, as appropriate.
Drawing number and detail references, as appropriate.
Field dimensions and conditions, as appropriate.
Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
Contractor's signature.
Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.

PDF Document Preparation: Where PDFs are required to be submitted to Architect, prepare as follows:

Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
Name file with submittal number or other unique identifier, including revision identifier.
Certifications: Where digitally submitted certificates and certifications are required, provide a digital signature with digital certificate on where indicated.

PROJECT MEETINGS

General: Schedule and conduct meetings and conferences at Project site unless otherwise indicated.

Preconstruction Conference: Construction Manager will schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner and Architect.

Attendees: Authorized representatives of Owner, Owner's Commissioning Authority, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
Agenda: Discuss items of significance that could affect progress, including the following:

Responsibilities and personnel assignments.
Tentative construction schedule.
Critical work sequencing and long lead items.
Designation of key personnel and their duties.
Lines of communications.
Procedures for processing field decisions and Change Orders.
Procedures for RFIs.
Procedures for testing and inspecting.
Procedures for processing Applications for Payment.
Distribution of the Contract Documents.
Submittal procedures.
Use of the premises and existing building.
Work restrictions.
Working hours.
Owner's occupancy requirements.
Responsibility for temporary facilities and controls.
Procedures for moisture and mold control.
Procedures for disruptions and shutdowns.
Construction waste management and recycling.
Parking availability.
Office, work, and storage areas.
Equipment deliveries and priorities.
First aid.
Security.

Progress cleaning.

Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.

Pre-installation Conferences: Conduct a preinstallation conference at Project site before each construction activity when required by other sections and when required for coordination with other construction.

Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect, and Owner's Commissioning Authority of scheduled meeting dates.

Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:

Contract Documents.
Options.
Related RFIs.
Related Change Orders.
Purchases.
Deliveries.
Submittals.
Sustainable design requirements.
Review of mockups.
Possible conflicts.
Compatibility requirements.
Time schedules.
Weather limitations.
Manufacturer's written instructions.
Warranty requirements.
Compatibility of materials.
Acceptability of substrates.
Temporary facilities and controls.
Space and access limitations.
Regulations of authorities having jurisdiction.
Testing and inspecting requirements.
Installation procedures.
Coordination with other work.
Required performance results.
Protection of adjacent work.
Protection of construction and personnel.

Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.

Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.

Progress Meetings: Conduct progress meetings at regular intervals.

Coordinate dates of meetings with preparation of payment requests.

Attendees: In addition to representatives of Owner, Owner's Commissioning Authority and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.

Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.

Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.

Review schedule for next period.

Review present and future needs of each entity present, including the following:

Interface requirements.
Sequence of operations.
Status of submittals.
Status of sustainable design documentation.
Deliveries.
Off-site fabrication.
Access.
Site use.
Temporary facilities and controls.
Progress cleaning.
Quality and work standards.
Status of correction of deficient items.
Field observations.
Status of RFIs.
Status of Proposal Requests.
Pending changes.
Status of Change Orders.
Pending claims and disputes.
Documentation of information for payment requests.

Minutes: Entity responsible for conducting the meeting will record and distribute the meeting minutes to each party present and to parties requiring information.

Schedule Updating: Revise Contractor's construction schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

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SECTION 01 33 00
SUBMITTAL PROCEDURES

PART 1 - GENERAL

SUMMARY
Section Includes:

- Submittal schedule requirements.
- Administrative and procedural requirements for submittals.

DEFINITIONS
Action Submittals: Written and graphic information and physical samples that require Architect's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."

Informational Submittals: Written and graphic information and physical samples that do not require Architect's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals."

SUBMITTAL FORMATS
Submittal Information: Include the following information in each submittal:

- Project name.
- Date.
- Name of Architect.
- Name of Contractor.
- Names of subcontractor, manufacturer, and/or supplier.
- Unique submittal number, including revision identifier. Include Specification Section number with sequential alphanumeric identifier; and alphanumeric suffix for resubmittals.
- Category and type of submittal.
- Submittal purpose and description.
- Number and title of Specification Section, with paragraph number and generic name for each of multiple items.
- Drawing number and detail references, as appropriate.
- Indication of full or partial submittal.
- Other necessary identification.
- Remarks.

Options: Identify options requiring selection by Architect.

Deviations and Additional Information: On each submittal, clearly indicate deviations from requirements in the Contract Documents, including minor variations and limitations; include relevant additional information and revisions, other than those requested by Architect on previous submittals. Indicate by highlighting on each submittal or noting on attached separate sheet.

Electronic Submittals: Prepare submittals as PDF package, incorporating complete information into each PDF file. Name PDF file with submittal number. Email submittal to landonj@apexengineering.biz

SUBMITTAL PROCEDURES
Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.

- Email: Prepare submittals as PDF package, and transmit to Architect by sending via email. Include PDF transmittal form. Include information in email subject line as requested by Architect.

Coordination: Coordinate preparation and processing of submittals with performance of construction activities.

Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.

Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.

Resubmittals: Make resubmittals in same form and number of copies as initial submittal.

Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.

SUBMITTAL REQUIREMENTS

Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.

If information must be specially prepared for submittal because standard published data are unsuitable for use, submit as Shop Drawings, not as Product Data.
Mark each copy of each submittal to show which products and options are applicable.
Include the following information, as applicable:

Manufacturer's catalog cuts.
Manufacturer's product specifications.
Standard color charts.
Statement of compliance with specified referenced standards.
Testing by recognized testing agency.
Application of testing agency labels and seals.
Notation of coordination requirements.
Availability and delivery time information.

For equipment, include the following in addition to the above, as applicable:

Wiring diagrams that show factory-installed wiring.
Printed performance curves.
Operational range diagrams.
Clearances required to other construction, if not indicated on accompanying Shop Drawings.

Submit Product Data before Shop Drawings, and before or concurrent with Samples.

Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.

Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:

Identification of products.
Schedules.
Compliance with specified standards.

Notation of coordination requirements.
Notation of dimensions established by field measurement.
Relationship and attachment to adjoining construction clearly indicated.
Seal and signature of professional engineer if specified.

Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other materials.

Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
Email Transmittal: Provide PDF transmittal. Include digital image file illustrating Sample characteristics, and identification information for record.
Paper Transmittal: Include paper transmittal including complete submittal information indicated.
Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.

Number of Samples: Submit one full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Architect will return submittal with options selected.

CONTRACTOR'S REVIEW

Action Submittals and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect.

Contractor's Approval: Indicate Contractor's approval for each submittal with a uniform approval stamp. Include name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

Architect will not review submittals received from Contractor that do not have Contractor's review and approval.

ARCHITECT'S REVIEW

Action Submittals: Architect will review each submittal, indicate corrections or revisions required, and return it.

PDF Submittals: Architect will indicate, via markup on each submittal, the appropriate action.

Informational Submittals: Architect will review each submittal and will not return it, or will return it if it does not comply with requirements. Architect will forward each submittal to appropriate party.

Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Architect.

Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.

Architect will discard submittals received from sources other than Contractor.

Submittals not required by the Contract Documents will be returned by Architect without action.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

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SECTION 01 50 00
TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

SUMMARY

Section includes requirements for temporary utilities, support facilities, and security and protection facilities.

Related Requirements:

Section 01 10 00 "Summary" for work restrictions and limitations on utility interruptions.

USE CHARGES

General: Installation and removal of and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities engaged in the Project to use temporary services and facilities without cost, including, but not limited to, Owner's construction forces, Architect, occupants of Project, testing agencies, and authorities having jurisdiction.

Water and Sewer Service from Existing System: Provide connections and extensions of services as required for construction operations, coordinate installation of temporary and new metering.

Electric Power Service from Existing System: Provide connections and extensions of services as required for construction operations, coordinate installation of temporary and new metering.

INFORMATIONAL SUBMITTALS

Site Utilization Plan: Show temporary facilities, temporary utility lines and connections, staging areas, construction site entrances, vehicle circulation, and parking areas for construction personnel.

Project Identification and Temporary Signs: Show fabrication and installation details, including plans, elevations, details, layouts, typestyles, graphic elements, and message content.

Fire-Safety Program: Show compliance with requirements of NFPA 241 and authorities having jurisdiction. Indicate Contractor personnel responsible for management of fire-prevention program.

Moisture-and Mold-Protection Plan: Describe procedures and controls for protecting materials and construction from water absorption and damage and mold.

QUALITY ASSURANCE

Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.

Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

Accessible Temporary Egress: Comply with applicable provisions in the United States Access Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.

PROJECT CONDITIONS

Temporary Use of Permanent Facilities: Engage Installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

PART 2 - PRODUCTS

TEMPORARY FACILITIES

Field Offices, General: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading. Owner will provide a field office for contractor use.

DUMPSTERS

Construction Manager and owner will provide necessary dumpsters for construction waste disposal.

EQUIPMENT

Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.

PART 3 - EXECUTION

TEMPORARY FACILITIES, GENERAL

Conservation: Coordinate construction and use of temporary facilities with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.

Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. See other Sections for disposition of salvaged materials that are designated as Owner's property.

INSTALLATION, GENERAL

Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.

Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

TEMPORARY UTILITY INSTALLATION

General: Install temporary service or connect to existing service.

Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.

Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.

Electric Power Service: Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations.

Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.

Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.

SECURITY AND PROTECTION FACILITIES INSTALLATION

Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.

Where access to adjacent properties is required in order to affect protection of existing facilities, obtain written permission from adjacent property owner to access property for that purpose.

OPERATION, TERMINATION, AND REMOVAL

Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.

Maintenance: Maintain facilities in good operating condition until removal.

Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.

Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.

Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.

Materials and facilities that constitute temporary facilities are property of Contractor. Owner reserves right to take possession of Project identification signs.

At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 01 77 00 "Closeout Procedures."

END OF SECTION

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SECTION 01 74 19
CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

SUMMARY

Section includes administrative and procedural requirements for the following:

- Salvaging nonhazardous demolition and construction waste.
- Recycling nonhazardous demolition and construction waste.
- Disposing of nonhazardous demolition and construction waste.

Related Requirements:

- Section 04 20 00 "Unit Masonry" for disposal requirements for masonry waste.

DEFINITIONS

Construction Waste: Building, structure, and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.

Demolition Waste: Building, structure, and site improvement materials resulting from demolition operations.

Disposal: Removal of demolition or construction waste and subsequent salvage, sale, recycling, or deposit in landfill, incinerator acceptable to authorities having jurisdiction, or designated spoil areas on Owner's property.

Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.

Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.

Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.

QUALITY ASSURANCE

Waste Management Conference(s): Conduct conference(s) at Project site to comply with requirements in Section 01 31 00 "Project Management and Coordination."

WASTE MANAGEMENT PLAN

General: Develop a waste management plan according to requirements in this Section.

PART 2 - PRODUCTS

PERFORMANCE REQUIREMENTS

General: Review with Owner and Architect what items will be salvaged, recycled, or disposed of.

PART 3 - EXECUTION

PLAN IMPLEMENTATION

General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.

Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

Designate and label specific areas on Project site necessary for separating materials that are to be salvaged and recycled.

Comply with Section 01 50 00 "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.

SALVAGING DEMOLITION WASTE

Comply with requirements in Section 02 41 19 "Selective Demolition" for salvaging demolition waste.

Salvaged Items for Owner's Use:

Clean salvaged items.

Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.

Store items in a secure area until delivery to Owner.

Protect items from damage during transport and storage.

RECYCLING WASTE, GENERAL

General: Recycle paper and beverage containers used by on-site workers.

Preparation of Waste: Prepare and maintain recyclable waste materials according to recycling or reuse facility requirements. Maintain materials free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling process.

Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical according to approved construction waste management plan.

RECYCLING DEMOLITION WASTE

Asphalt Paving: Break up and transport paving to asphalt-recycling facility.

Concrete: Remove reinforcement and other metals from concrete and sort with other metals.

Masonry: Remove metal reinforcement, anchors, and ties from masonry and sort with other metals.

Wood Materials: Sort and stack members according to size, type, and length. Separate lumber, engineered wood products, panel products, and treated wood materials.

Metals: Separate metals by type.

Structural Steel: Stack members according to size, type of member, and length.

Remove and dispose of bolts, nuts, washers, and other rough hardware.

Metal Suspension System: Separate metal members, including trim and other metals from acoustical panels and tile, and sort with other metals.

Piping: Reduce piping to straight lengths and store by material and size. Separate supports, hangers, valves, sprinklers, and other components by material and size.

Conduit: Reduce conduit to straight lengths and store by material and size.

Lamps: Separate lamps by type and store according to requirements in 40 CFR 273.

RECYCLING CONSTRUCTION WASTE

Packaging:

Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.

Polystyrene Packaging: Separate and bag materials.

Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site, break down pallets into component wood pieces and comply with requirements for recycling wood.

Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.

Wood Materials:

Clean Cut-Offs of Lumber: Grind or chip into small pieces.

Clean Sawdust: Bag sawdust that does not contain painted or treated wood.

DISPOSAL OF WASTE

General: Except for items or materials to be salvaged or recycled, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.

Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.

Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

General: Except for items or materials to be salvaged or recycled, remove waste materials and legally dispose of at designated spoil areas on Owner's property.

Burning: Do not burn waste materials.

END OF SECTION

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SECTION 01 77 00
CLOSEOUT PROCEDURES

PART 1 - GENERAL

SUMMARY

Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:

- Substantial Completion procedures.
- Final completion procedures.
- Warranties.
- Final cleaning.
- Repair of the Work.

ACTION SUBMITTALS

Product Data: For each type of cleaning agent.

Contractor's List of Incomplete Items: Initial submittal at Substantial Completion.

Certified List of Incomplete Items: Final submittal at final completion.

CLOSEOUT SUBMITTALS

Certificates of Release: From authorities having jurisdiction.

Certificate of Insurance: For continuing coverage.

Field Report: For pest control inspection.

SUBSTANTIAL COMPLETION PROCEDURES

Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's punch list), indicating the value of each item on the list and reasons why the Work is incomplete.

Submittals Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.

- Certificates of Release: Obtain and submit releases from authorities having jurisdiction permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
- Submit closeout submittals specified in other Division 01 Sections, including project record documents, operation and maintenance manuals, damage or settlement surveys, property surveys, and similar final record information.
- Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
- Submit maintenance material submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Architect. Label with manufacturer's name and model number.
- Submit testing, adjusting, and balancing records.
- Submit sustainable design submittals not previously submitted.
- Submit changeover information related to Owner's occupancy, use, operation, and maintenance.

Procedures Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.

- Advise Owner of pending insurance changeover requirements.
- Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
- Complete startup and testing of systems and equipment.
- Perform preventive maintenance on equipment used prior to Substantial Completion.
- Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings specified in Section 01 79 00 "Demonstration and Training."
- Advise Owner of changeover in utility services.
- Participate with Owner in conducting inspection and walkthrough with local emergency responders.
- Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
- Complete final cleaning requirements.
- Touch up paint and otherwise repair and restore marred exposed finishes to eliminate visual defects.

Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of 10 days prior to date the Work will be completed and ready for final inspection and tests. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Architect, that must be completed or corrected before certificate will be issued.

FINAL COMPLETION PROCEDURES

Submittals Prior to Final Completion: Before requesting final inspection for determining final completion, complete the following:

- Submit a final Application for Payment according to Section 01 29 00 "Payment Procedures."
- Certified List of Incomplete Items: Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect. Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
- Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.
- Submit pest-control final inspection report.

Inspection: Submit a written request for final inspection to determine acceptance a minimum of 10 days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.

LIST OF INCOMPLETE ITEMS (PUNCH LIST)

Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.

- Organize list of spaces in sequential order, starting with exterior areas first.
- Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
- Submit list of incomplete items in the following format:

PDF electronic file. Architect will return annotated file.

SUBMITTAL OF PROJECT WARRANTIES

Time of Submittal: Submit written warranties on request of Architect for designated portions of the Work where warranties are indicated to commence on dates other than date of Substantial Completion, or when delay in submittal of warranties might limit Owner's rights under warranty.

Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.

Warranty Electronic File: Provide warranties and bonds in PDF format. Assemble complete warranty and bond submittal package into a single electronic PDF file with bookmarks enabling navigation to each item. Provide bookmarked table of contents at beginning of document.

Submit on digital media acceptable to Architect.

Warranties in Paper Form:

Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.

Provide additional copies of each warranty to include in operation and maintenance manuals.

PART 2 - PRODUCTS

MATERIALS

Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 - EXECUTION

FINAL CLEANING

General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.

Cleaning: Clean each surface or unit, comply with manufacturer's written instructions.

Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:

Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.

Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.

Sweep concrete surfaces.

Clean light fixtures, lamps, globes, and reflectors to function with full efficiency.

Leave Project clean.

Pest Control: Comply with pest control requirements in Section 01 50 00 "Temporary Facilities and Controls." Prepare written report.

Construction Waste Disposal: Comply with waste disposal requirements in Section 01 50 00 "Temporary Facilities and Controls."

REPAIR OF THE WORK

Complete repair and restoration operations, before requesting inspection for determination of Substantial Completion.

Repair, or remove and replace, defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.

END OF SECTION

SECTION 01 78 23
OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

SUMMARY

Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:

- Operation and maintenance documentation directory manuals.
- Systems and equipment operation manuals.
- Systems and equipment maintenance manuals.
- Product maintenance manuals.

CLOSEOUT SUBMITTALS

Submit operation and maintenance manuals indicated. Provide content for each manual as specified in individual Specification Sections, and as reviewed and approved at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.

Format: Submit on digital media acceptable to Architect. Enable reviewer comments on draft submittals.

Final Manual Submittal: Submit (2) Two manuals in final form prior to requesting inspection for Substantial Completion before commencing demonstration and training.

- Correct or revise each manual to comply with Architect's comments.

Comply with Section 01 77 00 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

FORMAT OF OPERATION AND MAINTENANCE MANUALS

Manuals, Electronic File (1) One File: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.

- Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
- File Names and Bookmarks: Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.

Manuals, Paper Copies (2) Two Bound Books: Submit manuals in the form of hard-copy, bound and labeled volumes.

- Binders: Heavy-duty, three-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
- Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
    - If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
    - If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

OPERATION MANUALS

Systems and Equipment Operation: Assemble a complete set of data indicating operation of each system, subsystem, and piece of equipment not part of a system. Include information required for daily operation and management, operating standards, and routine and special operating procedures.

Systems and Equipment Maintenance: Assemble a complete set of data indicating maintenance of each system, subsystem, and piece of equipment not part of a system. Include manufacturers' maintenance documentation, preventive maintenance procedures and frequency, repair procedures, wiring and systems diagrams, lists of spare parts, and warranty information.

Product Maintenance: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.

Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 01 79 00
DEMONSTRATION AND TRAINING

PART 1 - GENERAL

SUMMARY

Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:

Instruction in operation and maintenance of systems, subsystems, and equipment.

QUALITY ASSURANCE

Preinstruction Conference: Conduct conference at Project site to comply with requirements in Section 01 31 00 "Project Management and Coordination."

COORDINATION

Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of Owner's personnel.

INSTRUCTION PROGRAM

Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.

INSTRUCTION

Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final Operation and Maintenance Manual.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

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SECTION 02 41 19
SELECTIVE DEMOLITION

PART 1 - GENERAL

SUMMARY

Section Includes:

Demolition and removal of selected portions of building or structure.

Salvage of existing items to be reused or recycled.

MATERIALS OWNERSHIP

Unless otherwise indicated, demolition waste becomes property of Contractor.

Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.

Carefully salvage in a manner to prevent damage and promptly return to Owner.

PREINSTALLATION MEETINGS

Predemolition Conference: Conduct conference at Project site.

INFORMATIONAL SUBMITTALS

Proposed Protection Measures: Submit report if requested by Owner, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and, for noise control. Indicate proposed locations and construction of barriers.

Pre-demolition photographs or video for Contractors records.

CLOSEOUT SUBMITTALS

Inventory of items that have been removed and salvaged.

FIELD CONDITIONS

Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.

Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

Storage or sale of removed items or materials on-site is not permitted.

Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

Maintain fire-protection facilities in service during selective demolition operations.

Arrange selective demolition schedule so as not to interfere with Owner's operations.

WARRANTY

Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials and using approved contractors so as not to void existing warranties.

PART 2 - PRODUCTS

PERFORMANCE REQUIREMENTS

Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

Standards: Comply with ANSI/ASSP A10.6 and NFPA 241.

PART 3 - EXECUTION

EXAMINATION

Verify that utilities have been disconnected and capped before starting selective demolition operations.

Inventory and record the condition of items to be removed and salvaged.

UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.

Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.

Arrange to shut off utilities with utility companies.

If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.

Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated on Drawings to be removed.

Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.

Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material and leave in place.

Equipment to Be Removed: Disconnect and cap services and remove equipment.

Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.

Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.

Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material and leave in place.

PROTECTION

Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

Remove temporary barricades and protections where hazards no longer exist.

SELECTIVE DEMOLITION

General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:

Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.

Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.

Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.

Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.

Dispose of demolished items and materials promptly.

Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

Removed and Salvaged Items:

Clean salvaged items.

Pack or crate items after cleaning. Identify contents of containers.

Store items in a secure area until delivery to Owner.

Transport items to Owner's storage area designated by Owner.

Protect items from damage during transport and storage.

Removed and Reinstalled Items:

Clean and repair items to functional condition adequate for intended reuse.

Pack or crate items after cleaning and repairing. Identify contents of containers.

Protect items from damage during transport and storage.

Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

CLEANING

Remove demolition waste materials from Project site and dispose of them in an EPA-approved construction and demolition waste landfill acceptable to authorities having jurisdiction.

Do not allow demolished materials to accumulate on-site.

Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.

Burning: Do not burn demolished materials.

Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION

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SECTION 03 30 53
MISCELLANEOUS CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

SUMMARY

Section includes cast-in-place concrete, including reinforcement, concrete materials, mixture design, placement procedures, and finishes.

ACTION SUBMITTALS

Product Data: For each type of product.

Sustainable Design Submittals:

Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.

Laboratory Test Reports: For curing and sealing compounds, indicating compliance with requirements for low-emitting materials.

Design Mixtures: For each concrete mixture.

QUALITY ASSURANCE

Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

PART 2 - PRODUCTS

FORM-FACING MATERIALS

As-Cast Surface Form-Facing Material:

Provide continuous, true, and smooth concrete surfaces.

Furnish in largest practicable sizes to minimize number of joints.

Acceptable Materials: As required to comply with Surface Finish designations specified

Lumber, plywood, metal, plastic, or other approved materials.

Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.

Formulate form-release agent with rust inhibitor for steel form-facing materials.

Form release agent for form liners shall be acceptable to form liner manufacturer.

CONCRETE, GENERAL

Comply with ACI 301 and ACI 117.

STEEL REINFORCEMENT

Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

Plain-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, plain, fabricated from as-drawn steel wire into flat sheets. 4x4 square opening, 0.250” diameter.

Anchors/Dowels: Stainless Steel wedge anchors, or #4 rebar dowels epoxied into existing floor slab.

CONCRETE MATERIALS

Regional Materials: Concrete shall be manufactured within 500 miles of Project site.

Cementitious Materials:

- Portland Cement: ASTM C 150/C 150M, Type I.
- Fly Ash: ASTM C 618, Class C or F.
- Slag Cement: ASTM C 989/C 989M, Grade 100 or 120.
- Blended Hydraulic Cement: ASTM C 595/C 595M, Type IS, portland blast-furnace slag cement.

Normal-Weight Aggregate: ASTM C 33/C 33M, 1-1/2-inch nominal maximum aggregate size.

Air-Entraining Admixture: ASTM C 260/C 260M.

Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

- Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
- Retarding Admixture: ASTM C 494/C 494M, Type B.
- Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.

Water: ASTM C 94/C 94M.

RELATED MATERIALS

Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber, or ASTM D 1752, cork or self-expanding cork.

Bonding Agent: Polymers and copolymers mixture designed to bind new and old concrete.

CURING MATERIALS

Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.

Absorptive Cover: AASHTO M 182, Class 3, burlap cloth or cotton mats.

Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.

CONCRETE MIXTURES

Normal-Weight Concrete:

- Minimum Compressive Strength: 4000 psi at 28 days.
- Maximum W/C Ratio: 0.45.
- Cementitious Materials: Use fly ash, pozzolan, slag cement, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.
- Slump Limit: 5 inches, plus or minus 1 inch.
- Air Content: Maintain within range permitted by ACI 301. Do not allow air content of trowel-finished floor slabs to exceed 3 percent.

CONCRETE MIXING

Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and ASTM C 1116/C 1116, and furnish batch ticket information.

When air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

CONCRETE PAD SCHEDULE

The below schedule lists the new mechanical equipment (housekeeping) concrete pads, location and approximate size.

Concrete Pad Location		**Pad Size (square feet)**	**Pad Depth**
Plan Sheet	Description		
3/M200	"L" shaped pad under Control Cabinet and BT 1	28 square feet*	4 inches
3/M200	Square pad under CP 3,4,5	25 square feet*	4 inches

*Coordinate final pad size and location with Mechanical Contractor.

PART 3 - EXECUTION

FORMWORK INSTALLATION

Design, construct, erect, brace, and maintain formwork according to ACI 301. Construct forms tight enough to prevent loss of concrete mortar. Construct removable forms for easy removal without hammering or prying against concrete surfaces.

EMBEDDED ITEM INSTALLATION

Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

Embed anchors/dowels into existing concrete floor 4", spaced them 2'-0" o.c.

STEEL REINFORCEMENT INSTALLATION

Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

Apply bonding agent to existing concrete per manufactures instructions.

Install welded-wire reinforcing, hold wire 1.5 inches above the existing concrete floor. It shall be held 1.5 inches below the top of the new concrete.

CONCRETE PLACEMENT

Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.

Do not add water to concrete during delivery, at Project site, or during placement.

Consolidate concrete with mechanical vibrating equipment according to ACI 301.

FINISHING FORMED SURFACES

Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch defective areas. Remove fins and other projections exceeding 1/8 inch.

Apply to concrete surfaces exposed to public view.

FINISHING UNFORMED SURFACES

General: Comply with ACI 302.1R for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

Screed surfaces with a straightedge and strike off. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane before excess moisture or bleedwater appears on surface.

Do not further disturb surfaces before starting finishing operations.

Trowel Finish: Apply a hard trowel finish to surfaces indicated and to floor and slab surfaces exposed to view.

CONCRETE PROTECTING AND CURING

General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and with ACI 305.1 for hot-weather protection during curing.

Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

Curing Methods: Cure formed and unformed concrete for at least seven days by one or a combination of the following methods:

Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period, using cover material and waterproof tape.

Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

FIELD QUALITY CONTROL

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

Tests: Perform according to ACI 301.

Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.

Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.

END OF SECTION

SECTION 07 51 13
BUILT-UP ASPHALT ROOFING

PART 1 - GENERAL

SUMMARY
Section Includes: Patching openings in existing roof

PREINSTALLATION MEETINGS
Preinstallation Roofing Conference: Conduct conference at Project site.

ACTION SUBMITTALS
Product Data: For each type of product.

INFORMATIONAL SUBMITTALS
Product Test Reports.

CLOSEOUT SUBMITTALS
Certified statement from existing roof membrane manufacturer, stating that existing roof warranty has not been affected by Work performed under this Section.

WARRANTY
Existing Warranty: Contractor shall not void any existing roof warranty.

PART 2 - PRODUCTS

PERFORMANCE REQUIREMENTS
Accelerated Weathering: Roof membrane to withstand 2000 hours of exposure when tested according to ASTM G152, ASTM G154, or ASTM G155.

Impact Resistance: Roof membrane to resist impact damage when tested according to ASTM D3746/C3746M, ASTM D4272/D4272M, or the "Resistance to Foot Traffic Test" in FM Approvals 4470.

MANUFACTURERS
Built-up Asphalt Roof System: See the following articles for individual roof materials required.

Source Limitations: Obtain components for roofing system from same manufacturer as roofing membrane or manufacturer approved by roofing membrane manufacturer.

ROOFING MEMBRANE SHEET MATERIALS
Asphalt-Coated, Glass-Fiber-Mat Base Sheet: ASTM D4601/D4601M, Type I, nonperforated, asphalt-impregnated and -coated, glass-fiber sheet, dusted with fine mineral surfacing on both sides.

Cap Sheet: ASTM D3909/D3909M, asphalt-impregnated and -coated, glass-fiber cap sheet, with white coarse mineral-granule top surfacing and fine mineral surfacing on bottom surface.

BASE FLASHING SHEET MATERIALS
Liquid Flashing System: Roof membrane manufacturer's standard one- or two-part moisture curing resin with low solvent content, consisting of a primer, flashing cement, and scrim.

ASPHALT MATERIALS
Asphalt Primer: ASTM D41/D41M.

Roofing Asphalt: ASTM D312/D312M, Type III or IV as recommended by roofing system manufacturer for application.

ACCESSORY ROOFING MATERIALS

General: Accessory materials recommended by roofing manufacturer for intended use and compatible with other roofing components.

Cold-Applied Asphalt Adhesive: ASTM D4479/D4479M, Type I or Type II, roof system manufacturer's standard asphalt-based, one- or two-part, asbestos-free, cold-applied adhesive, specially formulated for compatibility and use with roofing system and base flashings.

ROOF INSULATION

Extruded-Polystyrene Board Insulation: ASTM C578, Type IV, 1.6-lb/cu. ft. minimum density, 25 psi minimum compressive strength, to fill vent opening.

INSULATION ACCESSORIES AND COVER BOARD

Oriented Strand Board: DOC PS 2, Exposure 1, 7/16 inch thick.

PART 3 - EXECUTION

EXAMINATION

Examine existing substrates, areas, and conditions, for compliance with requirements and other conditions affecting performance of the Work.

PREPARATION

Prime existing roof surface. Carefully remove/brush existing ballast rock away from area of roof to be patched/repaired. After pipe for blow-down tank is removed, remove pip boot, prep area for patching and sealing.

INSTALLATION OF ROOFING PATCH

Install roofing system according to manufacturer's written instructions.

Fill opening with insulation, cover insulation with Oriented Strand Board.

Install roof membrane and cold-applied asphalt adhesive materials to tie in to existing roofing to maintain weathertightness of transition and to not void warranty for existing roofing system.

Re-distribute ballast rock over patched area.

PROTECTING AND CLEANING

Protect existing roofing system from damage and wear during construction.

Correct deficiencies in or remove roofing components that do not comply with requirements, repair substrates, and repair or reinstall roofing to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION

SECTION 09 90 00
PAINTING

PART 1 - GENERAL

SUMMARY
Section Includes: Primers and paint for

ACTION SUBMITTALS
Product Data: For each type of product.

Samples: For each type of topcoat product.

Product Schedule: Use same designations indicated on Drawings and in the Painting Schedule to cross-reference paint systems specified in this Section. Include color designations.

PART 2 - PRODUCTS

MANUFACTURERS
Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Benjamin Moore & Co.
2. PPG Paints; PPG Industries, Inc.
3. Rust-Oleum Corporation; a subsidiary of RPM International, Inc.
4. Sherwin-Williams Company (The).
5. Valspar; a brand of The Sherwin-Williams Company.

PAINT PRODUCTS, GENERAL
Material Compatibility:

Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.

For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.

Colors: As specified below, if not specified color shall be selected by Owner from manufacturer's full range.

PRIMERS
Alkali-Resistant, Water-Based Primer: Water-based primer formulated for use on alkaline surfaces, such as plaster, vertical concrete, and masonry.

Interior Latex Primer Sealer: Water-based latex sealer used on new interior plaster, concrete, and gypsum wallboard surfaces.

Oil-Based Rust-Inhibitive Primer: Corrosion-resistant, oil-based-emulsion primer formulated for resistance to flash rusting when applied to cleaned, interior ferrous metals subject to mildly corrosive environments.

Basis of Design: Rust-Oleum Protective Enamel Oil-Based, Grey

Cementitious Galvanized Primer: Solvent-based primer composed of linseed oil/alkyd resin and portland cement for cleaned galvanized metal prior to finish coating.

WATER-BASED FINISH COATS
Interior, Latex, Eggshell: Pigmented, water-based paint for use on primed/sealed interior plaster and gypsum board, and on primed wood and metals.

Gloss and Sheen Level: Manufacturer's standard eggshell finish.

Interior, Water-Based Light-Industrial Coating, Eggshell: Pigmented, water-based emulsion coating for interior primed wood and metal surfaces (e.g., walls, doors, frames, trim, and sash), providing resistance to moderate abrasion and mild chemical exposure and corrosive conditions.

Gloss and Sheen Level: Manufacturer's standard eggshell finish.

PART 3 - EXECUTION

EXAMINATION

Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.

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

Application of coating indicates acceptance of surfaces and conditions.

PREPARATION

Comply with manufacturer's written instructions and recommendations applicable to substrates and paint systems indicated.

Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

INSTALLATION

Apply paints according to manufacturer's written instructions.

Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

Painting new Fire-Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:

Paint the following new work where exposed in equipment rooms:

- Equipment, including panelboards.
- Uninsulated metal piping.
- Uninsulated plastic piping.
- Pipe hangers and supports.
- Metal conduit.
- Plastic conduit.
- Tanks that do not have factory-applied final finishes.
- Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.

Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

CLEANING AND PROTECTION

After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

PAINTING SCHEDULE

Concrete Substrates, Nontraffic Surfaces:

Latex System:

Prime Coat: Alkali-resistant, water-based primer.

Intermediate Coat: Matching topcoat.

Topcoat: Interior latex paint, eggshell.

Galvanized-Metal Substrates:

Water-Based Light-Industrial Coating System:

Prime Coat: Cementitious galvanized primer.

Intermediate Coat: Matching topcoat.

Topcoat: Interior, water-based, light-industrial coating, eggshell.

Cotton or Canvas Insulation-Covering Substrates: Including pipe and duct coverings.

Latex System:

Prime Coat: Interior latex primer sealer.

Intermediate Coat: Matching topcoat.

Topcoat: Interior, latex, eggshell.

Utility Service Piping:

Oil-Based Enamel:

Prime Coat: Oil-Based Rust-Inhibitive Primer.

Topcoat: Match prime coat.

END OF SECTION

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SECTION 23 05 00
COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Scope. This section includes information common to two or more technical specification sections or items that are of a general nature, not conveniently fitting into other technical sections. Included are the following topics:

B. PART 1 - GENERAL
   1. Scope
   2. Related Work
   3. Reference
   4. Reference Standards
   5. Quality Assurance
   6. Continuity of Existing Services
   7. Protection of Finished Surfaces
   8. Sleeves and Openings
   9. Sealing and Firestopping
   10. Equipment Substitutions
   11. Submittals
   12. Off-site Storage
   13. Certificates and Inspections
   14. Operating and Maintenance Data
   15. Training of Owner Personnel
   16. Record Drawings
   17. Temperature Controls

C. PART 2 - Products
   1. Identification
   2. Sealing and Firestopping

D. PART 3 - EXECUTION
   1. Demolition
   2. Cutting and Patching
   3. Building Access
   4. Equipment Access
   5. Coordination
   6. Identification
   7. Lubrication
   8. Sleeves and Openings
   9. Sealing and Firestopping
   10. Cleaning Equipment and Premises
   11. Guarantee
   12. Certification of Tests and Adjustments

1.02 RELATED WORK

A. Section 23 05 13 - Common Motor Requirements for HVAC
B. Section 23 33 00 - Air Duct Accessories

1.03 REFERENCE

A. Applicable provisions of Division 1 govern work under this section.

1.04 REFERENCE STANDARDS

A. Abbreviations of standards organizations referenced in other sections are as follows:

AABC	Associated Air Balance Council
ABMA	American Boiler Manufacturers Association
ADC	Air Diffusion Council
AGA	American Gas Association
AMCA	Air Movement and Control Association
ANSI	American National Standards Institute
ARI	Air Conditioning and Refrigeration Institute
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
AWS	American Welding Society
EPA	Environmental Protection Agency
GAMA	Gas Appliance Manufacturers Association
IEEE	Institute of Electrical and Electronics Engineers
ISA	Instrument Society of America
MCA	Mechanical Contractors Association
MICA	Midwest Insulation Contractors Association
MSS	Manufacturer's Standardization Society of the Valve & Fitting Industry, Inc.
NBS	National Bureau of Standards
NEBB	National Environmental Balancing Bureau
NEC	National Electric Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association. Inc.
UL	Underwriters Laboratories Inc.
ASTM E814	Standard Test Method for Fire Tests of Through-Penetration Fire Stops
ASTM E84	Standard Test Method for Surface Burning Characteristics of Building Materials
UL1479	Fire Tests of Through-Penetration Firestops
UL723	Surface Burning Characteristics of Building Materials

1.05 QUALITY ASSURANCE

A. Refer to Division 1, General Conditions, Equals and Substitutions.

B. Where equipment or accessories are used which differ in arrangement, configuration, dimensions, ratings, or engineering parameters from those indicated on the contract documents, the contractor is responsible for all costs involved in integrating the equipment or accessories into the system and for obtaining the performance from the system into which these items are placed. This may include changes found necessary during the testing, adjusting, and balancing phase of the project.

1.06 CONTINUITY OF EXISTING SERVICES

A. Do not interrupt or change existing services without prior written approval from the Owner. When interruption is required, coordinate the down time with the Owner to minimize disruption to their activities. Unless specifically stated, all work involved in interrupting or changing existing services is to be done during normal working hours.

1.07 PROTECTION OF FINISHED SURFACES

A. Refer to Division 1, General Requirements, Protection of Finished Surfaces.

B. Furnish one can of touch up paint for each different color factory finish which is to be the final finished surface of the product. Deliver touch up paint with other "loose and detachable parts" as covered in the General Requirements.

1.08 SLEEVES AND OPENINGS

A. Refer to Division 1, General Requirements, Sleeves and Openings.

1.09 SEALING AND FIRESTOPPING

A. Sealing and firestopping of sleeves/openings between ductwork, piping, etc. and the sleeve, structural or partition opening shall be the responsibility of the contractor whose work penetrates the opening. Provide all fire stopping of fire rated penetrations and sealing of smoke rated penetrations.

1.10 EQUIPMENT SUBSTITUTIONS

A. Contractors and/or manufacturers may submit catalog data on material proposed for substitution to the engineer for evaluation up to 10 days prior to the date for opening bids. The engineer will render an opinion on whether or not the material can be bid as a substitute based on the information received. Final approval for the use of substitute equipment will not be given until complete shop drawings, samples or other information deemed necessary by the engineer has been submitted.

1.11 SUBMITTALS

A. Refer to Division 1, General Conditions, Submittals.

B. Submit for all equipment and systems as indicated in the respective specification sections, marking each submittal with that specification section number. Mark general catalog sheets and drawings to indicate specific items being submitted and proper identification of equipment by name and/or number, as indicated in the contract documents.

C. Before submitting electrically powered equipment, verify that the electrical power and control requirements for the equipment are in agreement with the motor starter schedule on the electrical drawings. Starters and disconnects which are not explicitly defined as the responsibility of any contractor shall be provided by the Division 23 contractor. Include a statement on the shop drawing transmittal to the architect/engineer that the equipment submitted and the motor starter schedule are in agreement or indicate any discrepancies. See related comments in Section 23 05 13 in Part 1 under Electrical Coordination.

D. Include wiring diagrams of electrically powered equipment.

E. Submit sufficient quantities of shop drawings to allow the following distribution:
- Operating and Maintenance Manuals 3 copies
- Testing, Adjusting and Balancing Contractor 1 copy
- A/E 1 copy

F. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.12 OFF-SITE STORAGE

A. Prior approval by the Owner and the A/E will be needed.

B. Generally, ductwork, metal for making ductwork, duct lining, sleeves, pipe/pipe fittings and similar rough in material will not be accepted for off-site storage. For material that can be stored off site, no material will be accepted for off-site storage unless shop drawings for that material have been approved.

1.13 CERTIFICATES AND INSPECTIONS

A. Refer also to Division 1, General Conditions, Permits, Regulations, Utilities and Taxes.

B. Contractors installing heating, ventilating, and air conditioning systems or equipment in the State of Wisconsin must be licensed. The contractor must provide proof of current and valid license upon request and maintain license through project completion.

C. Obtain and pay for all required State installation inspections except those provided by the Architect/Engineer in accordance with Wis Adm Code SPS 302. Deliver originals of these certificates to the A/E. Include copies of the certificates in the Operating and Maintenance Instructions.

D. All utility connection fees shall be paid by the respective contractor.

1.14 OPERATING AND MAINTENANCE DATA

A. All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

B. Assemble material in three ring or post binders, using an index at the front of each volume and tabs for each system or type of equipment. In addition to the data indicated in the General Requirements, include the following information:
   - Copies of all approved shop drawings
   - Manufacturer's wiring diagrams for electrically powered equipment
   - Records of tests performed to certify compliance with system requirements
   - Certificates of inspection by regulatory agencies
   - Temperature control record drawings and control sequences
   - Parts lists for manufactured equipment
   - Valve schedules
   - Lubrication instructions, including list/frequency of lubrication done during construction
   - Warranties
   - Additional information as indicated in the technical specification sections
   - A copy of signed Certification of Tests and Adjustments Form
   - Final Testing, Adjusting, and Balance Report

1.15 TRAINING OF OWNER PERSONNEL

A. Instruct Owner personnel in the proper operation and maintenance of systems and equipment provided as part of this project. Include not less than 2 hours of instruction, using the Operating and Maintenance manuals during this instruction. Demonstrate startup and shutdown procedures for all equipment. All training to be during normal working hours.

1.16 RECORD DRAWINGS

A. Refer to Division 1, General Requirements, Record Drawings.

B. In addition to the data indicated in the General Requirements, maintain temperature control record drawings on originals prepared by the installing contractor/subcontractor. Include copies of these record drawings with the Operating and Maintenance manuals.1.17

1.17 TEMPERATURE CONTROLS

A. Temperature controls to match and integrate into existing BMS System. This work will be contracted separately by the Owner and performed by Complete Controls, Inc.

PART 2 - PRODUCTS

2.01 IDENTIFICATION

A. STENCILS: Not less than 1 inch high letters/numbers for marking pipe and equipment.

B. SNAP-ON PIPE MARKERS: Cylindrical self-coiling plastic sheet that snaps over piping insulation and is held tightly in place without the use of adhesive, tape or straps. Not less than 1 inch high letters/numbers and flow direction arrows for piping marking. W. H. Brady, Seton, Marking Services, or equal.

C. ENGRAVED NAME PLATES: White letters on a black background, 1/16 inch thick plastic laminate, beveled edges, screw mounting, Setonply Style 2060 by Seton Name Plate Company or Emedolite- Style EIP by EMED Co., or equal by Marking Services, or W. H. Brady.

2.02 SEALING AND FIRESTOPPING

A. FIRE AND/OR SMOKE RATED PENETRATIONS:

1. Provide all fire stopping of fire rated penetrations and sealing of smoke rated penetrations in compliance with UL & ASTM.

2. Use a product that has a rating not less than the rating of the wall or floor being penetrated. Reference architectural drawings for identification of fire and/or smoke rated walls and floors.

B. NON-RATED PENETRATIONS:

1. Pipe Penetrations: At pipe penetrations of non-rated interior partitions, floors and exterior walls above grade, use urethane caulk in annular space between pipe insulation and sleeve. For non-rated drywall, plaster or wood partitions where sleeve is not required use urethane caulk in annular space between pipe insulation and wall material.

PART 3 - EXECUTION

3.01 DEMOLITION

A. Perform all demolition as indicated on the drawings to accomplish new work. Where demolition work is to be performed adjacent to existing work that remains in an occupied area, construct temporary dust partition to minimize the amount of contamination of the occupied space. Where pipe or duct is removed and not reconnected with new work, cap ends of existing services as if they were new work. Coordinate work with the Owner to minimize disruption to the existing building occupants.

B. All pipe, wiring and associated conduit, insulation, ductwork, and similar items demolished, abandoned, or deactivated are to be removed from the site by the Contractor. All piping and ductwork specialties are to be removed from the site by the Contractor unless they are dismantled and removed or stored by the Owner. All designated equipment is to be turned over to the Owner for their use at a place and time so designated. Maintain the condition of material and/or equipment that is indicated to be reused equal to that existing before work began.

C. Mechanical systems are shown on drawings that were coordinated with the existing conditions; however, variations may occur. Contractor shall verify dimensions, heights, door swings and any other information critical to the placement of devices with the drawings and existing conditions to assure proper installation. Field measurements shall take precedence over drawing dimensions and shall be verified. Plans shall not be scaled to locate equipment.

D. It shall be the contractor's responsibility to visit the existing project site, become acquainted with all existing conditions, and ascertain the extent of work involved in installing equipment, ductwork, air distribution devices, piping, controls and all other appurtenances pertaining to the above. The contractor shall provide all labor, materials, etc., required for the complete, new installation required for the completion of the project. By the act of submitting a price; or in the case of time and material project, begin work, the contractor shall be deemed to have performed such an examination, to have accepted such conditions, and to have made allowances therefore preparing his price and resolving questions regarding work required.

3.02 CUTTING AND PATCHING

A. Refer to Division 1, General Requirements, Cutting and Patching.

B. Skilled tradesmen shall be employed to do cutting and patching. Each Contractor shall be responsible for cutting and patching new openings for their use, in existing or previously constructed walls, ceilings, floors, roofs, etc., unless otherwise designated. Use core drills or saws to cut all openings. Air, jack or manual hammers shall not be used unless approved by the Architect/Engineer. Provide personnel protection under coring operations in occupied areas. Submit methods of supporting and sealing floor sleeves for approval. Holes cut in roof and exterior wall shall be weatherproofed immediately. Provide temporary dust barriers for cutting operations in occupied spaces. Where openings require lintels, they shall be provided by the trade requiring the opening unless specifically indicated on the drawings as being provided in another trade. Each contractor shall be responsible for sealing finished openings, for their use, water and air tight, unless otherwise designated.

3.03 BUILDING ACCESS

A. Arrange for the necessary openings in the building to allow for admittance of all apparatus. When the building access was not previously arranged and must be provided by this contractor, restore any opening to its original condition after the apparatus has been brought into the building.

3.04 EQUIPMENT ACCESS

A. Install all piping, conduit, ductwork, and accessories to permit access to equipment for maintenance and service. Coordinate the exact location of wall and ceiling access panels and doors with the General Contractor, making sure that access is available for all equipment and specialties. Access doors in general construction are to be furnished by the Mechanical Contractor and installed by the General Contractor.

B. Ductwork, equipment, and piping below 7'-6" above finished floor shall have a resilient material (foam rubber, etc.) attached to all potentially dangerous edges.

3.05 COORDINATION

A. Mechanical systems are shown on drawings that were coordinated with the architectural drawings; however, variations may occur. Contractor shall verify all information critical to the placement of devices with the architectural drawings to assure proper installation. Field measurements shall take precedence over drawing dimensions and shall be verified. Plans shall not be scaled to locate equipment. It shall be the contractor's responsibility to become acquainted with all conditions, and ascertain the extent of work involved in installing equipment, ductwork, air distribution devices, piping, controls and all other appurtenances pertaining to the above. The contractor shall provide all labor, materials, etc., required for the complete, new installation required for the completion of the project. By the act of submitting a price; or in the case of time and material project, begin work, the contractor shall be deemed to have performed such an examination, to have accepted such conditions, and to have made allowances therefore preparing his price and resolving questions regarding work required.

B. Plans of piping and ductwork shown on scale drawings are diagrammatic only. They are intended to indicate size and/or capacity where stipulated, approximate location and/or direction and approximate general arrangement of one phase of work to another, but not the exact detail or arrangement of construction. Plans are based on equipment scheduled. Contractor shall be responsible for changes resulting from equipment other than scheduled.

C. Verify that all devices are compatible for the surfaces on which they will be used. This includes, but is not limited to, diffusers, register, grilles, and recessed or semi recessed heating and/or cooling terminal units installed in/on architectural surfaces.

D. Coordinate all work with other contractors prior to installation. Any installed work that is not coordinated and that interferes with other contractor's work shall be removed or relocated at the installing contractor's expense.

E. Cooperate with the test and balance agency in ensuring Section 23 05 93 specification compliance. Verify system completion to the test and balance agency (flushing, pressure testing, chemical treatment, filling of liquid systems, proper pressurization and air venting of hydronic systems, clean strainers, pipe systems cleaned, controls adjusted and calibrated, controls cycled through their sequences, etc.), ready for testing, adjusting and balancing work. Install shutoff and balancing valves, flow measuring devices, gauges, temperature controls, etc., required for functional and balanced systems. Demonstrate the starting, interlocking and control features of each system so the test and balance agency can perform its work.

3.06 IDENTIFICATION

A. Identify equipment in mechanical equipment rooms by stenciling equipment number and service with one coat of black enamel against a light background or white enamel against a dark background. Use a primer where necessary for proper paint adhesion. Do not label equipment such as cabinet heaters and ceiling fans in occupied spaces.

B. Where stenciling is not appropriate for equipment identification, engraved name plates may be used.

C. Identify piping not less than once every 30 feet, not less than once in each room, adjacent to each access door or panel, and on both side of the partition where exposed piping passes through walls, floors or roofs. Place flow directional arrows at each pipe identification location. Use one coat of black enamel against a light background or white enamel against a dark background for stenciling, or provide Snap-On pipe markers as specified in Part 2 – Products.

D. Identify valves with brass tags bearing a system identification and a valve sequence number. Provide a typewritten valve schedule indicating the valve number and the equipment or areas supplied by each valve; locate schedules in each mechanical room and in each Operating and Maintenance manual. Schedules in mechanical rooms to be framed under clear plastic.

E. All valves, coils, controls, and other equipment requiring service located above ceilings, shall have the ceiling tile directly below identified with a colored tack inserted into the tile.

F. Use engraved name plates to identify control equipment.

3.07 LUBRICATION

A. Lubricate all bearings with lubricant as recommended by the manufacturer before the equipment is operated for any reason. Once the equipment has been run, maintain lubrication in accordance with the manufacturer's instructions until the work is accepted by Owner. Maintain a log of all lubricants used and frequency of lubrication; include this information in the Operating and Maintenance Manuals at the completion of the project.

3.08 SLEEVES AND OPENINGS

A. PIPE SLEEVES:

1. Pipe penetrations in existing concrete floors and walls: Core drill openings.

2. Where penetrating pipe or conduit weight is supported by floor, provide manufactured product or structural bearing collar designed to carry load.

3.09 SEALING AND FIRESTOPPING

A. FIRE AND/OR SMOKE RATED PENETRATIONS:

1. Provide all fire stopping of fire rated penetrations and sealing of smoke rated penetrations in compliance with UL & ASTM.

B. NON-RATED PARTITIONS:

1. At all interior walls and exterior walls, pipe penetrations are required to be sealed. Apply sealant to both sides of the penetration in such a manner that the annular space between the pipe sleeve or cored opening and the pipe or insulation is completely blocked.

3.10 CLEANING EQUIPMENT AND PREMISES

A. Thoroughly clean all parts of the piping, valves, and equipment. Exposed parts which are to be painted shall be thoroughly cleaned of cement, plaster and other materials and all oil and grease spots shall be removed. Such surfaces shall be carefully wiped and all cracks and corners scraped out. Exposed metal work shall be carefully brushed down with steel brushes to remove rust and other spots and left smooth and clean.

B. Remove all construction debris, excess materials and equipment.

3.11 GUARANTEE

A. All materials and workmanship shall be guaranteed for a period of one year after substantial completion. Where extended warranties are required, they shall be provided by the manufacturer or contractor as specified, in the equipment specification.

3.12 CERTIFICATION OF TESTS AND ADJUSTMENTS

A. Contractor _____

B. Division of Work _____

C. Project Name _____

D. Project Number _____

E. The Contractor named above certifies that the tests and adjustments indicated below have been completed in accordance with the specifications on the date indicated. Start-up of all HVAC equipment installed in this project is the responsibility of this Contractor unless otherwise indicated.

F. Tests: Date

1. Fuel Gas _____
2. Heating Piping _____
3. Cooling Piping _____
4. Start-up of Heating Piping Systems and Pumps _____
5. Start-up of Cooling Piping Systems and Pumps _____
6. Boiler Start-up _____
7. Glycol Systems
   a. % of glycol in solution _____
   b. Freeze point of solution _____

G. Contact _____

H. Signed By _____

I. Date _____

END OF SECTION

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SECTION 23 05 13
COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Scope. This section includes requirements for single and three phase motors that are used with equipment specified in other sections. Included are the following topics:

B. PART 1 - GENERAL
   1. Scope
   2. Related Work
   3. Reference
   4. Reference Standards
   5. Quality Assurance
   6. Off-site Storage
   7. Operating and Maintenance Data
   8. Electrical Coordination
   9. Product Criteria

C. PART 2 - Products
   1. Three Phase, Single Speed Motors
   2. Single Phase, Single Speed Motors
   3. Motors Used on Variable Frequency Drives

D. PART 3 - EXECUTION
   1. Installation

1.02 RELATED WORK

A. Section 23 05 14 - Variable Frequency Drives
B. Section 23 09 14 - Pneumatic and Electric Instrumentation and Control Devices for HVAC
C. Division 26 - Electrical

1.03 REFERENCE

A. Applicable provisions of Division 1 govern work under this section.

1.04 REFERENCE STANDARDS

A. ANSI/IEEE 112 Test Procedure for Polyphase Induction Motors and Generators
B. ANSI/NEMA MG-1 Motors and Generators
C. ANSI/NFPA 70 National Electrical Code

1.05 QUALITY ASSURANCE

A. Refer to Division 1, General Conditions, Equals and Substitutions.

1.06 SUBMITTALS

A. Refer to Division 1, General Conditions, Submittals.

B. Include with the equipment which the motor drives the following motor information: motor manufacturer, horsepower, voltage, phase, hertz, rpm, full load efficiency. Include project wiring diagrams prepared by the contractor specifically for this work.

1.07 OPERATION AND MAINTENANCE DATA

A. All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

B. In addition to the general content specified under GENERAL REQUIREMENTS supply the following additional documentation:

1. Lubrication instructions, including list/frequency of lubrication.

2. Table noting full load power factor, service factor, NEMA design designation, insulation class and frame type for each motor provided.

1.08 ELECTRICAL COORDINATION

A. All starters, overload relay heater coils, disconnect switches and fuses, relays, wire, conduit, pushbuttons, pilot lights, and other devices required for the control of motors or electrical equipment are furnished and installed by the Electrical Contractor, except as specifically noted elsewhere in this division of specifications.

B. Electrical drawings and/or specifications show number and horsepower rating of all motors furnished by this Contractor, together with their actuating devices if these devices are furnished by the Electrical Contractor. Should any discrepancy in size, horsepower rating, electrical characteristics or means of control be found for any motor or other electrical equipment after contracts are awarded, Contractor is to immediately notify the architect/engineer of such discrepancy. Costs involved in any changes required due to equipment substitutions initiated by this contractor will be the responsibility of this contractor. See related comments in Section 23 05 00 - Common Work Results for HVAC, under Shop Drawings.

C. Electrical Contractor will provide all power wiring and control wiring, except temperature control wiring.

D. Furnish project specific wiring diagrams to Electrical Contractor for all equipment and devices furnished by this Contractor and indicated to be wired by the Electrical Contractor.

1.09 PRODUCT CRITERIA

A. Motors to conform to all applicable requirements of NEMA, IEEE, ANSI, and NEC standards and shall be listed by U.L. for the service specified.

B. Select motors for conditions in which they will be required to perform; i.e., general purpose, splashproof, explosion proof, standard duty, high torque or any other special type as required by the equipment or motor manufacturer's recommendations.

C. Furnish motors for starting in accordance with utility requirements and compatible with starters as specified.

PART 2 - PRODUCTS

2.01 THREE PHASE, SINGLE SPEED MOTORS

A. Use NEMA rated, three phase, 60 hertz motors for all motors 3/4 HP and larger unless specifically indicated.

B. Use NEMA general purpose, continuous duty, Design B, normal starting torque, T-frame or U-frame motors with Class B or better insulation unless the manufacturer of the equipment on which the motor is being used has different requirements. Use open drip-proof motors unless totally enclosed fan-cooled, totally enclosed non-ventilated, explosion-proof, or encapsulated motors are specified in the equipment sections.

C. Use grease lubricated anti-friction ball bearings with housings equipped with plugged/capped provision for relubrication, rated for minimum AFBMA 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at the end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

D. All open drip-proof motors to have a 1.15 service factor. Other motor types may have minimum 1.0 service factors.

E. All motors 1 HP and larger, except specially wound motors and inline pump motors 56 frame and smaller, to be high efficiency design with full load efficiencies which meet or exceed the values listed below when tested in accordance with NEMA MG 1.

FULL LOAD NOMINAL MOTOR EFFICIENCY BY MOTOR SIZE AND SPEED			
Open Drip Proof Motors			
	Nominal Motor Speed		
MOTOR HP	1200 RPM	1800 RPM	3600 RPM
1	82.5	85.5	77.0
1½	86.5	86.5	84.0
2	87.5	86.5	85.5
3	88.5	89.5	85.5
5	89.5	89.5	86.5
7½	90.2	91.0	88.5
10	91.7	91.7	89.5
15	91.7	93.0	90.2
20	92.4	93.0	91.0

FULL LOAD NOMINAL MOTOR EFFICIENCY BY MOTOR SIZE AND SPEED			
Totally Enclosed Fan-Cooled Motors			
	Nominal Motor Speed		
MOTOR HP	1200 RPM	1800 RPM	3600 RPM
1	82.5	85.5	77.0
1½	87.5	86.5	84.0
2	88.5	86.5	85.5
3	89.5	89.5	86.5
5	89.5	89.5	88.5
7½	91.0	91.7	89.5
10	91.0	91.7	90.2
15	91.7	92.4	91.0
20	91.7	93.0	91.0

2.02 SINGLE PHASE, SINGLE SPEED MOTORS

A. Use NEMA rated 115 volt, single phase, 60 hertz motors for all motors 3/4 HP and smaller.

B. Use electronically commutated motor, permanent split capacitor or capacitor start, induction run motors, as indicated, equipped with permanently lubricated and sealed ball or sleeve bearings and Class A insulation. Service factor to be not less than 1.35.

2.03 MOTORS USED ON VARIABLE FREQUENCY DRIVES

A. In addition to the requirements specified above, the motor must be suitable for use with the drive specified in Section 23 05 14, including but not limited to motor cooling. Motor shall comply with NEMA MG1 Part 31 to provide windings capable to withstand up to 1600 peak Volts with a rise time of 0.1 µs. Provide brush style bearing protection to bleed current from the motor shaft to the motor casing to suit motor application. Brushes shall be field replaceable. Manufacturers: Shaft Grounding Systems (SGS), Helwig Carbon Bearing Protection Kits (BPK), or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Mount motors on a rigid base designed to accept a motor, using shims if required under each mounting foot to get a secure installation.

B. Verify the proper rotation of each three-phase motor as it is being wired or before the motor is energized for any reason.

C. Lubricate all motors requiring lubrication. Record lubrication material used and the frequency of use. Include this information in the maintenance manuals.

END OF SECTION

SECTION 23 05 14
VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Scope. This section includes variable frequency drives, bypass starters, and line reactors. Included are the following topics:

B. PART 1 - GENERAL
   1. Scope
   2. Related Work
   3. Reference
   4. Reference Standards
   5. Submittals
   6. Operating and Maintenance Data
   7. Equipment Startup
   8. Warranty

C. PART 2 - Products
   1. Manufacturers
   2. Design and Construction
   3. Performance Requirements
   4. Control Features
   5. Protection Features
   6. Diagnostics
   7. Quality Assurance Tests
   8. AC Input Line Reactors

D. PART 3 - EXECUTION
   1. Variable Frequency Drives (VFD)
   2. Owner Training

1.02 RELATED WORK

A. Section 23 05 13 - Common Motor Requirements for HVAC
B. Section 23 21 23 - Hydronic Pumps
C. Section 26 05 26 - Grounding and Bonding for Electrical Systems
D. Section 26 05 29 - Hangers and Supports for Electrical Systems
E. Section 26 05 53 - Identification for Electrical Systems
F. Section 26 27 02 - Equipment Wiring Systems

1.03 REFERENCE

A. Applicable provisions of Division 1 govern work under this section.

1.04 REFERENCE STANDARDS

A. ANSI/IEEE 519 Guide for Harmonic Control and Reactive Compensation of Static Power Converters

1.05 SUBMITTALS

A. Submit shop drawings and product data under provisions of Division 1, General Conditions of the Contract, and Division 26.

B. Include physical, electrical, and performance characteristics of each variable frequency drive and associated components, including dimensions; weight; input and output performance; voltage, phase, current and overcurrent characteristics; installation instructions; protective features; wiring and block diagrams indicating specified options; electrical noise attenuation equipment where required to meet the criteria specified; line side voltage notch wave form and line side current harmonics; certified efficiency versus load and speed curves; and required operating environment.

1.06 OPERATION AND MAINTENANCE DATA

A. All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

1.07 EQUIPMENT STARTUP

A. Provide the services of a factory trained and certified technician to approve the installation; start-up, test, and adjust for proper operation of the unit(s). Upon completion of the equipment startup, submit a complete manufacturer's field report, including startup and test log, signed by the factory trained technician. Coordinate with the Temperature Control Contractor and the Balancing Contractor. The startup shall be coordinated with Division 26, Electrical and shall be completed within ten (10) working days from the startup date.

1.08 WARRANTY

A. The warranty shall be for a period of twenty-four (24) months from the date of project Substantial Completion. Further, the warranty shall include all parts, labor, travel time, administrative costs, overhead, travel expenses, technical support and any and all other costs to provide the warranty service.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. ABB, Siemens, Toshiba, Danfoss, Trane/Danfoss, Yaskawa, Eaton/Cutler Hammer, Mitsubishi, Allen Bradley, Square D.

2.02 DESIGN AND CONSTRUCTION

A. The unit shall be variable torque, modular design for control of the motors as specified in Division 23 and rated at the motor full load nameplate amps.

B. The unit, including bypass starter (if provided), shall be U.L. or ETL listed, solid state, microprocessor-based with a pulse width modulated (PWM) output wave form (none others are acceptable).

C. The VFD shall employ a full wave bridge rectifier and capacitors to minimize the ripple of the rectified voltage to maintain near constant DC voltage. Insulated gate bipolar transistors (IGBT's) shall be employed as the output switching device.

D. EMI/RFI filters to meet EMC Immunity IEC 61800 – 3 first and second environment.

E. The VFD package shall contain the equivalent of 5% impedance to reduce harmonic distortion. The 5% equivalent impedance shall be provided in the form of a DC bus choke, an input AC line reactor in each phase, or a combination of the two methods.

F. Control circuitry shall be plug-in, plug-out modular basis with a corrosion resistant coating on printed circuit boards.

G. Units to be suitable for an operating environment from 0°C to 40°C temperature and humidity up to 90% non-condensing.

H. Electrically and physically isolate control circuitry and conductors from power circuitry and power conductors. Control conductors and power conductors shall not be run in the same pathway.

I. The unit enclosure shall be NEMA Type 1, 3R, or 12 as required for the application minimum and all components shall be fully factory assembled and tested prior to leaving the manufacturing facility.

J. Include the following operating and monitoring devices mounted on the front cover:
   - A disconnect switch or circuit breaker to de-energize both the drive and bypass circuit with door interlocked handle and lock-open padlocking provisions.
   - Operating mode selector switch marked "hand-off-auto".
   - Manual speed adjustment via keypad, mounted on the door.
   - Manual bypass selector switch to select power through drive or bypass (if a bypass is provided).

K. Provide a manual bypass circuit and bypass starter to transfer from variable frequency drive operation to bypass operation (if a bypass is provided).

L. Drives shall have SCCR (short circuit current rating) of 65 amps.

2.03 PERFORMANCE REQUIREMENTS

A. Units shall be suitable for input power of electrical system as scheduled on the drawings ±10%, 3 phase, 60 Hertz nominal.

B. Use a current limiting control device to limit output current to 110% continuous for one minute; also refer to Protection Features in this section. Full load output current available from drive shall not be less than motor nameplate amperage. The full load amp rating of the VFD shall not be less than the values indicated in the NEC Table 430-150.

C. Output power shall be suitable for driving standard NEMA B design, three phase alternating current induction motors at full rated speed with capability of 6:1 turndown.

D. Additional performance capabilities to include the following:
   - Ride through a momentary power outage of 15 cycles.
   - Start into a rotating load without damage to drive components or motor.
   - Capable of automatic restart into a rotating load after a preset, adjustable time delay following a power outage.
   - Input displacement power factor: Min 0.95 throughout the speed range.
   - Minimum efficiency: 95% at 100% speed, 85% at 50% speed

2.04 CONTROL FEATURES

A. Use control circuits compatible with input signal from temperature control system in the automatic mode and from manual speed control in the manual mode. Vary motor speed in response to the input control signal. Include components necessary to accept the signal from the temperature control system in the form that it is sent.

B. Include the following additional control features:
   - Hand-Off-Automatic (HOA) selector to select local or remote start/stop and speed control.
   - Analog input, selectable 0-10v or 4-20 mA, for automatic control from the temperature control system.
   - Local speed control at the VFD.
   - Adjustable acceleration and deceleration rate so that the time period from start to full speed and from full speed to stop can be field adjusted
   - Adjustable minimum and maximum speed settings for both automatic and manual modes of operation.
   - Manual transfer bypass circuit (if bypass option is provided).
   - Field adjustment of minimum and maximum output frequency.
   - Two (2) sets of programmable form “A” contacts for remote indication of variable frequency drive condition. Note: default programming to be set for “Drive Run & Fault”.
   - When specified in the 23 09 93 sequence of operations, provide a VFD input and output for shutoff damper control that shall operate as follows: When the fan is remotely or locally commanded to start, VFD contact shall energize the shutoff damper to open the damper. The damper position end switch shall be wired to a run permissive input on the VFD and enable the VFD to start when the damper end switch provides the damper is open. This feature shall be provided for both inverter and bypass operation (if bypass option is provided).
   - Illuminated display keypad.
   - External Fault indicator.
   - One (1) input for a N.O. dry contact type input for a 2-wire remote start/stop.
   - One (1) input for a N.C. dry contact type input for external faults: (freezestats, fire alarm, smokes, etc). This input shall be factory wired to prevent both the VFD and bypass starter operation when external fault is present.
   - PID control loop capable of VFD control from an external device connected to a VFD analog input.

C. The VFD controller shall convert VFD information into the BACnet MSTP protocol that will be compatible with the building direct digital energy management system (EMS) supplied on the project. This output shall be through a serial interface port capable of two-way communication with the building EMS provided on this project. Final connection shall not require any additional intermediate gateway devices to provide throughput of data. The following data shall be provided at a minimum:
   - Fault condition
   - Speed
   - Amperage
   - Frequency
   - Voltage
   - Bypass status (if supplied)

2.05 PROTECTION FEATURES

A. Use electronic protection circuitry in the power circuits to provide an orderly shutdown of the drive without blowing fuses or tripping circuit breakers and prevent component loss under the following abnormal conditions:
   - Activation of any safety device
   - Instantaneous overcurrent and/or over voltage of output
   - Power line overvoltage and undervoltage protection
   - Phase loss
   - Single and three phase short circuiting
   - Ground faults
   - Control circuit malfunction
   - Overtemperature
   - Output current over limit

B. Provide the following additional protective features:
   - Input transient overvoltage protection up to 3000 volts per ANSI 37.90A
   - Input transient overvoltage protection up to 3000 volts per ANSI 37.90A;
   - DC bus fusing or other electronic controls which limit the rate of rise of the DC bus current and de-energizes the drive at a predetermined current level
   - Fusing for the control circuit transformer
   - Grounded control chassis
   - Devices and/or control circuitry to ensure that the variable frequency drive and bypass starter are not both energized and driving motor simultaneously

2.06 DIAGNOSTICS

A. Provide an English character display (no error codes) with indicators for the following:
   - Phase loss
   - Ground fault
   - Overcurrent
   - Overvoltage
   - Undervoltage
   - Over temperature
   - Overload
   - DC bus status

2.07 QUALITY ASSURANCE TESTS

A. Use a factory heat stress test to verify proper operation of all functions and components under full load.

B. Field performance test of variable frequency drives to determine compliance with this specification will be performed at the Owner's discretion and may include any specified feature, including operation of protective devices through a simulated fault. Contractor will pay for initial testing. Should drive be found deficient by this testing, drive manufacturer will be required to make any and all changes necessary to bring unit(s) into compliance with the specified performance and demonstrate this performance by retesting. Cost of changes and retest will be by this contractor.

C. Variable frequency drive manufacturer or designated representative to perform a field test of each drive, in the presence of the Owner's representative, for the following items:
   - Provide general inspection to verify proper installation
   - Demonstrate adequate protection during switching from variable frequency drive operation to bypass starter operation and back again

2.08 AC INPUT LINE REACTORS

A. When needed to comply with the requirement for 5% equivalent impedance, furnish and factory install AC input line reactors.

B. Line reactors shall be installed in each phase of the AC input side of the VFD and mounted within a common enclosure with the VFD

C. Line reactor shall be a three-phase inductor, iron core, 600V, Class H insulation, 115 degree C rise, copper windings with screw type terminal blocks.

PART 3 - EXECUTION

3.01 VARIABLE FREQUENCY DRIVES

A. Install where indicated on drawings and in accordance with approved submittals and manufacturer's published recommendations. Installation to be by the Division 26 00 00 - Electrical contractor.

B. Input power wiring shall be installed in a separate conduit, output power wiring shall be installed in a separate conduit and control wiring shall be installed in a separate conduit. Do not mix input power, output power, or control wiring in a common conduit. Separate conduits for input and output power wiring shall be provided for each motor. Input and output power wiring for more than one motor shall not share a common conduit. Power wiring shall be furnished and installed by the Div. 26 contractor. If provided, do not mount output line filter below the drive.

C. Control signal for drive will be provided under Division 23.

D. Temperature Control Contractor will furnish and install the required temperature control wiring in metal conduit and in accordance with Division 26 00 00 - Electrical of this specification.

3.02 OWNER TRAINING

A. Contractor to provide factory authorized representative and/or field personnel knowledgeable with the operations, maintenance and troubleshooting of the system and/or components defined within this section for a minimum period of two hours.

END OF SECTION

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SECTION 23 05 15
PIPING SPECIALTIES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Scope. This section contains specifications for HVAC piping specialties for all piping systems. Included are the following topics:

B. PART 1 - GENERAL
   1. Scope
   2. Related Work
   3. Reference
   4. Quality Assurance
   5. Submittals
   6. Operation and Maintenance Data
   7. Design Criteria

C. PART 2 - Products
   1. Thermometers
   2. Thermometer Sockets
   3. Test Wells
   4. P/T (Pressure/Temperature) Test Plugs
   5. Hose Connection Caps
   6. Pressure Gauges
   7. Strainers
   8. Coalescing Air and Dirt Separators
   9. Expansion Tanks
   10. Buffer Tanks
   11. Air Vents
   12. Suction Diffusers
   13. Flow Sensing Devices
   14. Cold Water Meters

D. PART 3 - EXECUTION
   1. Thermometers
   2. Thermometer Sockets
   3. Test Wells
   4. P/T (Pressure/Temperature) Test Plugs
   5. Hose Connection Caps
   6. Pressure Gauges
   7. Strainers
   8. Coalescing Air and Dirt Separators
   9. Expansion Tanks
   10. Buffer Tanks
   11. Air Vents
   12. Suction Diffusers
   13. Flow Sensing Devices
   14. Cold Water Meters

1.02 RELATED WORK

A. Section 23 21 13 - Hydronic Piping
B. Section 23 05 23 - General-Duty Valves for HVAC Piping
C. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment
D. Section 23 07 00 - HVAC Insulation

1.03 REFERENCE

A. Applicable provisions of Division 1 govern work under this section.

1.04 QUALITY ASSURANCE

A. Refer to Division 1, General Conditions, Equals and Substitutions.

1.05 SUBMITTALS

A. Refer to Division 1, General Conditions, Submittals.

B. Required for all items in this section. Include materials of construction, dimensional data, ratings/capacities/ranges, pressure drop data where appropriate, and identification as referenced in this section and/or on the drawings.

1.06 OPERATION AND MAINTENANCE DATA

A. All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

1.07 DESIGN CRITERIA

A. All piping specialties are to be rated for the highest pressures and temperatures in the respective system in accordance with ANSI B31, but not less than 125 psig unless specifically indicated otherwise.

PART 2 - PRODUCTS

2.01 THERMOMETERS

A. Manufacturers: Ashcroft, Marsh, Taylor, H. O. Trerice, U. S. Gauge, Weiss, Weksler, Winters.

B. Stem Type, cast aluminum case, nine inch scale, clear acrylic window. adjustable angle brass stem with stem of sufficient length so the end of the stem is near the middle of a pipe without reducing the thickness of any insulation, red indicating fluid, black lettering against a white background, with scale ranges as follows:

Service	Scale Range, °F	Min. Increment, °F
Hot and Chilled Water	30 - 240	2
Chilled Water Only	0 - 100	1

2.02 THERMOMETER SOCKETS

A. Brass with threaded connections suitable for thermometer stems and temperature control sensing elements in pipeline. Furnish with extension necks for insulated piping systems.

2.03 TEST WELLS

A. Similar to thermometer sockets except with a brass cap that thread into the inside of the test well to prevent dirt from accumulating. Secure cap to body with a short chain. Furnish with extension necks, where appropriate, to accommodate the pipeline insulation.

2.04 P/T (PRESSURE/TEMPERATURE) TEST PLUGS

A. Brass plug with 1/4" NPT threads, EPDM or neoprene valve core, knurled cap with cap strap. Use extended length plugs to clear insulated piping. Adaptors shall have 1/4" FPT connection for standard pressure gauges.

2.05 HOSE CONNECTION CAPS

A. Hose connection caps shall be pressure rated for 150 psig at 180 deg F.

2.06 PRESSURE GAUGES

A. Manufacturers: Ametek/U. S. Gauge Division, Ashcroft, Marsh, Taylor, H. O. Trerice, Weiss, Weksler, Winters.

B. Cast aluminum case of not less than 4.5 inches in diameter, double strength glass window, black lettering on a white background, phosphor bronze bourdon tube with bronze bushings, recalibration from the front of the dial, 99% accuracy over the middle half of the scale, 98.5% accuracy over the remainder of the scale, with scale range as follows:

Service	Scale Range, psig	Min. Increment, psig
Hot Water	0-60	1
Chilled Water	0-60	1

C. Pressure Snubbers: Bronze construction, suitable for system working pressure, 1/4" size.

Gauge Valves: Use valves as specified in Section 23 05 23 - General-Duty Valves for HVAC Piping. For water systems, use 1/4" ball valves.

2.07 STRAINERS

A. Manufacturers: Armstrong, Mueller Steam, Sarco, or Victaulic Company.

B. Water Systems:

1. Y type; cast ductile iron body; stainless steel screens; bolted or threaded screen retainer tapped for a blowoff valve; threaded body in sizes through 2 inch and rated at not less than 175 psi WOG; grooved end or flanged body in sizes over 2 inch and rated at not less than 300 psi WOG at 230°F. Screen to be 20 mesh for line sizes 2 inch and less, 0.125 inch perforations for line sizes 2-1/2 inch through 4 inch, and 0.25 inch perforations for line sizes 5 inch and larger. Equal to Victaulic Style 732 / W732.

2.08 COALESCING AIR AND DIRT SEPARATORS

A. Manufacturers: Bell & Gossett, Spirotherm, Inc., Wessels, Caleffi.

B. 2 inch and larger: Welded steel construction, ASME Section VIII, Division 1 constructed and stamped for a working pressure not less than 150 psig at 250°F, threaded or flanged connections for 2 inch size, flanged or grooved connections if grooved piping is allowed for all sizes over 2 inch. Provide unit with factory installed automatic air vent on the top, blow down connection at the bottom of the unit, and a skimming connection to remove floating dirt. Unit size shall be suitable for the system flow rates as indicated on the drawings.

C. Internal coalescing material shall be constructed of copper or 304 stainless steel. Unit shall include internal structured elements filling the entire vessel to suppress turbulence and provide air elimination efficiency of 100% entrained air, and 99% dissolved air at the installed location. Dirt separation efficiency shall be a minimum of 80% of all particles 30 micron and larger within 100 passes.

D. Provide removable head to access material for inspection and cleaning.

2.09 EXPANSION TANKS

A. Manufacturers: American Wheatley, Amtrol, Armstrong Pumps, Bell and Gossett, Taco, Thrush.

B. Diaphragm/Bladder Type: Steel construction, tested and stamped in accordance with Section 8D of the ANSI/ASME Code and furnished with the National Board Form U-1, rated for not less than 125 psig working pressure, precharged with air to the initial fill pressure indicated on the drawings, heavy duty butyl diaphragm suitable for fluid temperatures to 240°F, and furnished with a tank drain connection, system connection, mounting saddles for horizontal installation or base for vertical installation, prime coated, size/capacity as indicated on the drawings. Tank and bladder construction must allow field replacement of the bladder on its failure.

2.10 BUFFER TANKS

A. Manufacturers: American Wheatley, Amtrol, Taco, Wessels.

B. Carbon steel construction, tested and stamped in accordance with ASME Section VIII, Division 1, rated for not less than 125 psig working pressure and fluid temperatures to 450°F, and furnished with a tank drain connection, air vent connection, system connections, immersion type control well(s), base for vertical installation, prime coated, size/capacity as indicated on the drawings.

C. Standard Accessories:

1. Buffer tank(s) will include a solid brass high-capacity 3/4" air eliminator located on top of the tank, 3/4" full port brass drain valve, and 3/4” aquastat well.

2.11 AIR VENTS

A. Manual Key Type Vents:

1. Bell and Gossett Model 4V; Eaton/Dole Model 9, 9B, or 14A.

2. Bronze body with nonferrous internal parts, screwdriver operated, designed to relieve air from the system when vent is opened, rated at not less than 125 psig at 220°F.

B. Manual Ball Valve Vents: Provide 1/4" ball valves for manual venting of air handling unit coils and where indicated elsewhere on drawings and details. Reference specifications section 23 05 23.

C. Automatic Vents:

1. Thrush Model 720, Bell and Gossett Model 107, Watson McDaniel Model AV813W.

2. Cast iron body with nonferrous internal parts, designed to vent air automatically with float principle without allowing air to enter the system, rated at not less than 125 psig at 220°F.

2.12 SUCTION DIFFUSERS

A. Manufacturers: Amtrol/Thrush, Armstrong Pumps, Bell and Gossett, Taco, Victaulic.

B. Designed to replace the suction line strainer and the long entrance pipe at a pump suction; constructed with a strainer blowdown connection, provisions for a field supplied support foot, and bolted flange for strainer removal and cleaning; rated at not less than 250 psi working pressure at not less than 230°F.

C. Closed Systems: Body constructed of cast iron, ductile iron or carbon steel; cast iron or stainless steel straightening vanes; stainless steel, galvanized steel or stainless steel strainer; brass or bronze fine mesh startup strainer, strainer blowdown connection, inlet pressure gauge connection, provisions for a field supplied support foot, and bolted flange for strainer removal and cleaning; rated at not less than 125 psi working pressure at not less than 250°F.

2.13 FLOW SENSING DEVICES

A. For water flow sensing devices 2 inch and smaller, use balance valves as specified in Section 23 05 23 - General-Duty Valves for HVAC Piping:

1. Bell & Gossett Flow Meter – Type A, Flo-Pac, Oventrop, or approved equal.

2. Water type orifice insert installed between flanges with valved taps and chart for conversion of differential pressure readings to flow rate to monitor flow with a minimum friction head loss.

3. Victaulic Koil-Kits Series 799, 79V, 79A, and 79B may be used at coil connections. The kit shall include a Series 786/787/78K circuit balancing valve, Series 78Y Strainer-Ball or Series 78T Union-Ball valve combination, Series 78U Union-Port fitting, and required coil hoses. A Style 793 and/or 794 differential pressure controller shall be provided as required. A meter shall be provided by the valve manufacturer that shall remain with the building owner after balancing/commissioning.

2.14 COLD WATER METERS

A. Bronze body, minimum 3/4" NPT ends, positive displacement disc type meter with built-in strainer, magnetic drive and thermoplastic disc/register gearing. Meters shall meet ANSI/AWWA Standard C700. Sealed register shall be odometer type totalization display having 10,000,000 gallon capacity. Register shall also have 360 degree sweep hand with 10 gallon range and 0.1 per gallon increments. Meters shall be suitable for 150 psig pressure at 80 degrees F. Badger Recordall Disc Meter, Carlon Meter Co., Neptune, Hersey, Venture Measurement Niagara.

PART 3 - EXECUTION

3.01 THERMOMETERS

A. Stem Type: Install in piping systems as indicated on the drawings and/or details using a separable socket in each location.

3.02 THERMOMETER SOCKETS

A. Install at each point where a thermometer or temperature control sensing element is located in a pipeline.

3.03 TEST WELLS

A. Install in piping systems as indicated on the drawings and/or details wherever provisions are needed for inserting a thermometer at a later date.

3.04 P/T (PRESSURE/TEMPERATURE) TEST PLUGS

A. Install in piping systems as indicated on the drawings and/or details. Do not insulate over test plugs.

3.05 HOSE CONNECTION CAPS

A. Install in locations where indicated on the drawings and details.

3.06 PRESSURE GAUGES

A. Install in locations where indicated on the drawings and/or details, including any gauge piping, with scale range appropriate to the system operating pressures.

B. Pressure Snubbers: Install in gauge piping for all gauges used on water services.

C. Gauge Valves: Install at each gauge location as close to the main as possible and at each location where a gauge tapping is indicated.

3.07 STRAINERS

A. Install all strainers where indicated on the project details, allowing sufficient space for the screens to be removed. Rotate screen retainer where required by the installation so blowdown can remove accumulated dirt from the strainer body.

B. Water Systems: Install a ball valve for blowdown in the tapped screen retainer; valve to be the same size as the tapping.

3.08 COALESCING AIR AND DIRT SEPARATORS

A. Mount in hot and/or chilled water lines as indicated on the drawings/details. Install ball valve with hose adapter in bottom blowdown connection and skimming connection.

B. Open the drain/blowdown valve after system cleaning and again after 30 days of operation.

3.09 EXPANSION TANK

A. Install tanks where indicated on the drawings, coordinating concrete base installation with the General Contractor or fabricating steel supports to suit the application. Install all specified tank accessories.

B. Bladder Tanks: Verify proper air charge; recharge as necessary. Install an isolation valve in the piping connecting the tank to the system. In the piping between the tank and the isolation valve, install a pressure gauge and a drain valve with a hose adapter. Install a drain valve with hose adapter in the drain connection of the tank. Make sure that all drains are accessible and a hose can be attached.

3.10 BUFFER TANKS

A. Install tanks where indicated on the drawings, coordinating concrete base installation with the General Contractor or fabricating steel supports to suit the application. Install all specified tank accessories.

B. Install a drain valve with hose adapter in the drain connection of the tank. Make sure that all drains are accessible and a hose can be attached.

3.11 AIR VENTS

A. Manual Key Type Vents: Install at all high points where air may collect and not be carried by the system fluid. Use a soft Type L copper "pigtail" so the vent can be positioned for venting and collecting any water that might escape.

B. Manual Ball Valve Vents: Install on air handling coils and where indicated elsewhere as shown on drawings and details.

C. Automatic Vents: Install on the top of air separators on systems using bladder type expansion tanks. Install at other locations as indicated on the drawings or details. All locations to have a ball valve installed upstream of the vent for maintenance purposes.

3.12 SUCTION DIFFUSERS

A. Install at each pump suction connection for end suction pumps where shown. Provide sufficient space for removal of the strainer. Install a capped drain valve in the blowdown connection. Install support below the suction diffuser so the weight of the suction piping does not rest on the pump suction connection.

B. Install a pressure gauge across the suction diffuser, valved so that a single gauge can be used to read the inlet pressure and the outlet pressure across the strainer. Use gauge valves as specified with the gauges. This gauge can be the same one used to read pressures across the pump. Select gauge range appropriate to the system pressures.

C. Open the drain valve and blowdown the strainer after system cleaning and again after 30 days of operation. If the unit is furnished with a fine mesh startup strainer, remove this strainer after the system has been flushed and cleaned.

3.13 FLOW SENSING DEVICES

A. Install where indicated on the drawings and details for flow sensing in hydronic piping systems. Butterfly valves installed at the location of a flow sensing device are to have a memory stop.

3.14 COLD WATER METERS

A. Install water meters on makeup water line to hot water and chilled water systems ahead of water pressure reducing valve.

END OF SECTION

SECTION 23 05 23
GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Scope. This section includes valve specifications for all HVAC systems except where indicated under Related Work. Included are the following topics:

B. PART 1 - GENERAL
   1. Scope
   2. Related Work
   3. Reference
   4. Quality Assurance
   5. Submittals
   6. Operation and Maintenance Data
   7. Design Criteria

C. PART 2 - Products
   1. Manufacturers
   2. Water System Valves
      a. Ball Valves
      b. Butterfly Valves
      c. Spring Loaded Check Valves
      d. Balance Valves
      e. Drain Valves
      f. Combination Shut-off, Check, and Balancing Valves
      g. Water Pressure Reducing Valves
      h. Water Relief Valves
   3. Natural Gas Systems
      a. Shut-off Valves
      b. Gas Pressure Regulators
   4. Specialty Valves and Valve Accessories
      a. Gauge Valves
      b. Stem Extensions

D. PART 3 - EXECUTION
   1. General
   2. Shut-off Valves
   3. Balancing Valves
   4. Calibrated Balancing Valves
   5. Drain Valves
   6. Safety Relief Valves
   7. Spring Loaded Check Valves
   8. Combination Shut-off, Check, and Balancing Valves
   9. Pressure Reducing Valves
   10. Gas Pressure Regulators

1.02 RELATED WORK

A. Section 23 05 15 - Piping Specialties
B. Section 23 09 14 - Pneumatic and Electric Instrumentation and Control Devices for HVAC

1.03 REFERENCE

A. Applicable provisions of Division 1 govern work under this section.

1.04 QUALITY ASSURANCE

A. Refer to Division 1, General Conditions, Equals and Substitutions.

1.05 SUBMITTALS

A. Refer to Division 1, General Conditions, Submittals.

B. Contractors shall submit a schedule of all valves indicating type of service, dimensions, materials of construction, and pressure/temperature ratings for all valves to be used on the project. Temperature ratings specified are for continuous operation.

1.06 OPERATION AND MAINTENANCE DATA

A. All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

1.07 DESIGN CRITERIA

A. Where valves are specified for individual mechanical services (i.e. hot water heating, chilled water, steam, etc.) all valves shall be of the same manufacturer.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Anvil, Apollo, Armstrong, Bell & Gossett, Crane, Danfoss-Flomatic, DeZurik, Durco, Fisher, Grinnell, Griswold, Hoffman, Kitz, Kunkle, Leslie, Lunkenheimer/Cincinnati, Metraflex, Milwaukee, Mueller, Newco, Nexus, Nibco, Red-White Valve Corp, Sarco, Stockham, Taco, Thrush-Amtrol, Victaulic, Watts, or approved equal.

2.02 WATER SYSTEM VALVES

A. Ball Valves:

1. 2" and smaller: Two piece bronze or forged brass body; Vic-Press, threaded or soldered ends, as appropriate to the pipe material; stainless steel or chrome plated brass/bronze ball; conventional port; glass filled teflon seat; threaded packing gland follower; blowout-proof stem; 300 psig WOG.

2. Valve stems shall allow operators to clear insulation without interference. Provide stem extensions when valve operators interfere with pipe insulation.

3. Victaulic Series P589, Apollo 70-100/200 series, Hammond 8301/8311, Milwaukee BA100/150, Nibco T/S 585-70, Stockham S206/216.

4. 2-1/2" and over: Ball valves will not be accepted in sizes over 2 inch.

B. Butterfly Valves:

1. 2" and smaller: Use ball valves; butterfly valves will not be accepted in sizes 2 inch and smaller.

2. 2-1/2" and larger: Cast ductile iron body; stainless steel shaft; Teflon, nylatron, or acetal bearings; EPDM resilient seat (pressure responsive in sizes through 12"). Shaft shall be offset from the disc centerline to allow complete 360 degree circumferential seating. Disk to be bronze, aluminum-bronze, stainless steel, electroless-nickel plated or polyphenylene-sulfide coated ductile iron, cast iron with welded nickel edge, or stainless steel. Pressure rated to 300 psig. Valve assembly to be bi-directionally bubble tight to 300 psig with no downstream flange/pipe attached. Polymid or polyamide coated valves are not acceptable.

3. Valve stems shall allow operators to clear insulation without interference. Provide stem extensions when valve operators interfere with pipe insulation.

4. Use threaded lug type valves for installation with class 125/150 flanges.

5. Centerline Series 200, DeZurik BOS-CL, Keystone Fig. 222, Nibco LD2000 (2-1/2”-12”)/LD1000 (14” and above), Victaulic MasterSeal 300 series (2-1/2”-12”) / AGS-Vic300 series (14”-24”).

6. Provide ten-position lever actuators for valves 6" and smaller. Provide worm gear operators for valves 8" and larger.

7. Where butterfly valves are indicated or specified to be installed at the location of a flow sensing device, provide the butterfly valves with a memory stop.

C. Spring Loaded Check Valves:

1. 2" and smaller: Class 125, bronze body, threaded, solder or wafer ends, bronze trim, stainless steel spring, teflon seat unless only bronze available.

2. APCO 300 series, ConBraCo 61 series, Mueller 303BP, Nibco T-480-Y/S-480-Y, Val-Matic 1400 series.

3. 2-1/2" and larger: Class 125, cast iron or semi-steel body, wafer or globe flanged type, bronze trim, bronze or EPDM seat, stainless steel spring, stainless steel stem if stem is required. Valves with ductile iron in contact with the working fluid will not be accepted.

4. APCO 600 series, Metraflex 900 series, Milwaukee 1800 series, Mueller Steam 101M-AP/105M-AP, Nibco F910 series, Val-Matic 1800 series, Victaulic series 716 (2"-12") and Series W715 (14" – 24").

D. Balance Valves:

1. 2" and smaller: Multi-turn handwheel style balance valve, DZR brass (Ametal®), bronze or copper alloy body with calibrated ball, globe or venturi/valve arrangement, integral pointer and calibrated scale to register degree of valve opening, memory stop, drain tapping, threaded or soldered ends, with or without integral unions, P/T or Shraeder pressure taps with integral check valves and seals, adjustable memory stop, suitable for 250 psig water working pressure at 230°F.

2. Armstrong CBV, Griswold SpeedSet, Nexus Ultra MB, Tour & Anderson STAS/STAD, Victaulic series 786/787, Oventrop VTR.

3. Victaulic Koil-Kits Series 799, 79V, 79A, and 79B may be used at coil connections. The kit shall include a Series 786/787/78K circuit balancing valve, Series 78Y Strainer-Ball or Series 78T Union-Ball valve combination, Series 78U Union-Port fitting, and required coil hoses. A Style 793 and/or 794 differential pressure controller shall be provided as required. A meter shall be provided by the valve manufacturer that shall remain with the building owner after balancing/commissioning.

4. 2-1/2" and larger: Use butterfly valves as specified in this section along with a flow sensing device as specified in Section 23 05 15.

E. Drain Valves: Use 3/4 inch ball valve with threaded hose adapter except strainer blowdown valves to be the same size as the blowdown connection.

F. Combination Shut-Off, Check, and Balance Valves:

1. 2 inch and larger: Cast or ductile iron body, threaded or flanged or grooved end connections, stainless steel spring, bronze disc with EPDM seat, calibrated memory stop, backseating valve stem, inlet and outlet pressure tappings, capable of being repacked under full line pressure, and suitable for a minimum working pressure of 175 psig at 240°F when used in hot water heating systems.

2. Armstrong Flo-Trex, Bell & Gossett Triple Duty, Taco Multi-Purpose Valve, Thrush-Amtrol Tri-Flow.

3. Tri-Service Valve Assembly: Combination shut-off, throttling and non-slam check valve. Vic®-300 MasterSeal™ butterfly valve with memory stop feature assembled with Series 716 (2-1/2" & 3") (DN65 & DN75) or Style 779 Venturi Check (4" – 12") (DN100-DN300). Series 779 check valve with venturi like taps for flow measurement. Working pressures to 300 psi (2065 kPa).

G. Water Pressure Reducing Valves:

1. Brass or bronze body, diaphragm operated, with an integral anti-syphon check valve, inlet strainer, and adjustable reduced pressure range but pre-set for the scheduled pressure, 125 psig at 225°F.

2. Bell & Gossett, Cash-Acme, or Watts.

H. Water Relief Valves:

1. Iron or bronze body, direct pressure actuated, teflon seat, stainless steel stem and spring, suitable for 125 psig water working pressure at 240°F and ASME stamped, with capacity and set point as detailed.

2. Bell & Gossett, Cash-Acme, Consolidated, Kunkle, Watts.

2.03 NATURAL GAS SYSTEMS

A. Shut Off Valves:

1. 2" and smaller: Ball valve, bronze body, threaded ends, chrome-plated bronze or stainless steel ball, full or conventional port, teflon seat, blowout-proof stem, two-piece construction, suitable for 150 psig working pressure, U.L. listed for use as natural gas shut-off.

2. 2-1/2" through 4": Cast iron body, flanged ends, bronze bearings, electroless nickel-plated cast iron plug with Hycar resilient plug seal, Buna-N stem seal packing, lever actuator, 175 psi W.O.G., U.L. listed for use as natural gas shut-off.

3. DeZurik, Homestead, Rockwell, Walworth.

B. Gas Pressure Regulators: 2" and smaller: Cast iron body, aluminum spring and diaphragm, Nitrile diaphragm, threaded ends, 150 psi W.O.G., -20°F to 150°F.

2.04 SPECIALTY VALVES AND VALVE ACCESSORIES

A. Gauge Valves:

1. Water Service: Use 1/4" ball valves.

B. Stem Extensions: Provide stem extensions when valve operators interfere with pipe insulation.

PART 3 - EXECUTION

3.01 GENERAL

A. Properly align piping before installation of valves in an upright position; operators installed below the valves will not be accepted.

B. Install valves in strict accordance with valve manufacturer's installation recommendations. Do not support weight of piping system on valve ends.

C. Install all temperature control valves.

D. Install all valves with the stem in the upright position. Valves may be installed with the stem in the horizontal position only where space limitations do not allow installation in an upright position or where large valves are provided with chain wheel operators. Valves installed with the stems down, will not be accepted.

E. Install stem extensions when shipped loose from valve.

F. Prior to flushing of piping systems, place all valves in the full-open position.

3.02 SHUT-OFF VALVES

A. Install shut-off valves at all equipment, at each branch take-off from mains, and at each automatic valve for isolation or repair.

B. Water System: Butterfly valves installed at the location of a flow sensing device are to have a memory stop.

3.03 BALANCING VALVES

A. Provide balancing valves for all major equipment and at each major branch takeoff and at the discharge of each pump as indicated on drawings and details.

3.04 CALIBRATED BALANCE VALVES

A. Install where indicated on the drawings and details for balancing of hydronic systems.

3.05 DRAIN VALVES

A. Provide drain valves for complete drainage of all systems. Locations of drain valves include low points of piping systems, equipment locations specified or detailed including reheat coils, other locations required for drainage of systems.

3.06 SAFETY RELIEF VALVES

A. Use air pressure to clean piping prior to installation of safety relief valves.

B. Install valves in the vertical position, with drain holes, including those from dip pan elbows, piped to the nearest drain.

C. Inlet and outlet piping connecting to valves must be the same size as valve connections or larger.

D. Pipe discharge from water system relief valves to nearest drain.

3.07 SPRING LOADED CHECK VALVES

A. Install a spring loaded check valve in each pump discharge line where two pumps operate in parallel and no combination shutoff, check and balancing valve is being used.

3.08 COMBINATION SHUT-OFF, CHECK, AND BALANCING VALVES

A. Contractor may use combination shut-off, check and balancing valves where separate shut-off valve, check valve, and balancing valve are specified or detailed in pump discharge piping.

3.09 PRESSURE REDUCING VALVES

A. Provide ball valve and strainer at inlet. Provide ball valve at outlet.

B. Install pressure gauges to indicate inlet and outlet pressure at each pressure reducing valve in accordance with Section 23 05 15 - Piping Specialties.

C. Use eccentric reducers at inlet and outlet of reducing valves where connections are not the same size as adjacent piping.

3.10 GAS PRESSURE REGULATORS

A. When the gas pressure regulator is equipped with a vent connection, run a connection size vent to outside air in accordance with codes. Use a larger size vent when required by the manufacturer's installation instructions.

END OF SECTION

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SECTION 23 05 29
HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Scope. This section includes specifications for supports of all HVAC equipment and materials as well as piping system anchors. Included are the following topics:

B. PART 1 - GENERAL
   1. Scope
   2. Related Work
   3. Reference
   4. Reference Standards
   5. Quality Assurance
   6. Description
   7. Submittals
   8. Design Criteria

C. PART 2 - Products
   1. Pipe Hanger and Support Manufacturers
   2. Structural Supports
   3. Pipe Hangers and Supports
   4. Concrete Inserts
   5. Pipe Penetrations through Roof

D. PART 3 - EXECUTION
   1. Installation
   2. Hanger and Support Spacing
   3. Vertical Riser Clamps
   4. Pipe Penetration through Roof

1.02 RELATED WORK

A. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment
B. Section 23 07 00 - HVAC Insulation

1.03 REFERENCE

A. Applicable provisions of Division 1 govern work under this section.

1.04 REFERENCE STANDARDS

A. MSS SP-58 Pipe Hangers and Supports - Materials, Design and Manufacture.
B. MSS SP-59 Pipe Hangers and Supports - Selection and Application.

1.05 QUALITY ASSURANCE

A. Refer to Division 1, General Conditions, Equals and Substitutions.

1.06 DESCRIPTION

A. Provide all supporting devices as required for the installation of mechanical equipment and materials. All supports and installation procedures are to conform to the latest requirements of the ANSI Code for pressure piping.

B. Do not hang any mechanical item directly from a metal deck or run piping so it rests on the bottom chord of any truss or joist.

C. Support apparatus and material under all conditions of operation, variations in installed and operating weight of equipment and piping, to prevent excess stress, and allow for proper expansion and contraction.

D. Protect insulation at all hanger points; see Related Work above.

1.07 SUBMITTALS

A. Refer to Division 1, General Conditions, Submittals.

B. Schedule of all hanger and support devices indicating shields, attachment methods, and type of device for each pipe size and type of service. Reference section 23 05 00.

1.08 DESIGN CRITERIA

A. Materials and application of pipe hangers and supports shall be in accordance with MSS Standard Practice SP-58 and SP-69 unless noted otherwise.

B. Piping supported by lying on the bottom chord of joists or trusses will not be accepted.

C. Fasteners depending on soft lead for holding power or requiring powder actuation will not be accepted.

D. Allow sufficient space between adjacent pipes and ducts for insulation, valve operation, routine maintenance, etc.

PART 2 - PRODUCTS

2.01 PIPE HANGER AND SUPPORT MANUFACTURERS

A. Anvil, B-Line, Fee and Mason, Kindorf, Michigan Hanger, Unistrut, or approved equal. Anvil figure numbers are listed below; equivalent material by other manufacturers is acceptable.

2.02 STRUCTURAL SUPPORTS

A. Provide all supporting steel required for the installation of mechanical equipment and materials, whether or not it is specifically indicated or sized, including angles, channels, beams, etc. to suspend or floor support tanks and equipment.

2.03 PIPE HANGERS AND SUPPORTS

A. Hangers for Steel Pipe Sizes 1/2" through 2": Carbon steel, adjustable, clevis, black finish. Anvil figure 65 or 260.

B. Hangers for Steel Pipe Sizes 2-1/2" and Over:

1. Carbon steel, adjustable, clevis, black finish. Anvil figure 260.

C. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods if calculations are submitted.

D. Wall Support:

1. Welded steel bracket with hanger. B-Line 3068 Series, Anvil 194 Series.

2. Perforated epoxy painted finish, 16-12 gauge min., steel channels securely anchored to wall structure with interlocking, split type, bolt secured, galvanized pipe/tubing clamps. B-Line type S channel with B-2000 series clamps, Anvil type AS200 H with AS 1200 clamps. When copper piping is being supported, provide flexible elastomeric/thermoplastic isolation cushion material to completely encircle the piping and avoid contact with the channel or clamp, equal to B-Line B1999 Vibra Cushion or provide manufacturers clamp and cushion assemblies, B-Line BVT series, Anvil cushion clamp assembly.

E. Vertical Riser Support: Carbon steel riser clamp, copper plated when used with copper pipe. Anvil figure 261 for steel pipe, figure CT121 for copper pipe.

F. Floor Support for Pipe Sizes through 4": Cast iron adjustable pipe saddle, locknut nipple, floor flange, and concrete pier or steel support.

G. Floor Support for Pipe Sizes 5" and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.

H. Copper Pipe Support: Carbon steel ring, adjustable, copper plated or polyvinylchloride coated.

I. Insulation Protection Shields: Galvanized carbon steel of not less than 18 gauge for use on insulated pipe 2-1/2" and larger. Minimum shield length is 12". Equal to Anvil figure 167.

J. Steel Hanger Rods:

1. Threaded both ends, threaded one end, or continuous threaded, black finish.

2. Size rods for individual hangers and trapeze support as indicated in the following schedule.

3. Total weight of equipment, including valves, fittings, pipe, pipe content, and insulation, are not to exceed the limits indicated.

Maximum Load (Lbs.) (650°F Maximum Temp.)	Rod Diameter (inches)
610	3/8
1130	1/2
1810	5/8
2710	3/4
3770	7/8
4960	1
8000	1-1/4

4. Provide rods complete with adjusting and lock nuts.

2.04 CONCRETE INSERTS

A. Carbon steel expansion anchors, vibration resistant, with ASTM B633 zinc plating. Use drill bit of same manufacturer as anchor. Hilti, Rawl, Redhead.

2.05 PIPE PENETRATIONS THROUGH ROOF

A. Single Pipe Penetrations:

1. A stack flashing penetration may be utilized for single pipe penetrations through built up roofs and single ply membrane roofs. Utilize high temperature sealant for all high temperature applications. This includes but is not limited to steam condensate vent piping, steam safety relief piping, gas regulator vent piping and flues.

2. A single pre-manufactured boot may be utilized for single pipe penetrations through single ply membrane roofs only.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install supports to provide for free expansion of the piping and duct system. Support all piping from the structure using concrete inserts, beam clamps, ceiling plates, wall brackets, or floor stands. Fasten ceiling plates and wall brackets securely to the structure and test to demonstrate the adequacy of the fastening.

B. Piping shall be supported independently from ductwork and all other trades.

C. Where piping can be conveniently grouped to allow the use of trapeze type supports, use standard structural shapes for the supporting steel.

D. Perform all welding in accordance with standards of the American Welding Society. Clean surfaces of loose scale, rust, paint or other foreign matter and properly align before welding. Use wire brush on welds after welding. Welds shall show uniform section, smoothness of weld metal and freedom from porosity and clinkers. Where necessary to achieve smooth connections, joints shall be dressed smooth.

3.02 HANGER AND SUPPORT SPACING

A. Place a hanger within 12" of each horizontal elbow, valve, strainer, or similar piping specialty item.

B. Where several pipes can be installed in parallel and at the same elevation, provide multiple or trapeze hangers.

C. Support riser piping independently of connected horizontal piping.

D. Adjust hangers to obtain the slope specified in the piping section of this specification.

E. Space hangers for pipe as follows:

Pipe Material	Pipe Size	Horizontal Max. Spacing	Vertical Max Spacing
Steel	1/2" through 1-1/4"	6'-6"	15’-0"
Steel	1-1/2" through 6"	10'-0"	15’-0"
Copper	1/2" through 1-1/4"	5'-0"	10’-0"
Copper	1-1/2" and larger	8'-0"	10’-0"
Cast Iron	All Sizes	5'-0"	15’-0"
CPVC	1" and smaller	3'-0"	10’-0"
CPVC	1-1/4" and larger	4'-0"	10’-0"

3.03 VERTICAL RISER CLAMPS

Support vertical piping with clamps secured to the piping and resting on the building structure or secured to the building structure below at each floor. Mid-story supports may be necessary to meet the requirements listed above.

3.04 PIPE PENETRATION THROUGH ROOF

A. Install at points where pipes penetrate roof. Install as shown on the drawings, as detailed and according to the manufacturer's installation instructions. Flashing and counterflashing by the General Contractor.

END OF SECTION

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SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Scope. This section includes air and water testing, adjusting and balancing for the entire project. Included are the following topics:

B. PART 1 - GENERAL
   1. Scope
   2. Related Work
   3. Reference
   4. Reference Standards
   5. Description
   6. Quality Assurance (Qualifications)
   7. Pre-Installation Meeting and Scheduling
   8. Pre-Balance Conference
   9. Submittals

C. PART 2 - Products
   1. Instrumentation

D. PART 3 - EXECUTION
   1. Daily Reports
   2. Preliminary Procedures
   3. Existing Equipment
   4. Performing Testing, Adjusting, and Balancing
   5. Deficiencies

1.02 RELATED WORK

A. Section 23 05 00 Common Work Results for HVAC
B. Section 23 07 00 HVAC Insulation
C. Section 23 09 14 Pneumatic and Electric Instrumentation and Control Devices for HVAC
D. Section 23 09 23 Direct Digital Control System for HVAC
E. Section 23 09 24 Direct Digital Control System for HVAC (Informational Purposes Only)
F. Section 23 09 25 Direct Digital Control System for HVAC Integrated Terminal Units

1.03 REFERENCE

A. Applicable provisions of the General Conditions, Supplementary General Conditions and General Requirements in Division 1 govern work under this section.

1.04 REFERENCE STANDARDS

A. AABC National Standards for Total System Balance, Sixth Edition, 2002.

B. ASHRAE ASHRAE Handbook, 2007 HVAC Applications, Chapter 37, Testing Adjusting and Balancing.

C. NEBB Procedural Standards for Testing Adjusting Balancing of Environmental Systems, Seventh Edition, 2005.

D. TABB Tab Procedural Guide, First Edition, 2003.

1.05 DESCRIPTION

A. The Contractor will separately contract with T&B Services, LLC, an independent test and balance agency, to perform all testing, adjusting, and balancing of air and hydronic systems required for this project. Work related to the testing, adjusting, and balancing that must be performed by the installing mechanical contractor is specified in other section of these specifications.

B. Provide total mechanical systems testing, adjusting and balancing. Requirements include the balance of air and water distribution, adjustment of new and existing systems and equipment to provide design requirements indicated on the drawings, electrical measurement and verification of performance of all mechanical equipment, all in accordance with standards published by AABC, NEBB, or TABB.

C. Test, adjust and balance all air and hydronic systems so that each room, piece of equipment or terminal device meets the design requirements indicated on the drawings and in the specifications.

D. Accomplish testing, adjusting and balancing work in a timely manner that allows partial occupancy of major buildings, occupancy of one building when the project involves many buildings, and completion of the entire project in the time stated in the Instruction to Bidders and in accordance with the completion schedule established for this project.

E. Verify that provisions are being made to accomplish the specified testing, adjusting and balancing work. If problems are found, handle as specified in Part 3 under Deficiencies.

1.06 QUALITY ASSURANCE (QUALIFICATIONS)

A. T&B Services, LLC from Eau Claire, WI.

1.07 PRE-INSTALLATION MEETING AND SCHEDULING

A. The test and balance agency is required to attend a pre-installation meeting with all other project contractors before the construction process is started. The test and balance agency shall give the Lead Contractor a detailed schedule of testing and balancing tasks for incorporation into the project schedule.

1.08 PRE-BALANCE CONFERENCE

A. 90 days prior to beginning testing, adjusting and balancing, schedule and conduct a conference with the Architect/Engineer, Owner's Project Representative and the mechanical system and temperature control system installing Contractors. Provide A/E with a complete copy of the TAB plan for the project. The objective is final coordination and verification of system operation and readiness for testing, adjusting and balancing procedures and scheduling procedures with the above-mentioned parties. Indicate work required to be completed prior to testing, adjusting, and balancing and identify the party responsible for completion of that work.

1.09 SUBMITTALS

A. See also Related Work in this section.

B. Submit testing, adjusting and balancing reports bearing the seal and signature of the NEBB, AABC, or TABB Certified Test and Balance Supervisor. The reports certify that the systems have been tested, adjusted and balanced in accordance with the referenced standards; are an accurate representation of how the systems have been installed and are operating; and are an accurate record of all final quantities measured to establish normal operating values of the systems.

1. Submission:

   a. Distribute electronic copies of the Report to the Mechanical Contractor and the Prime A/E.

   b. Provide three (3) hard copies of Final Report to be included in O&M Manuals.

2. Format: Cover page identifying project name, project number and descriptive title of contents. Divide the contents of the report into the below listed divisions:

   - General Information
   - Summary
   - Air Systems: AHU-5
   - Hydronic Systems

3. Contents: Provide the following minimum information, forms and data:

   a. General Information: Inside cover sheet identifying Test and Balance Agency, Contractor, Architect, Engineer, Project Name and Project Number. Include addresses, contact names and telephone numbers. Also include a certification sheet containing the seal and signature of the Test and Balance Supervisor.

   b. Summary: Provide summary sheet describing mechanical system deficiencies. Describe objectionable noise or drafts found during testing, adjusting and balancing. Provide recommendations for correcting unsatisfactory performances and indicate whether modifications required are within the scope of the contract, are design related or installation related. List instrumentation used during testing, adjusting and balancing procedures.

   c. The remainder of the report to contain the appropriate standard NEBB, AABC, or TABB forms for each respective item and system. Fill out forms completely. Where information cannot be obtained or is not applicable indicate same.

PART 2 - PRODUCTS

2.01 INSTRUMENTTION

A. Provide all required instrumentation to obtain proper measurements. Application of instruments and accuracy of instruments and measurements to be in accordance with the requirements of NEBB, AABC, or TABB Standards and instrument manufacturer's specifications.

B. All instruments used for measurements shall be accurate, and calibration histories for each instrument to be available for examination by A/E upon request. Calibration and maintenance of all instruments to be in accordance with the requirements of NEBB, AABC, or TABB Standards.

PART 3 - EXECUTION

3.01 DAILY REPORTS

A. Submit to Owner's Project Representative daily work activity reports for each day on which testing and balancing work is performed. Reports shall include description of day's activities and description of any system deficiencies.

3.02 PRELIMINARY PROCEDURES

A. Review preconstruction meeting report, applicable construction bulletins, applicable change orders and approved shop drawings of equipment, outlets/inlets and temperature controls.

B. Check filters for cleanliness, dampers and valves for correct positioning, equipment for proper rotation and belt tension, temperature controls for completion of installation and hydronic systems for proper charge and purging of air.

C. Notify Owner's Project Representative on a daily basis during balancing. Identify deficiencies preventing completion of testing, adjusting and balancing procedures. Do not proceed until systems are fully operational with all components necessary for complete testing, adjusting and balancing. Installing Contractors are required to provide personnel to check and verify system completion, readiness for balancing and assist Balancing Agency in providing specified system performance.

3.03 EXISTING EQUIPMENT

A. Existing Air Cooled Chiller and pumps.

B. Existing AHU-5.

3.04 PERFORMING TESTING, ADJUSTING, AND BALANCING

A. Perform testing, adjusting and balancing procedures on each system identified, in accordance with the detailed procedures outlined in the referenced standards except as may be modified below.

B. Unless specifically instructed in writing, all work in this specification section is to be performed during the normal workday.

C. Cut insulation, ductwork and piping for installation of test probes to the minimum extent necessary for adequate performance of procedures. Patch using materials identical to those removed, maintaining vapor barrier integrity and pressure rating of systems.

D. Measure and record system measurements at the fan and/or pump to determine total flow. Adjust equipment as required to yield specified total flow at terminals. Proceed taking measurements in mains and branches as required for final terminal balancing. Perform terminal balancing to specified flows balancing branch dampers, deflectors, extractors and valves prior to adjustment of terminals.

E. Measure and record static air pressure conditions across fans, coils and filters. Indicate in report if cooling coil measurements were made on a wet or dry coil and if filter measurements were made on a clean or dirty filter. Spot check static air pressure conditions directly ahead of terminal units.

F. Adjust outside air, return air and relief air dampers for design conditions at both the minimum and maximum settings and record both sets of data. Balance modulating dampers at extreme conditions and record both sets of data. Balance variable air volume systems at maximum air flow rate, full cooling, and minimum flow rate, full heating; record all data.

G. Adjust register, grille and diffuser vanes and accessories to achieve proper air distribution patterns and uniform space temperatures free from objectionable noise and drafts within the capabilities of the installed system.

H. Provide fan and motor drive sheave adjustments necessary to obtain design performance. Provide drive changes specifically noted on drawings, if any. If work of this section indicates that any drive or motor is inadequate for the application, advise the owner's project representative by giving the representative properly sized motor/drive information (in accordance with manufacturers original service factor and installed motor horsepower requirements); Confirm any change will keep the duct/piping system within its design limitations with respect to speed of the device and pressure classification of the distribution system. Required motor/drive changes not specifically noted on drawings or in specifications will be considered an extra cost and will require an itemized cost breakdown submitted to owner's project representative. Prior authorization is needed before this work is started.

I. Areas or rooms designed to maintain positive, negative or balanced air pressures with respect to adjacent spaces, as indicated by the design air quantities, require special attention. Adjust fan drives, distribution dampers, terminals and controls to maintain indicated pressure relationship.

J. Final air system measurements to be within the following range of specified cfm:

Fans	0% to +10%
Supply grilles, registers, diffusers	0% to +10%
Return/exhaust grilles, registers	0% to -10%
Room pressurization air	-5% to +5%

K. Final water system measurements must be within the following range of specified gpm:

Heating flow rates	0% to +10%
Cooling flow rates	-5% to +5%

L. Contact the Temperature Control Contractor (Complete Control, Inc.) for assistance in operation and adjustment of controls during testing, adjusting and balancing procedures. Cycle controls and verify proper operation and setpoints. Include in report description of temperature control operation and any deficiencies found.

M. Permanently mark equipment settings, including damper and valve positions, control settings, and similar devices allowing settings to be restored. Set and lock memory stops.

N. Leave systems in proper working order, replacing belt guards, closing access doors and electrical boxes, and restoring temperature controls to normal operating settings.

O. Coordinate air handling unit minimum outside air set points with the Temperature Control Contractor.

P. Hydronic Systems
   1. Verify butterfly valves utilized for hydronic system balancing are provided with position-lock operators (memory stops) in accordance with Section 23 05 23. The adjustment and marking of lever-lock operators that use throttling notches will not be accepted. Lock all memory stops so the valves can be reopened to their balanced positions if they are used for isolation purposes.

3.05 DEFICIENCIES

A. Division 23 00 00 contractor to correct any installation deficiencies found by the test and balance agency that were specified and/or shown on the Contract Documents to be performed as part of that division of work. Test and balance agency will notify the Owner's Project Representative of these items and instructions will be issued to the Division 23 00 00 contractor for correction of the deficient work. All corrective work to be done at no cost to the Owner. Retest mechanical systems, equipment, and devices once corrective work is complete as specified.

END OF SECTION

SECTION 23 07 00
HVAC INSULATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Scope. This section includes insulation specifications for heating, ventilating and air conditioning piping, ductwork and equipment. Included are the following topics:

B. PART 1 - GENERAL
   1. Scope
   2. Related Work
   3. Reference
   4. Reference Standards
   5. Quality Assurance
   6. Description
   7. Definitions
   8. Submittals
   9. Operation and Maintenance Data
   10. Environmental Requirements

C. PART 2 - Products
   1. Materials
   2. Insulation Types
   3. Adhesives, Mastics, Sealants, and Reinforcing Materials
   4. Jackets
   5. Insulation Inserts and Pipe Shields
   6. Accessories

D. PART 3 - EXECUTION
   1. Examination
   2. Installation
   3. Protective Jacket Installation
   4. Piping, Valve and Fitting Insulation
   5. Piping Protective Jackets
   6. Pipe Insulation Schedule
   7. Duct Insulation
   8. Ductwork Protective Coverings
   9. Duct Insulation Schedule
   10. Equipment Insulation
   11. Equipment Insulation Schedule

1.02 RELATED WORK

A. Section 23 05 00 - Common Work Results for HVAC
B. Section 23 21 13 - Hydronic Piping
C. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment
D. Section 23 31 00 - HVAC Ducts and Casings

1.03 REFERENCE

A. Applicable provisions of Division 1 govern work under this section.

1.04 REFERENCE STANDARDS

ASTM B209	Aluminum and Aluminum Alloy Sheet and Plate
ASTM C165	Test Method for Compressive Properties of Thermal Insulations
ASTM C177	Heat Flux and Thermal Transmission Properties
ASTM C195	Mineral Fiber Thermal Insulation Cement
ASTM C240	Cellular Glass Insulation Block
ASTM C302	Density of Preformed Pipe Insulation
ASTM C303	Density of Preformed Block Insulation
ASTM C355	Test Methods for Test for Water Vapor Transmission of Thick Materials
ASTM C449	Mineral Fiber Hydraulic Setting Thermal Insulation Cement
ASTM C518	Heat Flux and Thermal Transmission Properties
ASTM C533	Calcium Silicate Block and Pipe Thermal Insulation
ASTM C534	Preformed Flexible Elastomeric Thermal Insulation
ASTM C547	Mineral Fiber Preformed Pipe Insulation
ASTM C552	Cellular Glass Block and Pipe Thermal Insulation
ASTM C553	Mineral Fiber Blanket and Felt Insulation
ASTM C578	Preformed, Block Type Cellular Polystyrene Thermal Insulation
ASTM C591	Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
ASTM C610	Expanded Perlite Block and Thermal Pipe Insulation
ASTM C612	Mineral Fiber Block and Board Thermal Insulation
ASTM C921	Properties of Jacketing Materials for Thermal Insulation
ASTM C1136	Flexible Low Permeance Vapor Retarders for Thermal Insulation
ASTM D412	Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension
ASTM D1000	Methods for Pressure-Sensitive Adhesive-Coated Tapes Used for Electrical and Electronic Applications
ASTM D1621	Standard Test Method for Compressive Properties Of Rigid Cellular Plastics
ASTM D1622	Standard Test Method for Apparent Density of Rigid Cellular Plastics
ASTM D1940	Method of Test for Porosity of Rigid Cellular Plastics
ASTM D2126	Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging
ASTM D2240	Standard Test Method for Rubber Property—Durometer Hardness
ASTM E84	Surface Burning Characteristics of Building Materials
ASTM E814	Standard Test Method for Fire Tests of Penetration Firestop Systems
ASTM E2336	Standard Test Methods for Fire Resistive Grease Duct Enclosure Systems
MICA	National Commercial & Industrial Insulation Standards
NFPA 225	Surface Burning Characteristics of Building Materials
UL 723	Surface Burning Characteristics of Building Materials

1.05 QUALITY ASSURANCE

A. Refer to Division 1, General Conditions, Equals and Substitutions.

B. Label all insulating products delivered to the construction site with the manufacturer's name and description of materials.

C. Insulation systems shall be applied by experienced contractors. Within the past five (5) years, the contractor shall be able to document the successful completion of a minimum of five (5) projects of at least 50% of the size and similar scope of the work specified in this section.

1.06 DESCRIPTION

A. Furnish and install all insulating materials and accessories as specified or as required for a complete installation. The following types of insulation are specified in this section:
   - Pipe Insulation
   - Duct Insulation
   - Equipment Insulation

B. Install all insulation in accordance with the latest edition of MICA (Midwest Insulation Contractors Association) Standard and manufacturer's installation instructions. Exceptions to these standards will only be accepted where specifically modified in these specifications.

1.07 DEFINITIONS

A. Concealed: shafts, furred spaces, space above finished ceilings, utility tunnels and crawl spaces. All other areas, including walk-through tunnels, shall be considered as exposed.

1.08 SUBMITTALS

A. Refer to Division 1, General Conditions, Submittals.

B. Submit a schedule of all insulating materials to be used on the project, including adhesives, fastening methods, fitting materials along with material safety data sheets and intended use of each material. Include manufacturer's technical data sheets indicating density, thermal characteristics, jacket type, and manufacturer's installation instructions.

1.09 OPERATION AND MAINTENANCE DATA

A. All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

1.10 ENVIRONMENTAL REQUIREMENTS

A. Do not store insulation materials on grade or where they are at risk of becoming wet. Do not install insulation products that have been exposed to water.

B. Protect installed insulation work with plastic sheeting to prevent water damage.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Manufacturers: Armacell, CertainTeed, Manson, Childers, Dow, Extol, Fibrex, Halstead, Foster, Imcoa, ITW, Johns Manville, Knauf Insulation, Owens-Corning, Pittsburgh Corning, VentureTape or approved equal.

B. Materials or accessories containing asbestos will not be accepted.

C. Use composite insulation systems (insulation, jackets, sealants, mastics, and adhesives) that have a flame spread rating of 25 or less and smoke developed rating of 50 or less, with the following exception:

1. Pipe insulation which is not located in an air plenum may have a flame spread rating not over 25 and a smoke developed rating no higher than 450 when tested in accordance with UL 723 and ASTM E84.

2.02 INSULATION TYPES

A. Insulating materials shall be fire retardant, moisture and mildew resistant, and vermin proof. Insulation shall be suitable to receive jackets, adhesives and coatings as indicated.

B. Flexible Fiberglass Insulation: Minimum nominal density of 0.75 lbs. per cu. ft., and thermal conductivity of not more than 0.3 at 75 degrees F, rated for service to 250 degrees F.

C. Rigid Fiberglass Insulation: Minimum nominal density of 3 lbs. per cu. ft., and thermal conductivity of not more than 0.23 at 75°F mean temperature, 0.25 at 125°F, 0.27 at 150°F, 0.29 at 200°F, 0.32 at 250°F, minimum compressive strength of 25 PSF at 10% deformation, rated for maximum service temperature of 450°F.

D. Semi-Rigid Fiberglass Insulation: Minimum nominal density of 3 lbs. per cu. ft., thermal conductivity of not more than 0.28 at 75°F, minimum compressive strength of 25 PSF at 10% deformation, rated for service to 450°F. Insulation fibers perpendicular to jacket and scored for wrapping cylindrical surfaces.

E. Elastomeric Insulation: Flexible closed cell, minimum nominal density of 5.5 lbs. per cu. ft., thermal conductivity of not more than 0.27 at 75°F, minimum compressive strength of 4.5 psi at 25% deformation, maximum water vapor permeability of 0.17 perm inch, maximum water absorption of 6% by weight, rated for service range of -20°F to 220°F on piping and 180°F where adhered to equipment.

F. Polyolefin Insulation: Flexible closed cell, minimum nominal density of 1.5 lbs. per cu. ft., thermal conductivity of not more than 0.24 at 75°F, minimum compressive strength of 5 psi at 25% deformation, maximum water vapor permeability of 0.0 perm inch, maximum water absorption of 0% by weight and volume, rated for service range of -165°F to 210°F.

G. Polyisocyanurate Insulation: Rigid closed cell polyisocyanurate, minimum nominal density of 2.0 lbs. per cu. ft., thermal conductivity of not more than 0.19 at 75°F aged 180 days, minimum compressive strength of 24 psi parallel and 13 psi perpendicular, maximum water vapor permeability of 4 perm inch, maximum water absorption of 2% by volume, rated for service range of -290°F to 300°F.

2.03 ADHESIVES, MASTICS, SEALANTS, AND REINFORCING MATERIALS

A. Products shall be compatible with surfaces and materials on which they are applied and shall be suitable for use at operating temperatures of systems to which they are applied.

B. Fiberglass Insulation Adhesive: Must comply with ASTM C916, Type II: Foster 85-60, Childers CP-127, Duro Dyne SSG.

C. Vapor Retarding Mastic: For below ambient equipment/piping use a water-based mastic with a water vapor permeance of less than 0.04 perms at 40 mils dry film thickness per ASTM E 96: Childers CP-34, Foster 30-65 Vapor-Fas, Knauf Insulation, KI-900 or KI-905, Vimasco 749.

D. Lagging Adhesive/Coatings: For all indoors applications used in conjunction with canvas/glass cloth: Foster 30-36, Childers CP-50A MV1, Vimasco 713.

E. For all indoor applications used in conjunction with canvas/glass cloth: the coating must be anti-fungal and shall meet ASTM D 5590 with 0 growth rating (AF): Foster 30-36 AF Seal Fas, Childers CP-137 AF Chil-Seal.

F. Insulation Joint Sealant: Joint sealants to be non-shrinking and permanently flexible.

- Used on all below ambient piping to prevent moisture ingress.
- For Elastomeric use Armaflex 520 or equal.

2.04 JACKETS

A. PVC Fitting Covers and Jackets (PFJ): White PVC film, gloss finish one side, semi-gloss other side, FS LP-535D, Composition A, Type II, Grade GU. Ultraviolet inhibited indoor/outdoor grade to be used where exposed to high humidity, ultraviolet radiation, in kitchens or food processing areas or installed outdoors. Jacket thickness to be minimum 30 mil unless otherwise noted.

B. All Service Jackets (ASJ Max): Heavy duty, poly-encapsulated, fire retardant material with white kraft reinforced foil vapor barrier, factory applied to insulation with a self-sealing pressure sensitive adhesive lap, maximum permeance of .02 perms and minimum beach puncture resistance of 50 units.

C. Foil Scrim All Service Jackets (FSJ): Glass fiber reinforced foil kraft laminate, factory applied to insulation. Maximum permeance of .02 perms and minimum beach puncture resistance of 25 units.

D. Self-Adhering Jackets (SAJ).

1. 5-ply, self-adhering multiple laminated waterproofing material with reflective aluminum foil, high density polymer films and cold weather acrylic adhesive providing zero (0.0) permeability. Minimum 6 mils material thickness, 35lb puncture resistance when tested in accordance with ASTM D1000 and flame spread/smoke developed rating of 10/20 when tested in accordance with UL 723.

2. Vapor retarding tape shall be specifically designed and manufactured for use with the self-adhering jacket specified above. Tape shall be provided by the same manufacturer that provides jacketing. Vapor retarding tapes used with self-adhering jackets shall have a maximum permeance of 0.0 perms.

E. Fabric Reinforced Mastic Jackets (FMJ): Glass fiber reinforcing fabric imbedded in weather barrier mastic as per manufacturer’s recommended procedure for 2 coat application.

F. Vapor Retarding Jackets (VRJ).

1. Polyvinylidene chloride (PVDC) vapor retarding jacket material with minimum 6 mils material thickness and maximum permeance of 0.01 perms. Material shall not support the growth of mold or mildew. Dow Saran or equivalent.

2. Vapor retarding tape shall be specifically designed and manufactured for use with the vapor retarding jacket specified above. Tape shall be provided by the same manufacturer that provides jacketing. Vapor retarding tapes used with vapor retarding jackets shall have a maximum permeance of 0.01 perms.

2.05 INSULATION INSERTS AND PIPE SHIELDS

A. Manufacturers: B-Line, Pipe Shields, Value Engineered Products.

B. Construct inserts with calcium silicate or polyisocyanurate (service temperatures below 300°F only), minimum 140 psi compressive strength. Piping 12" and larger, supplement with high density 600 psi structural calcium silicate insert. Provide galvanized steel shield. Insert and shield to be minimum 180 degree coverage on bottom supported piping and full 360 degree coverage on clamped piping. On roller mounted piping and piping designed to slide on support, provide additional load distribution steel plate.

C. Where contractor proposes shop/site fabricated inserts and shields, submit schedule of materials, thicknesses, gauges and lengths for each pipe size to demonstrate equivalency to preengineered/premanufactured product described above. On low temperature systems, high density rigid polyisocyanurate may be substituted for calcium silicate provided insert and shield length and shield gauge are increased to compensate for lower insulation compressive strength.

D. Precompressed 20# density molded fiberglass blocks, Hamfab or equal, of the same thickness as adjacent insulation may be substituted for calcium silicate inserts with one 1"x6" block for piping through 2-1/2" and three 1"x6" blocks for piping through 4". Submit shield schedule to demonstrate equivalency to preengineered/premanufactured product described above.

E. Wood blocks will not be accepted.

2.06 ACCESSORIES

A. All products shall be compatible with surfaces and materials on which they are applied, and be suitable for use at operating temperatures of the systems to which they are applied.

B. Adhesives, sealants, and protective finishes shall be as recommended by insulation manufacturer for applications specified.

C. Insulation bands to be 3/4" wide, constructed of aluminum or stainless steel. Minimum thickness to be .015" for aluminum and .010" for stainless steel.

D. Tack fasteners to be stainless steel ring grooved shank tacks.

E. Staples to be clinch style.

F. Insulating cement to be ANSI/ASTM C195, hydraulic setting mineral wool.

G. Finishing cement to be ASTM C449.

H. Fibrous glass or canvas fabric reinforcing shall have a minimum untreated weight of 6 oz./sq. yd.

I. Fungicidal water base duct liner coating (Foster 40-20 or equal) to be compatible with vapor retarding coating. This product must be EPA registered to be used inside HVAC ducts. Coating must comply with ASTM D 5590 with 0 growth rating.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that all piping, equipment, and ductwork are tested and approved prior to installing insulation. Do not insulate systems until testing and inspection procedures are completed.

B. Verify that all surfaces are clean, dry and without foreign material before applying insulation materials.

3.02 INSTALLATION

A. All materials shall be installed by skilled labor regularly engaged in this type of work. All materials shall be installed in strict accordance with manufacturer's recommendations, building codes, and industry standards. Do not install products when the ambient temperature or conditions are not consistent with the manufacturer's recommendations. Surfaces to be insulated must be clean and dry.

B. Locate insulation and cover seams in the least visible location. All surface finishes shall be extended in such a manner as to protect all raw edges, ends and surfaces of insulation.

C. Install insulation with smooth and even surfaces. Poorly fitted joints or use of filler in voids will not be accepted. Provide neatly beveled and coated terminations at all nameplates, uninsulated fittings, or at other locations where insulation terminates.

D. Install fabric reinforcing without wrinkles. Overlap seams a minimum of 2".

E. Use full length material (as delivered from manufacturer) wherever possible. Scrap piecing of insulation or pieces cut undersize and stretched to fit will not be accepted.

F. All pipe and duct insulation shall be continuous through walls, ceiling or floor openings and through sleeves except where firestop or firesafing materials are required. Vapor barriers shall be maintained continuous through all penetrations.

G. Provide a continuous unbroken moisture vapor barrier on insulation applied to systems noted below. Attachments to cold surfaces shall be insulated and vapor sealed to prevent condensation.

H. Provide a complete vapor barrier for insulation on the following systems:
- Cold Water Make-Up
- Chilled Water
- Insulated Duct
- Equipment, ductwork or piping with a surface temperature below 65°F

3.03 PROTECTIVE JACKET INSTALLATION

A. PVC Fitting Covers and Jackets (PFJ): Lap seams and joints a minimum of 2" and continuously seal PVC with welding solvent recommended by jacket manufacturer. Lap slip joint ends 4" without fasteners where required to absorb expansion and contraction. For sections where vapor barrier is not required and jacket requires routine removal, tack fasteners may be used. Secure PVC fitting covers with tack fasteners. For systems requiring a vapor barrier, apply a 1-1/2" band of mastic over ends, throat, seams and penetrations.

B. All Service Jackets (ASJ) and Foil Scrim Kraft Jackets (FSK): Install according to manufacturer's recommendations using factory supplied lap seals and butt strip seals. In addition to factory adhesive, secure lap seals and tape with clinch type staples

C. Self-Adhering Jackets (SAJ):

1. Install according to manufacturer's recommendations. Cut allowing minimum 4" overlap on ends and 6" on longitudinal joints. Align parallel to surface. Remove release paper and press flat to surface to avoid wrinkles. Rub entire surface for full adhesion and sealing at joint overlaps. On exterior applications, provide a bead of compatible caulk along exposed edges.

2. Piping with self-adhering (SAJ) jackets shall have elbows, fittings, valves and butt joints wrapped with 2 layers of vapor retarding tape. Piping with a PVC jacket (PFJ) installed over the self-adhering (SAJ) jacket may be provided with a single, lapped layer of vapor retarding tape for elbows, fittings and valves under the PVC jacket. Vapor retarding tape shall be compatible with the jacket material used.

3.04 PIPING, VALVE, AND FITTING INSULATION

A. General:

1. Install insulation with butt joints and longitudinal seams closed tightly. Provide minimum 2" lap on jacket seams and 3" tape on butt joints, firmly cemented with lap adhesive unless otherwise noted. Additionally, secure with clinch style staples along seams and butt joints.

2. On systems requiring a vapor retarding jacket, seal off all raw ends of insulation and butt joints with vapor retarding mastic at intervals of not more than 20 feet on piping to create a vapor dam. Also provide a vapor dam on each side of valves, unions, and tees. Coat staples, longitudinal and transverse seams with vapor retarding mastic and on systems requiring vapor retarding jacket, coat insulated elbows, fittings, and valves with vapor retarding mastic.

3. Where insulated piping is installed on hangers and supports, the insulation shall be installed continuous through the hangers and supports. High density inserts shall be provided as required to prevent the weight of the piping from crushing the insulation. Pipe shields are required at all support locations. The insulation shall not be notched or cut to accommodate the supporting channels.

4. On low temperature systems, use premanufactured insulated pipe riser clamps such as Pipe Shields E1000 and E 2000 series.

5. Fully insulate all reheat coil piping, fittings and valves (except for unions) up to coil connection to prevent condensation when coil is inactive during cooling season. Provide a vapor proof seal between the pipe insulation and the insulated coil casing.

B. Insulation Inserts and Pipe Shields:

1. Provide pipe shields at all hanger and support locations. Rigid insulation inserts shall be installed between the pipe and the insulation shields. Quantity and placement of inserts shall be according to the manufacturer's installation instructions, however the inserts shall be no less than 12" in length. Inserts shall be of equal thickness to the adjacent insulation and shall be vapor sealed as required for system.

2. Provide insulation inserts and pipe shields at all hanger and support locations. Inserts may be omitted on 3/4" and smaller copper piping provided 12" long 22 gauge pipe shields are used.

C. Fittings and Valves: Fittings, valves, unions, flanges, couplings and specialties may be insulated with factory molded or built up insulation of the same thickness as adjoining insulation. Where the ambient temperature exceeds 150°F, cover insulation with fabric reinforcing and mastic. Where the ambient temperatures do not exceed 150°, furnish and install PVC fitting covers.

D. Elastomeric and Polyolefin: Where practical, slip insulation on piping during pipe installation when pipe ends are open. Miter cut fittings allowing sufficient length to prevent stretching. Completely seal seams and joints for vapor tight installation. For elastomeric insulation, apply full bed of adhesive to both surfaces. For polyolefin, seal factory preglued seams with roller and field seams and joints with full bed of hot melt polyolefin glue to both surfaces. Cover elastomeric insulation on systems operating below 40°F with vapor barrier mastic.

3.05 PIPING PROTECTIVE JACKETS

A. In addition to the jackets specified in the pipe insulation schedule below the following protective jackets are required:

B. Provide a protective PVC jacket (PFJ) for the following insulated piping:

- Piping exposed in finished locations where indicated on plans

C. Provide a protective PVC (PFJ) or Fabric Reinforced Mastic (FMJ) jacket for the following insulated piping:

- All piping within mechanical rooms

3.06 PIPE INSULATION SCHEDULE

A. Provide insulation on new and existing remodeled piping as detailed, as noted on plans, and as indicated in the following schedule:

Service	Insulation	Jacket	Insulation Thickness by Pipe Size				
			< 1"	1" < 2"	2" - <4"	4" < 8"	8" >
Heating Hot Water Only	Rigid Fiberglass	ASJ	1.5"	1.5"	2"	2"	
Chilled Water & Shared Hot Water Piping	Polyiso.	VRJ or SAJ	1.5"	1.5"	1.5"	1.5"	
Cold Water Piping	Rigid Fiberglass	ASJ	0.5"	0.5"	1"	1"	

Note: Rigid fiberglass insulation for Chilled Water & Shared Hot Water Piping to be an alternate deduct.

B. The following piping and fittings are not to be insulated:
- Hot water piping inside radiation, convector, or cabinet heater enclosures
- Piping unions for systems not requiring a vapor barrier

C. For systems with fluid temperatures 65°F or less, furnish and install removable elastomeric insulation covers, plugs or caps for all mechanical equipment and devices that require access by balancing contractors or service and maintenance personnel. Examples include but are not limited to: flow sensing devices, circuit setters, manual ball valve air vents, drain valves, blowdown valves, pressure/temperature test plugs, grease fittings, pump bearing caps, equipment labels, etc. Covers shall be tight fitting to ensure a complete vapor barrier.

3.07 DUCT INSULATION

A. General:

1. Install duct insulation where noted and detailed on plans.

2. Secure rigid board insulation to ductwork with weld pins. Apply insulation with joints firmly butted as close as possible to the equipment surface. Pins shall be located a maximum of 3" from each edge and spaced no greater than 12" on center.

3. Install weld pins without damage to the interior galvanized surface of the duct. Clip pins back to washer and cover penetrations with tape of same material as jacket. Firmly butt seams and joints and cover with 4" tape of same material as jacket. Seal tape with plastic applicator and secure with staples. All joints, seams, edges and penetrations to be fully vapor sealed with vapor retarding mastic.

4. Stop and point insulation around access doors and damper operators to allow operation without disturbing insulation or jacket material.

5. Where insulated ductwork is supported by trapeze hangers, the insulation shall be installed continuous through the hangers. Drop the supporting channels required to facilitate the installation of the insulation. Where rigid board or flexible insulation is specified, install high density inserts to prevent the weight of the ductwork from crushing the insulation.

6. Where insulated low temperature (below 45°F) ductwork is supported by steel metal straps or wire ropes that are secured directly to the duct, the straps or ropes shall be completely covered with insulation and sealed to provide a complete vapor barrier.

3.08 DUCTWORK PROTECTIVE COVERINGS

A. In addition to the jackets specified in the duct insulation schedule below the following protective coverings are required:

B. Provide a protective covering of 2 coats of indoor/outdoor vapor retarding mastic with fibrous glass or canvas fabric covering (FMJ) or self-adhering jacket (SAJ) meeting 25/50 Flame Spread/Smoke Rating for the following ductwork:

- Insulated ductwork located in mechanical rooms or as otherwise noted on plans.

3.09 DUCT INSULATION SCHEDULE

A. Provide duct insulation on new and existing remodeled ductwork as detailed, as noted and scheduled on plans, and as indicated in the following schedule:

Service	Insulation Type	Jacket	Insulation Thickness
Combustion air ducts	Rigid Fiberglass	FSK	2"
Louver blank-off panels	Rigid Fiberglass	FSJ	2"

3.10 EQUIPMENT INSULATION

A. General: Do not insulate over equipment access manholes, fittings, nameplates or ASME stamps. Bevel and seal insulation at these locations.

B. Semi-Rigid Fiberglass: Apply insulation to equipment shells using weld pins, bonding adhesive, banded and wired in place. Fill all joints, seams and depressions with insulating cement to a smooth, even surface. Cover with reinforcing fabric and 2 coats of mastic (FMJ). Use vapor barrier mastic on systems requiring a vapor barrier.

C. Elastomeric/Polyolefin: Apply full cover coat of adhesive to surface to be insulated, insulation and edge butt joints. Place insulation with edge joints firmly butted pressing to surface for full adhesion. Seal seams and joints vapor tight.

3.11 EQUIPMENT INSULATION SCHEDULE

A. Provide equipment insulation as follows:

Equipment	Insulation Type	Jacket	Insulation Thickness
Hot water air separators	Semi-Rigid Fiberglass	ASJ	1.5"
Hot/Chilled water air separators	Elastomeric/Polyolefin	None	1"
Hot/Chilled water pumps	Elastomeric/Polyolefin	None	1"
Hot/Chilled water buffer tank	Elastomeric/Polyolefin	None	2”
Hot/Chilled water expansion tank	Elastomeric/Polyolefin	None	1”

Note: Hot/Chilled water - Equipment is used for both hot water and chilled water system.

END OF SECTION

SECTION 23 09 14
PNEUMATIC AND ELECTRIC INSTRUMENTATION AND CONTROL DEVICES FOR HVAC
(FOR INFORMATIONAL PURPOSES ONLY)

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Scope. The work associated with this section WILL NOT be bid as part of the Division 23 scope of work. This section includes control system specifications for all HVAC work as well as related control for systems found in other specification sections. Included are the following topics:

B. PART 1 - GENERAL
1. Scope
2. Point List
3. Related Work
4. Reference
5. Quality Assurance
6. Reference Standards
7. System Description
8. Submittals
9. Demolition
10. Design Criteria
11. Operation and Maintenance Data
12. Material Delivery and Storage

C. PART 2 - Products
1. Control Valves
2. Control System Instrumentation
3. Temperature Control Panels
4. Temperature Sensors
5. Pressure Transducers (Liquid/Steam)
6. Current Status Switches
7. Emergency Shutdown Switches
8. Power Supplies

D. PART 3 - EXECUTION
1. Installation
2. Wire and Air Piping Conduit and Tubing Installation Schedule
3. Control Valves
4. Control System Instrumentation
5. Room Thermostats and Temperature Sensors
6. Pressure Transducers and High Limit Pressure Switches
7. Temperature Control Panels
8. Current Status Switches

1.02 POINT LIST (Section 23 09 15)

1.03 RELATED WORK

A. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC - Coordination
B. Section 23 09 15 - Direct Digital Control Input/Output Point Summary Tables
C. Section 23 09 24 - Direct Digital Control System for HVAC (Informational purposes only)
D. Section 23 09 93 - Sequence of Operation
E. Section 23 33 00 - Ductwork Accessories - for control damper installation
F. Division 23 - HVAC - Equipment provided to be controlled or monitored

1.04 REFERENCE

A. Applicable provisions of Division 1 govern work under this section.

1.05 QUALITY ASSURANCE

A. Refer to Specification Section 23 09 24.

1.06 REFERENCE STANDARDS

A.	ANSI B16.22	Wrought Copper and Wrought Copper Alloy Solder Joint Pressure Fittings
B.	ANSI/ASTM B32	Specification for Solder Metal
C.	ASTM B75	Seamless Copper Tube
D.	ASTM D1693	Environmental Stress-Cracking of Ethylene Plastics
E.	ASTM D 635	Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
F.	UL 94	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
G.	AMCA 500-D	Laboratory Method of Testing Dampers for Rating

1.07 SYSTEM DESCRIPTION

A. System is to use direct digital control with electric actuation for room temperature, room humidity, and terminal units.

1.08 SUBMITTALS

Include the following information:

A. Manufacturer’s data sheets indicating model number, pressure/temperature ratings, capacity, methods and materials of construction, installation instructions, and recommended maintenance. General catalog sheets showing a series of the same device is not acceptable unless the specific model is clearly marked.

B. Schematic flow diagrams of systems showing fans, pumps, coils, dampers, valves, and other control devices. Label each device with setting or adjustable range of control. Indicate all wiring, clearly, differentiating between factory and field installed wiring. Wiring should be shown in schematics that detail contact states, relay references, etc. Diagrammatic representations of devices alone are not acceptable.

C. Details of construction, layout, and location of each temperature control panel within the building, including instruments location in panel and labeling. Also include on drawings location of mechanical equipment controlled (room number), horsepower and flow of motorized equipment (when this data is available on plans), locations of all remote sensors and control devices (either by room number or column lines).

D. Schedule of control dampers indicating size, leakage rating, arrangement, pressure drop at design airflow, and number and size of operators required.

E. Schedule of control valves indicating system in which the device is to be used, rated capacity, flow coefficient, flow required by device served, actual pressure drop at design flow, size of operator required, close-off pressure, and locations where valves are to be installed.

F. A complete description of each control sequence for equipment that is not controlled by direct digital controls. Direct digital controlled equipment control sequences will be provided by the DDC control contractor.

G. Prior to request for final payment, submit record documents which accurately record actual location of control components including panels, thermostats, wiring, and sensors. Incorporate changes required during installation and start-up.

1.09 DEMOLITION

A. Where existing control devices, piping, or wiring are discontinued from use, remove and turn over to owner. If owner does not want them remove from premises. Remove any previously abandoned control devices in a similar manner.

1.10 DESIGN CRITERIA

A. Size all control apparatus to properly supply and/or operate and control the apparatus served.

B. Provide control devices subject to corrosive environments with corrosion protection or construct them so they are suitable for use in such an environment.

C. Provide devices exposed to outside ambient conditions with weather protection or construct them so they are suitable for outdoor installation.

D. Use only UL labeled products that comply with NEMA Standards. Electrical components and installation to meet all requirements of the electrical sections (Division 26) of project specifications.

1.11 OPERATION AND MAINTENANCE DATA

A. All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

B. In addition to the general content specified under GENERAL REQUIREMENTS supply the following additional documentation:

1. Lubrication instructions, including list/frequency of lubrication.
2. List indicating types and grades of oil and/or grease, packing materials, normal and abnormal tolerances for devices, and method of equipment adjustment.

3. Table noting full load power factor, service factor, NEMA design designation, insulation class and frame type for each motor provided.
4. A complete set of record control drawings.

1.12 MATERIAL DELEVERY AND STORAGE

A. Provide factory shipping cartons for each piece of equipment and control device. This contractor is responsible for storage of equipment and materials inside and protected from the weather.

PART 2 - PRODUCTS

2.01 CONTROL VALVES

A. Provide all control valves as shown on the plans/details and as required to perform functions specified. Spring ranges must be selected to prevent overlap of operation and simultaneous heating and cooling.

B. Size operators to allow smooth and positive operation of devices served and to provide sufficient torque capacity for tight shutoff against system temperatures and pressure encountered. For electric modulating actuation, use fully proportional actuators with 0-10VDC inputs and zero and span adjustments unless specified otherwise in the chart below. If TriState with feedback is specified, valve position shall be fed back to the controller and controller shall position valve based on this feedback. For two-position electric actuation use 24 VAC for DDC controlled actuators, 120 VAC actuators may be used for hardwire interlocking. Electric actuators, for applications other than terminal units, shall be provided with a manual override capability. All electric actuators shall be provided with a visible position indicator.

C. All power required for electric actuation shall be provided by this contractor if it is not able to be directly provided from the DDC controller.

D. Provide operators that are full proportioning or two-position, as required for specified sequence of operation. Provide spring-return for applications involving fire, freeze protection, moisture protection or specified normally open/closed operation. Valves shall move to their fail positions on loss of electrical power to the actuator.

E. Provide end switches integral to the valve actuator to prove the valve open, closed, or both to meet the application where specified in the plans or specifications. End switch contact ratings shall be suitable for application.

F. Two-position shut-off valves shall be sized for a maximum pressure drop of 2 PSI at design flow and shall be a minimum of line size.

G. Provide operators with linkages and brackets for mounting on device served.

H. All valves unless specifically noted on the plans or indicated below shall be globe style valves.

VALVE SERVING	TYPE Globe Butterfly (BF) Ball Press. Independ. Ball (PI Ball)	Signal 0-10 VDC TriState (24VAC) 2-Position Elect.	Spring Return Required Yes/No	Fail Position Open (thru coil) Closed (bypass coil) Last Position
UH	Ball	0-10 VDC	No	Last Position

See plan details, notes, and schedules for where 2-way and 3-way valves should be used.

I. Water Systems:

1. Use equal percentage valves for two-way control valves; size for a pressure drop not less than 4 psi or more than 6 psi. Where valve sizes are less than line size, Corrected Cv should be used to correct for piping reducers/increasers. Modulating valve size should never be less than half of line size. Consult with A/E for acceptable pressure drop if available valve selections do not fall within the desired pressure range. Note: For low flows, the required minimum Cv size will result in lower pressure drop than 4 psi.

2. Use three-way valves sized for a maximum pressure drop of 5 psi and that have linear characteristics so that the valve pressure drop remains constant regardless of the valve position.

3. Butterfly valves: Iron body, stainless steel shaft, bronze bearings, and resilient seat. Disc to be aluminum-bronze, nickel-plated ductile iron, cast iron with welded nickel edge, or stainless steel. Valve assembly to be bubble tight, suitable for use on water systems at 150 psig and 240°F. When butterfly valves are used in modulating applications, entering and leaving pipe sizes and required transition distances shall be detailed on the control valve submittals. The control contractor shall be responsible for coordinating the proper pipe sizes and transitions with the mechanical contractor to provide the correct Cv at 70° open position.

4. Characterized Ball Valves 2” and smaller: The following manufacturers are acceptable: Honeywell, Belimo, Johnson Controls, KMC Controls, Yamatake, Bray, Siemens. Forged brass or bronze body, stainless steel shaft and ball, reinforced Teflon or PTFE ball seals, double O-ring stem seals, characterized disk, maximum of ANSI Class IV (0.01%) leakage, suitable for use on water systems at 150 psig and 212°F. Minimum size for ball valves shall be 0.4 Cv.

2.02 CONTROL SYSTEM INSTRUMENTATION

A. Manufacturers: Averaging Type - Johnson Controls, or equal; Bulb Type - Johnson Controls, Ashcroft, Marshall, Weksler.

B. PIPE THERMOMETERS: 9" stem type with an adjustable swivel mount. Scale graduations of 2°F and mid-range accuracy of ±1°F. Install thermometers in separable brass wells filled with conductive fluid. Thermometer temperature range shall not be more than twice the expected temperature range at installed location.

C. REMOTE BULB THERMOMETERS: 3" or larger dial type with recalibration screw on face. Accuracy within 1% of scale range. Thermometers with sensing elements in air ducts with an area of above 6 square feet to have averaging liquid or gas filled capillary sensing elements. Provide separable wells for all pipeline applications. Thermometer temperature range shall not be more than twice the expected temperature range at installed location.

2.03 TEMPERATURE CONTROL PANELS

A. Constructed of steel or extruded aluminum, with hinged door, keyed lock, and baked enamel finish. Install controls, relays, transducers, and automatic switches inside panels. Label devices with permanent printed labels and provide asbuilt wiring/piping diagram within enclosure. Provide raceways for wiring and poly within panel for neat appearance. Provide termination blocks for all wiring terminations. Label outside of panel with panel number corresponding to plan tags and asbuilt control drawings as well as building system(s) served.

B. Control panels that have devices or terminations that are fed or switch 50V or higher shall enclose the devices, terminations, and wiring so that Personal Protective Equipment (PPE) is not required to service the under 50V devices and terminations within the control panel. As an alternative, a separate panel for only the 50V and higher devices may be provided and mounted adjacent to the under 50V control panel.

C. For panels that have 120VAC power feeds provide a resettable circuit breaker. Provide label within the panel indicating circuit number of 120VAC serving panel.

D. Provide a service shutdown toggle switch for each air handling unit system and associated exhaust fan systems (not general exhaust fans) and energy recovery systems located inside the temperature control panel that will initiate a logical shutdown of the air handling unit system as specified under Section 23 09 15. Label the switch “Service Shutdown” and so it is clear which position is shut down and which is auto.

2.04 TEMPERATURE SENSORS

A. Thermistor temperature sensor manufacturers: PreCon, BAPI, and ACI.

B. Use thermistor or RTD type temperature sensing elements constructed so accuracy and life expectancy is not affected by moisture, physical vibration, or other conditions that exist in each application.

C. RTD’s shall be of nickel or platinum construction and have a base resistance of 1000Ω at 70°F and 77°F respectively. 100Ω platinum RTD’s are acceptable if used with temperature transmitters.

D. The temperature sensing device used must be compatible with the DDC controllers used on the project.

RTD	
Accuracy (Room Sensor Only)	minimum ± 1.0°F
Accuracy (Averaging)	minimum ± 1.2°F
Accuracy (Other than Room Sensor or Averaging)	minimum ± 0.65°F
Range	minimum -40 - 220°F

Thermistor	
Accuracy (All)	minimum ± 0.36°F
Range	minimum -30 - 230°F
Heat Dissipation Constant	minimum 2.7 mW/°C

Temperature Transmitter	
Accuracy	minimum ± 0.1°F or ±0.2% of span
Output	4-20 mA

E. Provide limited range or extended range sensors if required to sense the range expected for a respective point. Use RTD type sensors for extended ranges beyond -30 to 230°F. If RTD's are incompatible with DDC controller direct temperature input use temperature transmitters in conjunction with RTD's.

F. Use wire size appropriate to limit temperature offset due to wire resistance to 1.0°F. If offset is greater than 1.0°F due to wire resistance, use temperature transmitter. If feature is available in DDC controller, compensate for wire resistance in software input definition.

G. Terminal unit discharge temperature sensors shall be provided under this Section.

H. Terminal unit sensors shall be provided with digital displays that indicate room temperature and setpoint. Provide setpoint adjustment as specified in the DDC Input/Output Summary Table and sequence of operation.

I. In piping systems use temperature sensors with separable wells designed to be used with temperature element.

2.05 CURRENT STATUS SWITCHES

A. Provide a current sensor with adjustable threshold and digital output with LED display, equal to a Veris model H-708/H-904. Threshold adjustment must be by a multi-turn potentiometer or set by multiprocessor that will automatically compensate for frequency and amperage changes associated with variable frequency drives. When used on variable speed motor applications, use a current sensor that will not change state due to varying speeds. Current switches with integral relays shall not be used for start/stop and status motor applications.

2.06 EMERGENCY SHUTDOWN SWITCHES

A. Boiler Kill Switch: Kele WPS-MP-BS-CLM with auxiliary contacts Kele PILNCCB or equal. Switch shall be a push-pull maintained contact switch with clear hinged lockout lid and auxiliary contacts for DDC monitoring and each boiler. Labeling shall be provided to indicate switch is for Emergency Boiler Shut-Down and action required to reset.

2.07 POWER SUPPLIES

A. Provide all required power supplies for transducers, sensors, transmitters, and relays. All low voltage transformers shall have a resettable secondary circuit breaker and be listed as class 2 power supplies. All transformer assemblies in enclosures shall have isolated high and low voltage compartments with separate removeable covers for connections.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install system with trained mechanics and electricians employed by the control equipment manufacturer or an authorized representative of the manufacturer. Where installing contractor is an authorized representative of the control manufacturer, such authorization shall have been in effect for a period of no less than three years.

B. Install all control equipment, accessories, wiring, and piping in a neat and workmanlike manner. All control devices must be installed in accessible locations. This contractor shall verify that all control devices furnished under this Section are functional and operating the mechanical equipment as specified in Section 23 09 93.

C. Label all control devices except for terminal unit devices with permanent printed labels that correspond to control drawings. Labeling for each device shall be unique within each mechanical system. Temperature control junction and pull boxes shall be identified utilizing spray painted green covers. Other electrical system identification shall follow the 26 05 53 specification. For control devices mounted above accessible ceilings, label the ceiling tile grid at the ceiling tile that is to be removed for access to the control device. The label shall be pre-printed using clear polyester tape with black bold 28 size font for ceilings under 12 feet. For ceilings over 12 feet high, use bold 40 size font. For accessible ceilings, use an arrow to point at ceiling tile to be removed for access.

D. All control devices and electrical boxes mounted on insulated ductwork shall be mounted over the insulation. Provide mounting stand-offs where necessary for adequate support. Cutting and removal of insulation to mount devices directly on ductwork is not acceptable. This contractor shall coordinate with the insulation contractor to provide for continuous insulation of ductwork.

E. Mounting of electrical or electronic devices shall be protected from weather if the building is not completely enclosed. This Contractor shall be solely responsible for replacing any equipment that is damaged by water that infiltrates the building if equipment is installed prior to the building being enclosed.

F. Provide all electrical relays and wiring, line, and low voltage, for control systems, devices, and components. Install all high voltage and low voltage wiring (includes low voltage cable) in metal conduit, Electrical Non-metallic Tubing (ENT), or Electrical Metallic Tubing (EMT), as scheduled below and hereafter referred to generically as conduit except above accessible ceilings as noted below. See Wire and Air Piping Conduit Installation Schedule below for specific conduit or tubing to be used. All raceways, enclosures, fittings, and associated supports shall be provided and installed according to the requirements set forth in Division 26, NFPA 90 (NEC) and Chapter SPS 316 of the Wisconsin Administrative Code. All conduits shall be routed parallel and/or perpendicular to walls and adjacent piping. Raceways shall be located to maintain headroom and working clearance around equipment and devices that require inspection and service.

G. In general, support all raceways from the building structure. No component of a raceway system shall be secured to corrugated metal roof deck. Do not impose on the installations of other trades. Securing conduit, rods, straps, hangers, etc. to suspended ceiling components, electrical raceways, plumbing piping, fire protection sprinkler piping, HVAC piping or ductwork, or their associated support systems, will not be accepted.

H. Conduit shall be a minimum of 1/2" for low voltage control provided the pipe fill does not exceed 40%.

I. Minimum low voltage wiring gauge to be 18 AWG for outputs and 20 AWG for inputs. All low voltage wiring to be stranded.

J. Low voltage wiring can be run without conduit above accessible lay-in tile ceilings. All wiring in mechanical rooms, above inaccessible hard ceilings, exterior locations, and in any exposed areas, and in all other locations shall be installed in conduit. Wire for wall sensors shall be installed in conduit concealed in the wall. Wiring for radiation valves shall be installed in conduit concealed in the wall. For retrofit installations, all wiring for sensors and valves shall be installed in conduit concealed in new walls. Sensor wiring for existing walls shall be installed without conduit and concealed in the wall (fished) where possible. If running wire concealed in the existing wall is not possible, install in surface raceway as specified or if not specified, consult with the A/E for raceway type and color to be provided.

K. Where wiring is installed free-air, installation shall consider the following:

- Wiring shall utilize the cable tray wherever possible.
- Wiring shall run at right angles and be kept clear of other trades work.
- Wiring shall be supported utilizing "J" or "Bridal-type" steel mounting rings anchored to ceiling concrete, piping supports, walls above ceiling or structural steel beams. Mounting rings shall be of open design (not a closed loop) to allow additional wire to be strung without being threaded through the ring. For mounting rings that do not completely surround the wire, attach the wire to the mounting ring with a strap.
- At HVAC terminal units only, where the wiring serves a specific device; e.g., controller, actuator, transmitter, etc. associated with the unit, the j-hooks or Bridal rings required to support the wiring, may be secured to the rods or straps that support the ductwork or piping that serves the unit. Wall penetrations shall be sleeved.
- Supports shall be spaced at a maximum 4-foot interval unless limited by building construction. If wiring "sag" at mid-span exceeds 6-inches; another support shall be used.
- Wall penetrations shall be sleeved, and fire stopped as specified.
- Wiring shall not be supported from existing cabling, existing tubing, plumbing or steam piping, ductwork, any component of a suspended ceiling, or electrical or communications conduit.

L. Control panels serving equipment fed by emergency power shall also be served by emergency power. This contractor shall be responsible for all 120VAC power, not provided in the Division 26 specifications, required for equipment provided under this section. Power shown for temperature control panels on plans may be utilized by the 23 09 contractor.

M. Provide communication trunk wiring to integrated devices (i.e. VFD's, Flow Meters, Chillers, Lighting Panels, Electrical Meters, etc.) that are specified to be connected to the building automation system. Communication trunk wiring shall be as required by the equipment specified under the 23 09 24 Sections and shall be routed to the DDC panel designated for that equipment as shown on the plans or the closest DDC panel if not designated. If communication trunks required daisy chained style wiring, provide two communication cables to the DDC panel so that the communication trunk is not dead ended.

N. Install all terminal unit DDC controls and associated sensors furnished under Section 23 09 14, 23 09 24 that are field mounted at the terminals units (not terminal unit controls that are mounted in centralized temperature control panels). For terminal units, i.e., fin tube radiation, convectors, cabinet unit heaters, fan coils, where the DDC controller is to be installed in the terminal unit enclosure, the DDC controller shall be installed in a location within the terminal unit enclosure designed to house controls. In no cases shall DDC controllers be installed in the convective or forced air flow stream of the terminal unit.

O. Provide all 24VAC power transformers and wiring for DDC terminal unit controls. Provide all communication wiring to the DDC supervisory controller for the terminal units provided under 23 09 24. Provide all power and communication wiring type and installation as required by the DDC controller manufacturer for the terminal units. Tag all terminal units with printed labels to match the terminal unit room schedules. Terminate wiring for all terminal unit controllers and perform end to end point checkout of all inputs and outputs to the terminal unit controllers. Verify the communication trunk and controller addressing.

P. Start/stop and safety relays for motor loads shall be mounted remotely at the VFD or starter being controlled. Label these relays per above tagging requirements and locate in position on the VFD or starter where the label and power indication light for the relay is visible.

Q. Install "hand/off/auto" selector switches on systems where automatic interlock controls are specified and "hand/off/auto" selector switches are not supplied with the equipment controlled. Control panel power will not be required for "hand" switch to operate. When switch is in "hand" position, allow manual operation of the selected device without operating the interlocked motors but allowing all unit safety devices to stay in the circuit.

R. Install all shutdown switches furnished under this Section where specified or shown on the plans. Boiler kill switches shall be wired to each boiler safety circuit and an auxiliary contact shall be wired to a DDC binary input. Emergency HVAC shutdown switches shall be wired to DDC binary inputs for shutdown of all HVAC equipment serving the building.

S. For service shutdown switches provided in temperature control panels for service shutdown of HVAC systems, label the associated VFD's or motor starters that there is a service shutdown switch and the temperature control panel designation where the switch is located.

T. All wiring in control panels shall be terminated on a terminal strip. Wire nuts are not acceptable. A maximum of two wires shall be terminated under any one terminal.

U. Utilizing a control panel as a raceway for wiring to another control panel is prohibited.

V. All pneumatic tubing, cabling and electrical wiring terminated at controllers, devices and terminal strips are to be permanently tagged or labeled with permanent adhesive labels within one inch of terminal strip with a numbering system to correspond exactly with the "Record Drawings". Jumpers where both ends of the wire are visible and terminations are within 6” of each other do not need to be labeled. Spare wires are to be labeled as “Spare” with unique number designations.

W. After completion of installation, test and adjust control equipment. Submit data showing set points and final adjustments of controls.

3.02 WIRE AND AIR PIPING CONDUIT AND TUBING INSTALLATION SCHEDULE

A. The following conduit schedule shall apply to both polyethylene tubing and wire in conduit where conduit is specified for air tubing or wiring. Conduit and tubing referenced below shall meet specifications in Section 26 05 33 and as defined below.

1. Air piping shall be run in independent conduit without wiring. In no cases shall wiring and air piping share a conduit, raceway or cable tray.

2. Where air piping and wiring share a trough or wire management system above a control panel, code required separation shall be provided.

3. Conduit other than that specified below for specific applications shall not be used.

4. Underground Installations within Five Feet (1.5 m) of Foundation Wall: Rigid steel conduit.

5. Underground Installations More than Five Feet (1.5 m) From Foundation Wall: Rigid steel conduit. Plastic-coated rigid steel conduit. Schedule 40 PVC conduit.

6. Under Slab on Grade Installations: Schedule 40 PVC conduit.

7. Exposed Outdoor Locations: Rigid steel conduit.

8. Concealed in Concrete and Block Walls: Rigid steel conduit. Schedule 40 PVC conduit.

9. Within Concrete Slab: Rigid steel conduit. Schedule 40 PVC conduit.

10. Wet Interior Locations: Rigid steel conduit. Schedule 40 PVC conduit.

11. Concealed Dry Interior Locations: Rigid steel conduit. Intermediate metal conduit. Electrical metallic tubing.

12. Exposed Dry Interior Locations: Rigid steel conduit. Intermediate metal conduit. Electrical metallic tubing.

13. Exposed Dry Interior Locations for Control Devices with Conduit Connections: EMT or Flexible Metal Conduit (FMC). Minimum length shall be one foot (300 mm); maximum length shall be three feet (900 mm). Minimum size FMC of 3/8”.

14. Exposed Dry Interior Locations for Control Devices without Conduit Connections: Where HVAC equipment control panels or devices do not provide for the direct connection of conduits, exposed wiring may be extended to complete the final connections in dry locations, providing it does not exceed 18 inches in length.

3.03 CONTROL VALVES

A. All temperature control valves furnished by the control manufacturer are to be installed by the Mechanical Contractor under the coordinating control and supervision of the Control Contractor in locations shown on plans or where required to provide specified sequence of control.

3.04 CONTROL SYSTEM INSTRUMENTATION

A. Install thermometers at each point of temperature transmission (sensors) and control, except reheat coils, unless the drawings indicate a thermometer is to be installed by the piping or sheetmetal installer. Install thermometers to permit easy reading from the floor or operating platform. Provide remote mounting or swiveled mounting as required for easy reading. Flush mounting where not easily read is not acceptable.

3.05 ROOM THERMOSTATS AND TEMPERATURE SENSORS

A. Check and verify location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation. Locate room thermostats and sensors 48 inches above floor. Align with light switches. For drywall installations, thermostat mounting shall use a back-box attached to a wall stud, drywall anchors are not acceptable.

B. Any room thermostats or sensors mounted on an exterior wall shall be mounted on a thermally insulated sub-base. Subbase to provide a minimum of one-half inch of insulation.

C. Where thermostats or sensors are mounted on exterior walls or in any location where air transfer will affect the measured temperature or humidity seal the conduit and any other opening that will affect the measurement.

3.06 TEMPERATURE CONTROL PANELS

A. Mount control panels adjacent to associated equipment on vibration-free walls or freestanding angle iron supports. All control panel openings shall be plugged. Conduits and other penetrations on the top of the cabinets shall be sealed on the exterior of the cabinet with silicone caulk to resist water penetration. One cabinet may accommodate more than one system in same equipment room. Provide permanent printed labeling for instruments and controls inside cabinet and engraved plastic nameplates on cabinet face.

B. Provide as-built control drawings of all systems served by each local panel in a location adjacent to or inside of panel cover. Provide a protective cover or envelope for drawings.

3.07 CURRENT STATUS SWITCHES

A. Provide for each fan or pump specified or shown on point list. Set threshold adjustment to indicate belt or coupling loss. Readjust threshold for proper operation after final balancing is completed. Use the variable frequency drive (VFD) integrated relay output for motor status, if provided on the VFD, in lieu of a discrete current switch. A separate current switch provided under this Section shall be wired in parallel with the VFD motor status relay when a bypass starter is provided on the VFD to prove motor status in the bypass mode. When a VFD serves more than one fan, provide a separate current switch for each fan served.

END OF SECTION

DDC INPUT / OUTPUT SUMMARY TABLE

PROJECT NO: 22101 — **DDC CONTROLLERS PROVIDED UNDER SPECIFICATION SECTION 23 09 24**

PROJECT: Boiler Replacement for Clark County Courthouse

LOCATION: 517 Court Street - Neillsville, WI

SYSTEM: HOT WATER BOILER SYSTEM

POINT DESCRIPTION	HARDWARE: OUTPUT / DIGITAL: Control Relay	24VAC	Contactor	2-Pos Actuator	OUTPUT / ANALOG: Tri-State Actuator	Duration Adjust Actuator	4-20 mA	0-10 VDC	HARDWARE: INPUT / DIGITAL: Current Sensing Switch	Control Relay Contact	Switch Closure	Auxiliary Contact	Diff Pressure Switch	Flow Switch	INPUT / ANALOG: Temperature	Relative Humidity	Differential Pressure	Gauge Pressure	Static Pressure	Flow	SOFTWARE: ALARMS / DIGITAL: Equipment Status	Maintenance	Pressure	ALARMS / ANALOG: High Limit	Low Limit			ENERGY MANAGEMENT SYSTEM FUNCTIONS: Day/Night Setback	Demand Limiting	Dial-up I/O	Duty Cycling	Optimum Start/Stop	Scheduled Start/Stop	Totalization	Trend		Equipment Integration	Fire Alarm Integration	Security/Access Integration	Elect PQM Integration	Chiller Integration	Dry-bulb Economizer	HW/OA Reset	CHW Reset	Smoke Control	Fire Alarm Override	Comments
HOT WATER																																												
Outside Air Temperature															X																			X						X				Globally shared point.
Boiler System Enable	X																																	X									
Boiler System Setpoint Reset																																		X		X							
Boiler 1 Status																					X													X		X							
Boiler 1 Modulation																																		X		X							
Boiler 2 Status																					X													X		X							
Boiler 2 Modulation																																		X		X							
Boiler Kill Swtich Status												X									X													X									
Boiler 1 Primary Supply Temp															X									X	X									X		X				X			
Boiler 2 Primary Supply Temp															X									X	X									X		X				X			
HW Primary Return Temp															X																			X		X							
HW Secondary Supply Temp															X									X	X									X						X			
HW Secondary Return Temp															X																			X									
Hot Water Pump 1 S/S	X																																	X									
Hot Water Pump 1 Status																					X													X		X							
HW Pump 1 VFD Speed																																		X		X							
HW Pump 1 Flow																																		X		X							
Hot Water Pump 2 S/S	X																																	X									
Hot Water Pump 2 Status																					X													X		X							
HW Pump 2 VFD Speed																																		X		X							
HW Pump 2 Flow																																		X		X							
HW Diff Press																								X	X									X		X							
HW Pump Suction Press																			X					X	X									X									

Notes:

The minimum integrated points listed shall be mapped. Any additional software points that are available and requested by the owner shall be mapped by the DDC contractor.

DDC INPUT / OUTPUT SUMMARY TABLE

PROJECT NO: 22101 — **DDC CONTROLLERS PROVIDED UNDER SPECIFICATION SECTION 23 09 24**

PROJECT: Boiler Replacement for Clark County Courthouse

LOCATION: 517 Court Street - Neillsville, WI

SYSTEM: HOT WATER BOILER SYSTEM

POINT DESCRIPTION	HARDWARE: OUTPUT – DIGITAL: Control Relay	24VAC	Contactor	2-Pos Actuator	HARDWARE: OUTPUT – ANALOG: Tri-State Actuator	Duration Adjust Actuator	4-20 mA	0-10 VDC	HARDWARE: INPUT – DIGITAL: Current Sensing Switch	Control Relay Contact	Switch Closure	Auxiliary Contact	Diff Pressure Switch	Flow Switch	HARDWARE: INPUT – ANALOG: Temperature	Relative Humidity	Differential Pressure	Gauge Pressure	Static Pressure	Flow	SOFTWARE: ALARMS – DIGITAL: Equipment Status	Maintenance	Pressure	ALARMS – ANALOG: High Limit	Low Limit			SOFTWARE: ENERGY MANAGEMENT SYSTEM FUNCTIONS: Day/Night Setback	Demand Limiting	Dial-up I/O	Duty Cycling	Optimum Start/Stop	Scheduled Start/Stop	Totalization	Trend		Equipment Integration	Fire Alarm Integration	Security/Access Integration	Elect PQM Integration	Chiller Integration	Dry-bulb Economizer	HW/OA Reset	CHW Reset	Smoke Control	Fire Alarm Override	Comments
HOT WATER																																														
Outside Air Temperature															X																			X						X				Globally shared point.
Boiler System Enable	X																																X										
Boiler System Setpoint Reset																																	X		X								
Boiler and BCP 3-9 Status																					X												X		X								
Boiler 3-9 Modulation																																	X		X								
Boiler 3-9 Primary Supply Temp															X									X	X								X		X						X		
HW Primary Return Temp															X																		X		X								
HW Secondary Supply Temp															X									X	X								X								X		
HW Secondary Return Temp															X																		X										
BT-1 Temp															X									X	X								X										
Hot/Chilled Water Pump 3 S/S	X																																X										
Hot/Chilled Water Pump 3 Status																					X												X	X	X								
HW/CHW Pump 3 VFD Speed																																	X		X								
HW/CHW Pump 3 Flow																																	X		X								
Hot/Chilled Water Pump 4 S/S	X																																X										
Hot/Chilled Water Pump 4 Status																					X												X	X	X								
HW/Chilled Pump 4 VFD Speed																																	X		X								
HW/Chilled Pump 4 Flow																																	X		X								
Hot/Chilled Water Pump 5 S/S	X																																X										
Hot/Chilled Water Pump 5 Status																					X												X	X	X								
HW/Chilled Pump 5 VFD Speed																																	X		X								
HW/Chilled Pump 5 Flow																																	X		X								
HW Diff Press																								X	X								X		X								
HW Pump Suction Press																			X					X	X								X										

Notes:

The minimum integrated points listed shall be mapped. Any additional software points that are available and requested by the owner shall be mapped by the DDC contractor.

DDC INPUT / OUTPUT SUMMARY TABLE

PROJECT NO: 22101																																															
PROJECT: **Boiler Replacement for Clark County Courthouse**	**HARDWARE**																				**SOFTWARE**																										
LOCATION: **517 Court Street - Neillsville, WI**	**OUTPUT**								**INPUT**												**ALARMS**																										
	DIGITAL				**ANALOG**				**DIGITAL**						**ANALOG**						**DIGITAL**			**ANALOG**				**ENERGY MANAGEMENT SYSTEM FUNCTIONS**																			
SYSTEM: VFD POINTS Thru Integrated Communication Interface for all VFD's Provided on Project (excludes heat wheel VFD's)	Control Relay	Solenoid	Contactor	24 VAC	Tri-State Actuator	Duration Adjust Actuator	4-20 mA	0-10 VDC	Current Sensing Switch	Control Relay Contact	Switch Closure	Auxiliary Contact	Diff Pressure Switch	Flow Switch	Temperature	Resistive	Differential Pressure	Acutator Feedback	Static Pressure	Flow	Equipment Status	Maintenance	Pressure	High Limit	Low Limit			Day/Night Setback	Demand Limiting	Dial-up I/O	Duty Cycling	Optimum Start/Stop	Scheduled Occ/Unoc	Totalization	Trend	Redundancy Control	VFD Integration	Fire Alarm Integration	Security/Access Integration	Elect PQM Integration	Chiller Integration	CFM Offset	OA Lockout	CHW Reset	Smoke Control	Fire Alarm Override	**Comments**
POINT DESCRIPTION																																															
Integrated Points																																															
VFD Total Run Time																																					X										
KWH																																					X										
KW																																					X										
VFD Temperature																																					X										
Voltage Output																																					X										
Amperage Output																																					X										
Output Frequency																																					X										
Remote Fault Reset																																					X										
Hand Auto Status																																					X										
VFD Fault Status																																					X										

Notes:

The minimum integrated points listed shall be mapped. Any additional software points that are available and requested by the owner shall be mapped by the DDC contractor.

DDC INPUT / OUTPUT SUMMARY TABLE

PROJECT NO: 22101 — **DDC CONTROLLERS PROVIDED UNDER SPECIFICATION SECTION 23 09 24**

PROJECT: Boiler Replacement for Clark County Courthouse

LOCATION: 517 Court Street - Neillsville, WI

SYSTEM: Unit Heaters (See plans for Qty)

POINT DESCRIPTION	HARDWARE: OUTPUT – DIGITAL: Control Relay	Solenoid	Contactor	24 VAC	OUTPUT – ANALOG: Tri-State Actuator	Duration Adjust Actuator	4-20 mA	0-10 VDC	HARDWARE: INPUT – DIGITAL: Current Sensing Switch	Control Relay Contact	Switch Closure	Auxiliary Contact	Diff Pressure Switch	Flow Switch	INPUT – ANALOG: Temperature	Resistive	Differential Pressure	Feedback for Tri-State	Static Pressure	Flow	SOFTWARE: ALARMS – DIGITAL: Equipment Status	Maintenance	Pressure	ALARMS – ANALOG: High Limit	Low Limit	Run Time	ENERGY MANAGEMENT SYSTEM FUNCTIONS: Day/Night Setback	Demand Limiting	Dial-up I/O	Duty Cycling	Optimum Start/Stop	Scheduled Start/Stop	Totalization	Trend	Redundancy Control	Lighting Integration	Fire Alarm Integration	Security/Access Integration	Elect PQM Integration	Chiller Integration	CFM Offset	OA Lockout	CHW Reset	Smoke Control	Fire Alarm Override	Comments
Hardware Points																																														
Zone Temperature															X									X	X									X												
Temperature Setpoint Adjust																X																													
HW Control Valve								X																											X							X				
Software Points (Mapped) [1]																																														
Occupied Heating Setpoint																																														
Unoccupied Heating Setpoint																																														
Radiation Lockout Command																																														
Occupied/Unoccupied Command																																													
Actual Heating Setpoint																																				X										
Temperature Setpoint Adjust Range																																														

Notes:

1. The minimum software points listed, if necessary to the application, shall be mapped. Any additional software points that are available and requested by the owner shall be mapped by the DDC contracto

SECTION 23 09 24
DIRECT DIGITAL CONTROL SYSTEM FOR HVAC
(INFORMATIONAL PURPOSES ONLY)

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Scope. The work associated with this section WILL NOT be bid as part of the Division 23 scope of work. Work in this section includes Direct Digital Control (DDC) panels, main communication trunk, software programming, and other equipment and accessories necessary to constitute a completely coordinated extension of the existing building Direct Digital Control (DDC) system. This system interfaced with pneumatic/electric controls (Section 23 09 14) utilizing Direct Digital Control signals to operate actuated control devices will meet, in every respect, all operational and quality standards specified herein, a fully coordinated modification and extension via DDC of the existing Central Building Automation System.

B. PART 1 - GENERAL
   1. Scope
   2. Related Work
   3. Reference
   4. Reference Standards
   5. Additional Work
   6. Quality Assurance
   7. Submittals
   8. Operation and Maintenance Data
   9. Material Delivery and Storage

C. PART 2 - Products
   1. General
   2. Local Control Panels
   3. Direct Digital Controls (DDC)
   4. Networking/Communications
   5. BACnet Requirements
   6. Supervisory Controllers
   7. System Software Features
   8. Programmable Controllers
   9. Application Specific Controllers - HVAC
   10. Operator Interface Requirements
   11. Web Based HTML Browser Interface

D. PART 3 - EXECUTION
   1. General
   2. Installation
   3. Owner Training

1.02 RELATED WORK

A. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC - Coordination
B. Section 23 09 14 - Pneumatic and Electric Instrumentation and Control Devices for HVAC
C. Section 23 09 15 - Direct Digital Control Input/Output Point Summary Tables
D. Section 23 09 93 - Sequence of Operation for HVAC Controls
E. Division 23 - HVAC - Equipment provided to be controlled or monitored

1.03 REFERENCE

A. Applicable provisions of Division 1 govern work under this section.

1.04 REFERENCE STANDARDS

A. FCC Part 15, Subpart J, Class A - Digital Electronic Equipment to Radio Communication Interference.

1.05 ADDITIONAL WORK

A. Section 23 09 14 work includes furnishing and installing all field devices, including electronic sensors for the DDC of this section, equipment, and all related field wiring, interlocking control wiring between equipment, pneumatic tubing, sensor mounting, etc., that is covered in that section.

B. Motorized control dampers and actuators, thermowells (temperature sensing wells), automatic control valves and their actuators are also covered in Section 23 09 14.

1.06 QUALITY ASSURANCE

A. MANUFACTURER: Siemens by Complete Control, Inc.

B. INSTALLER: A firm specializing and experienced in DDC control system installation for no less than 5 years. All engineering and commissioning work shall be done by qualified employees of this manufacturer, or qualified employees of an Authorized Representative of that manufacturer that provides engineering and commissioning of the manufacturer's control equipment. Where installing contractor is an authorized representative of the control equipment manufacturer, submit written confirmation of such authorization. Indicate in letter of authorization that the installing contractor has successfully completed all necessary training required for the engineering, installation, and commissioning of equipment and systems to be provided for the project and that such authorization has been in effect for a period of not less than three years. The letter of authorization should also indicate that the installing contractor is authorized to install the manufacturer's DDC equipment at the project location at the time the project is bid. Installation of the equipment shall be done by qualified mechanics and/or electricians in the direct employ or be directly subcontracted and under the supervision of the manufacturer or Authorized Representative. The contractor providing and installing the equipment under this specification section shall be the same contractor providing and installing equipment under the 23 09 14 specification section.

C. RESPONSE TIME: During warranty period, four (4) hours or less, 24-hours/day, 7 days/week.

D. ELECTRICAL STANDARDS: Provide electrical products, which have been tested, listed and labeled by Underwriters' Laboratories (UL) and comply with NEMA standards.

E. DDC Standards: DDC manufacturer shall provide written proof with shop drawings that the equipment being provided is in compliance with F.C.C. rules governing the control of interference caused by Digital Electronic Equipment to Radio Communications (Part 15, Subpart J, Class A).

1.07 SUBMITTALS

A. Include the following information: Details of construction, layout, and location of each temperature control panel within the building, including instrument's location in panel and labelling. Indicate which piece of mechanical equipment is associated with each controller and what area within the building is being served by that equipment. For terminal unit control, provide a room schedule that would list mechanical equipment tag, room number of space served, address of DDC controller, and any other pertinent information required for service.

B. PRODUCT DATA: Submit manufacturer's specifications for each control device furnished, including installation instructions and startup instructions. General catalog sheets showing a series of the same device is not acceptable unless the specific model is clearly marked. Annotated software program documentation shall be submitted for system sequences, along with descriptive narratives of the sequence of operation of the entire system involved. Submit wiring diagram for each electrical control device along with other details required to demonstrate that the system has been coordinated and will function as a system.

C. MAINTENANCE DATA: Submit maintenance data and spare parts lists for each control device. Include this data in maintenance manual.

D. RECORD DRAWINGS: Prior to request for final payment provide complete composite record drawings incorporating the DDC and Pneumatic/Electric fieldwork.

1.08 OPERATION AND MAINTENANCE DATA

A. All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

1.09 MATERIAL DELIVERY AND STORAGE

A. Provide factory shipping cartons for each piece of equipment and control device. This contractor is responsible for storage of equipment and materials inside and protected from the weather.

PART 2 - PRODUCTS

2.01 GENERAL

A. Provide DDC control products in sizes and of capacities as required, conforming to manufacturer's standard materials and components as published in their product information, designed and constructed as recommended by the manufacturer and as required for application indicated.

B. System shall be capable of operating with 120 VAC power supply, fully protected with a shutdown-restart circuit, and associated hardware and software.

C. All DDC controllers shall use screw terminals for termination of individual wires. Spade lugs are not acceptable.

2.02 LOCAL CONTROL PANELS

A. Use control panels with suitable mounting brackets for each supply fan system. Locate panel adjacent to system served.

B. Fabricate panels of 14 gauge furniture grade steel or 6063-T5 extruded aluminum alloy, totally enclosed on six sides, hinged door and keyed lock, with manufacturer's standard shop painted finish and color.

C. Provide UL listed cabinets for use with line voltage devices.

D. Control panels that have devices or terminations that are fed or switch 50V or higher shall enclose the devices, terminations, and wiring so that Personal Protective Equipment (PPE) is not required to service the under 50V devices and terminations within the control panel. As an alternative, a separate panel for only the 50V and higher devices may be provided and mounted adjacent to the under 50V control panel. For DDC controllers that are directly fed by 120VAC, provide an externally mounted 120VAC, 5A fast blow fuse to feed these controllers.

E. Plastic control enclosures will be approved provided all conduits are bonded and grounded.

F. Provide control panels for all DDC Controllers, ASC's and associated function modules. All controls to be in control panels provided under this Section except for the following:

1. Terminal unit controllers mounted within the terminal unit equipment enclosure as specified under Section 23 09 14.
2. Above accessible lay-in tile ceilings where VAV box controllers designed to be directly mounted on air terminals.
3. Above accessible lay-in tile ceilings where additional controllers are required for air terminal unit control. Where additional controllers are required, they shall not be mounted directly to the ductwork but be mounted on din rail or back panel in an accessible location as close as possible to the terminal unit(s) being controlled.
4. Any devices other than DDC controllers, i.e. relays, pressure switches, etc. shall be installed in an enclosure.

G. All wiring for controllers shall be managed in a neat and workmanlike manner.

H. Permanently label all controls; tag all control wiring and document both on control drawings.

2.03 DIRECT DIGITAL CONTROLS (DDC)

A. System to be capable of integrating multiple building functions, including equipment supervision and control, alarm management, energy management, and trend data collection.

B. DDC to consist of Supervisory Controllers, Programmable Controllers, stand-alone Application Specific Controllers (ASC's), and operator interface devices.

C. The vendor of the system provided under this Section shall provide all software and communication interface hardware necessary to program and upload/download programmable and application specific controllers from a laptop computer and make additional copies and future software revisions available for sale directly to the Owner.

D. The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, ASC's, and operator devices.

E. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

2.04 NETWORKING/COMMUNICATIONS

A. The design of the DDC shall be networked. The highest level networking shall use Ethernet and the sub-level networking shall use serial communications. Inherent in the system's design shall be the ability to expand or modify the highest network either via a local area network (LAN), wide area network (WAN), or a combination of the two schemes.

B. The highest-level DDC communications network shall be capable of direct connection to and communication with a high-speed LAN or WAN utilizing an Ethernet connection. Communication protocol used shall be BACnet/IP.

C. The supervisory controller shall directly oversee a local network such that communications may be executed directly to and between programmable controllers and ASC's. All operator devices, either network resident or connected via dial-up modems, shall have the ability to access all points and application reports on the network.

D. Provide serial communication ports on all ASC's for operator's terminal communications with the DDC Controller.

E. Access to system data shall not be restricted by the hardware configuration of the DDC system.

F. Global data sharing or global point broadcasting shall allow point data to be shared between programmable controllers and ASC's when it would be impractical to locate multiple sensors.

G. Network design shall include the following provisions:

- Data transfer rates for alarm reporting and quick point status from multiple programmable controllers and ASC's. The minimum baud rate shall be 9600 baud.

- Support of any combination of programmable controllers and ASC's. A minimum of 32 programmable controllers and ASC's shall be supported on a single local network. The buss shall be addressable for up to 32 ASC's.

- Detection of single or multiple failures of ASC's or the network media.

- Error detection, correction, and re-transmission to guarantee data integrity.

- Use commonly available, multiple-sourced, networking components.

- Use of an industry standard communication transport, such as, ARCNET, Ethernet, and IEEE RS-485 communications interface.

2.05 BACNET REQUIREMENTS

A. BACnet of highest level network communications will utilize BACnet/IP over Ethernet and field level communications shall utilize BACnet MSTP. No other communication protocol is acceptable.

B. All controllers shall provide a Protocol Implementation Conformance Statement (PICS) and BACnet Interoperability Building Blocks (BIBB"S) as required by the American National Standards Institute/American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ANSI/ASHRAE) Standard 135-2001, BACnet protocol.

C. In general, all devices shall support the following:

1. Segmentation Capability
2. Segmentation requests supported
3. Segmentation responses supported
4. Standard Object Types Supported
    - Analog input
    - Analog output
    - Analog value
    - Binary input
    - Binary output
    - Binary value
    - Calendar
    - Device
    - Event enrolment
    - Group
    - Multistate input
    - Multistate output
    - Multistate value
    - Notification class
    - Schedule
5. Character Sets supported
    - ANSI X3.4
    - ISO 10646 Universal Character Set-2
6. All highest level networked supervisory devices shall support the following:
    a. Data Link Layer Option
        - BACnet Internet Protocol (IP) (Annex J)
    b. Networking Options
7. BACnet/IP Broadcast Management Device (BBDM)

D. BACnet object name and description shall match the existing naming conventions used by the Owner for their existing Building Automation System, where applicable. Coordinate with Owner control personnel to establish the naming conventions prior to programming of any controllers provided under this specification section. All controllers shall have object names, descriptions, and engineering units that are writable at the controller level and shall be programmed so that the object names, descriptions, and engineering units match the desired naming standards as specified above. Ensure that the BACnet object attributes for object name, object description, engineering units and other required attributes will be transferred through to the Supervisory Controller when the auto-discovery function is executed.

E. Coordinate BACnet device instance numbering with the facility personnel for controllers provided under this Section that are being connected to an existing building automation system. This contractor shall be responsible for correcting any conflicts with existing devices that may occur or changing the device instance numbers to comply to follow the agency BACnet device instance numbering scheme.

2.06 SUPERVISORY CONTROLLERS

A. Supervisory controllers shall be microprocessor-based, multi-tasking, multi-user and digital control processors.

B. Supervisory controllers shall be BTL Listed and shall be provided with open connectivity to any manufacturers BACnet programmable or application specific direct digital controllers.

C. The contractor shall provide all labor to build the supervisory controller database in conjunction with and under the supervision of the Owner's control personnel. Naming conventions, database structure, and global application strategies shall be reviewed and approved by the Owner's control personnel before implementation

D. Each supervisory controller shall have sufficient memory to support its own operating system and databases including:

- Control processes
- Energy management application
- Alarm management
- Trend data
- Maintenance support applications
- Operator I/O
- Dial-up communications
- Manual override monitoring

E. The system shall be modular in nature, and shall permit easy expansion through the addition of field controllers, sensors, and actuators.

F. Supervisory controllers shall provide at least two RS-232C or USB serial communication ports or Ethernet ports for simultaneous operation of multiple operator I/O devices, such as laptop computers, personal computers, and video display terminals.

G. Supervisory controllers shall monitor the status of all overrides and include this information in the logs and summaries to inform the operator that automatic control has been inhibited.

H. Each supervisory controller shall continuously perform self-diagnostics, communications diagnostics, and diagnostics of all subsidiary equipment. Supervisory controllers shall provide both local and remote annunciation of any detected component failures, or repeated failure to establish communication. Indication of the diagnostic results shall be provided at each supervisory controller.

I. Isolation shall be provided at all network terminations, as well as all field point terminations, to suppress induced voltage transients consistent with IEEE Standard 587-1980. Isolation levels shall be sufficiently high to allow all signal wiring to be run in the same conduit as high voltage wiring acceptable by electrical code.

J. In the event of the loss of normal power, there shall be an orderly shutdown of the supervisory controller to prevent the loss of data base or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data, and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours.

K. Upon restoration of normal power, the supervisory controller shall automatically resume full operation without manual intervention.

L. Should supervisory controller memory be lost for any reason, the supervisory controller shall have the capability of reloading its programming via high speed local area network from the control system archive workstation or server, the local RS-232C port, or telephone line dial-in.

2.07 SYSTEM SOFTWARE FEATURES

A. All necessary software to form a complete operating system, as described in this specification, shall be provided as an integral part of the supervisory controller, and shall not be dependent upon higher level computer for execution

B. Control software shall include a provision for limiting the number of times that each piece of equipment may be cycled within any one-hour period.

C. The system shall provide protection against excessive demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.

D. Supervisory controllers shall have the ability to perform any or all of the following energy management routines:

- Time of day scheduling
- Calendar based scheduling
- Holiday scheduling
- Optimal start
- Optimal stop
- Demand limiting
- Load rolling
- Heating/cooling interlock

E. All programs to be executed automatically without the need for operator intervention, and be flexible enough to allow user customization. Programs shall be applied to building equipment described in Section 23 09 93 of this specification.

F. Supervisory controllers shall be able to execute configured processes defined by the user to automatically perform calculations and control routines.

G. It shall be possible to use any of the following in a configured process:

- Any system-measured point data or status
- Any calculated data
- Any results from other processes
- Boolean logic operators (and, or)

H. Configured processes may be triggered based on any combination of the following:

- Time of day
- Calendar date
- Other processes
- Events (e.g., point alarms)

I. A single process shall be able to incorporate measured or calculated data from any and all other ASC's.

J. A single process shall be able to issue commands to points in any and all other programmable controllers and ASC's on the local network.

K. Alarm management shall be provided to monitor, buffer, and direct alarm reports to operator devices and memory files. Each supervisory controller shall perform distributed; independent alarm analysis and filtering to minimize network traffic and prevent alarms from being lost. At no time shall the ability of supervisory controllers to report alarms be affected by either operator activity at the local I/O device or communications with other ASC's on the network.

L. All alarm or point change reports shall include the English language description of each point and the time and date of the occurrence.

M. The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of three priority levels shall be provided. Users shall have the ability to manually inhibit alarm reporting for each point.

N. The user shall also be able to define conditions under which point changes need to be acknowledged by an operator and/or logged for analysis at a later date.

O. Alarms reports and messages shall be directed to an operator device.

P. In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a 60-character alarm message to more fully describe the alarm condition or direct operator response.

Q. Each supervisory controller shall be capable of storing a library of at least 100 messages. Each message may be assignable to any number of points in the panel.

R. A data collection utility shall be provided to automatically sample, store, and display system data.

S. Measured and calculated analog and binary data shall be assignable to user definable trends for the purpose of collecting operator specified performance data over extended periods of time. Sample intervals of 1 minute to 24 hours, in one minute or one hour intervals, shall be provided. Each supervisory controller shall have a dedicated buffer for trend data and shall be capable of storing 16 trend logs. Each trend log shall have up to four points trended at 48 data samples each. Data shall be stored at the supervisory controller and up-loaded to the DDC system server when archiving is desired.

T. Supervisory controllers shall automatically accumulate and store runtime hours for binary input and output points specified in Section 23 09 14 of this specification.

U. Supervisory controllers shall automatically sample, calculate and store consumption totals on a daily, weekly, or monthly basis, user defined, for user-selected analog and binary pulse input type points.

V. Totalization shall provide calculation and storage accumulations of up to 9,999,999 units (e.g., KWH, gallons KBTU, tons, etc.).

W. The totalization routine shall have a sampling resolution of one minute.

X. The user shall have the ability to define a warning limit. Unique, user specified messages shall be generated when the limit is reached.

Y. The information available from pulse totalization shall include, but not be limited to, the following:
- Peak demand, with date and time stamp
- 24-hour demand log
- Accumulated KWH for day
- Sunday through Saturday KWH usage
- Demand KW annual history for past 12 periods
- KWH annual history for past periods

Z. Supervisory controllers shall have the ability to count events, such as the number of times a pump or fan system is cycled on and off.

AA. The event totalization feature shall be able to store the records associated with a minimum of 9,999,999 events before reset.

2.08 PROGRAMMABLE CONTROLLERS

A. Programmable controllers shall be provided with a software program that shall allow the user to design flexible software algorithms for the control sequences as described in Sections 23 09 14 and 23 09 93 portions of this specification.

B. Programmable controllers shall support all necessary point inputs and outputs to perform the specified control sequence in a totally stand-alone fashion.

C. Each programmable controller shall perform its own limit and status monitoring and analysis to maximize network performance by reducing unnecessary communications.

D. Each programmable controller shall support the use of a locally mounted status and adjust panel interface to allow for the local adjustment of all setpoints, temporary override of any input or output points and status of all points directly at the controller. The capabilities of the locally mounted status and adjust panel shall include, but not be limited to, the following information for the programmable controllers to which:
- Display temperatures
- Display status
- Display setpoints
- Display control parameters
- Override binary output control
- Override analog output control
- Override analog setpoints
- Modification of gain and offset constants

E. All system set points, proportional bands, control algorithms, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the programmable controller.

F. Programmable controllers shall support, but not be limited to, the following configurations of systems to address current requirements as described in Sections 23 09 14 and 23 09 93 portions of this specification, and for future expansion of air handling units:
   - Mixed air handling units
   - Boiler or chiller plants with pump logic
   - Generic system interlocking through hardware

2.09 APPLICATION SPECIFIC CONTROLLERS - HVAC

A. Each supervisory controller shall be able to extend its monitoring and control through the use of stand-alone application specific controllers (ASC's).

B. Each ASC shall operate as a stand-alone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each ASC shall be a microprocessor based, multi-tasking, real-time digital control processor.

C. Each ASC shall have sufficient memory to support its own operating system and databases including:
   - Control Processes
   - Energy Management Applications
   - Operator I/O (Portable Service Terminal)

D. The operator interface to any ASC point or program shall be through the supervisory controller connection to any ASC on the network.

E. ASC's shall directly support the temporary use of a portable service terminal that can be connected to the ASC via zone temperature or directly at the controller. The capabilities of the portable service terminal shall include, but not be limited to, the following information for the:
   - Display temperatures
   - Display status
   - Display setpoints
   - Display control parameters
   - Override binary output control
   - Override analog output control
   - Override analog setpoints
   - Modification of gain and offset constants

F. All system set points, proportional bands, control algorithms, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the ASC.

G. ASC’s shall support, but not be limited to, the following configurations of systems to address current requirements as described in Sections 23 09 14 and 23 09 93 portions of this specification, and for future expansion of air handling units:
   - Variable Air Volume Terminals
   - Reheat Terminals

H. All system setpoints, proportional bands, control algorithms, calibration constants, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the ASC.

I. All application specific controllers shall be fully programmable. Question and answer or template programming are not acceptable unless this is used to generate the initial application program and the result is able to be freely modified without restriction. Control sequences for terminal unit control that utilize devices wired directly to the terminal unit application controller shall be programmed in the application specific controller and shall be stand-alone in function, i.e., occupancy sensing, temperature setpoint setback, etc. Supervisory controllers shall not be involved in the control sequence logic unless it involves sharing data between or from individual terminal unit controllers to be utilized in a global sequence, i.e., trim and respond strategies, terminal unit grouping, etc.

2.10 OPERATOR INTERFACE REQUIRMENTS

A. COMMAND ENTRY/MENU SELECTION PROCESS: Operator interface software shall minimize operator training through the use of English language prompting and English language point identification.

B. TEXT-BASED DISPLAYS: The operator interface shall provide consistent text-based displays of all system point and application data described in this specification. Point identification, engineering units, status indication, and application naming conventions shall be the same at all operator devices.

C. GRAPHIC-BASED DISPLAYS: The operator interface shall provide graphic based displays of each system. The point data associated with each system shall dynamically update at a minimum of every 30 seconds. Graphic displays shall be linked to each other to provide a “drill down” capability from main graphic displays to more specific system-based displays. Provide a building level graphic display that links to system graphics. For systems that have ASC controlled terminal unit controls, provide a building floor plan with dynamic temperatures shown on the graphic that can be drilled into for more specific terminal information. Points provided in the graphic shall have the override and adjust capability specified under operator commands. The contractor providing the DDC system under this Section shall provide all graphic displays for the project. Submit all graphic displays to the Owner’s control personnel for review and approval. Graphics shall be completed to provide enough time for approval and time for binding to be in place before control system commissioning is scheduled to occur.

D. PASSWORD PROTECTION:

1. Multiple-level password access protection shall be provided to allow the user/manager to limit control, display, and data base manipulation capabilities as he deems appropriate for each user, based upon an assigned password.

2. Passwords shall be exactly the same for all operator devices.

3. A minimum of three levels of access shall be supported:

    - Level 1: Data access and display
    - Level 2 = Level 1 + operator overrides and commands
    - Level 3 = Level 2 + database generation and modification

4. A minimum of 4 passwords shall be supported at each supervisory controller.

5. Operators will be able to perform only those commands available for their respective passwords. Menu selections displayed at any operator device shall be limited to only those items defined for the access level of the password used to log-on.

6. Provide user definable, automatic log-off timers of from 1 to 60 minutes to prevent operators from inadvertently leaving devices on-line.

E. OPERATOR COMMANDS: The operator interface shall allow the operator to perform commands including, but not limited to, the following:

- Start-up or shutdown selected equipment
- Adjust setpoints
- Override analog and binary outputs
- Add/modify/delete time programming
- Enable/disable process execution
- Lock/unlock alarm reporting for each point
- Enable/disable totalization for each point
- Enable/disable trending
- Enter temporary override schedules
- Define holiday schedules
- Change time/date
- Enter/modify analog alarm limits
- Enable/disable analog alarm limits
- Enable/disable demand limiting
- Enable/disable duty cycle

F. LOGS AND SUMMARIES:

1. Reports shall be generated manually, and directed to the displays. As a minimum, the system shall allow the user to easily obtain the following general listing of all points in the system that shall include, but not be limited to:

   - Points currently in alarm
   - Off-line points
   - Points currently in override status
   - Points in weekly schedules
   - Holiday programming

2. Summaries shall be provided for specific points, for a logical point group, for a user-selected group of groups, or for the entire facility without restriction due to the hardware configuration on the facility management system. Under no conditions shall the operator need to specify the address of hardware controller to obtain system information.

G. SYSTEM CONFIGURATION AND DEFINITION:

1. All temperature and equipment control strategies and energy management routines shall be definable by the operator. System definition and modification procedures shall not interfere with normal system operation and control.

2. The system shall be provided complete with all equipment, software, and documentation necessary to allow an operator to independently perform the following functions:

- Add/delete/modify application specific controllers
- Add/delete/modify points of any type, and all associated point parameters, and tuning constants
- Add/delete/modify alarm reporting definition for each point
- Add/delete/modify energy management applications
- Add/delete/modify time and calendar-based programming
- Add/delete/modify totalization for every point
- Add/delete/modify historical data trending for every point
- Add/delete/modify configured control processes
- Add/delete/modify dial-up telecommunication definition
- Add/delete/modify all operator passwords
- Add/delete/modify alarm messages

H. PROGRAMMING DESCRIPTION: Definition of operator device characteristics, ASC's, individual points, and shall be performed through fill-in-the-blank templates.

I. NETWORK-WIDE STRATEGY DEVELOPMENT: Inputs and outputs for any process shall not be restricted to a single ASC, but shall be able to include data from any and all other ASC's to allow the development of network-wide control strategies.

J. SYSTEM DEFINITION/CONTROL SEQUENCE DOCUMENTATION: All portions of system definition shall be self-documenting and be capable of providing hardcopy printouts of all configuration and application data.

K. DATA BASE SAVE/RESTORE/BACK-UP: Backup copies of all programmable controller, ASC and supervisory controller databases shall be stored in at least one personal computer or laptop. Users shall also have the ability to manually execute downloading of a programmable controller, ASC or supervisory controller database.

2.11 WEB BASED HTML BROWSER INTERFACE

A. Provide a HTML based browser interface (Web Server) for accessing the DDC system. This shall include all hardware and software to provide an Ethernet twisted pair connection to the owners local or wide area network (LAN or WAN) that can be used to access the DDC system through a standard internet browser.

B. All information shall be provided to the owner’s IT staff to facilitate connection through the owner’s LAN/WAN.

C. At a minimum, this interface shall be capable of all functions described under the Operator Interface section, Password Protection, Operator Commands, and Logs and Summary subsections of this specification.

PART 3 - EXECUTION

3.01 GENERAL

A. All electronic work required as an integral part of the central building automation system work is the responsibility of this section unless specifically indicated otherwise in this section, Section 23 09 14, or in Division 26.

B. This contractor shall provide all labor, materials, engineering, software permits, tools, check-out and certificates required to install a complete DDC expansion to the existing central building automation system as herein specified. This system expansion shall be compatible with and interfaced to the existing computer driven automation center, and shall operate through all the existing I/O devices, central processing unit (CPU), and digital communication trunks. This connection to the digital communications trunk shall be true bi-directional analog and digital communications with the existing central building automation system.

C. Any and all points added with this project shall be properly interfaced into the existing central building automation system format and grouped for display purposes into the system such that all points associated with a new or existing DDC system can appear together on the CRT display or printed log. Assignment of points to a group shall not be restricted by hardware configuration of the points of direct digital control. It shall be possible to assign a point to appear in more than one system. An English descriptor and an alpha/numeric identifier shall identify each system.

D. This central building automation system expansion as herein specified shall be fully integrated and completely installed by this section. It shall include all required computer CPU software and hardware. Include the engineering, installation, supervision, calibration, software programming, and checkout necessary for a fully operational system.

3.02 INSTALLATION

A. All work and materials are to conform in every detail to the rules and requirements of the National Electrical Code and present manufacturing standards. All wiring and cable installation shall conform to the wiring installation as specified in the installation section of Section 23 09 14. All material shall be UL approved.

B. The addition of this specified system expansion shall in no way impair the future capabilities of any existing functions of the computer driven central building automation system. A system expansion with lessor capabilities will not be accepted. Further, this contractor will not put in jeopardy the normal, uninterruptable operation of the entire building automation system the time it is interfaced through the completion of this project.

C. Install system and materials in accordance with manufacturer's instructions, rough-in drawings and details on drawings.

D. Line voltage wiring to power the DDC Controllers, not provided by the Division 26 contractor, to be by this contractor.

E. Control panels serving equipment fed by emergency power shall also be served by emergency power.

F. Provide uninterruptable power supplies where necessary to provide proper startup of equipment or to accomplish power restart control sequences specified.

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

H. Provide as-built control drawings of all systems served by each local panel in a location adjacent to or inside of panel cover. Provide a protective cover or envelope for drawings.

I. Where a new system is required to be extended to an existing Building Automation Network (BAN) (typically connected via the Owner Local Area Network (LAN) or Wide Area Network (WAN)), extension of the data-net between DDC Controllers and to the BAN to be by this contractor. All wiring and cable installation shall conform to the wiring installation as specified in the installation section of Section 23 09 14.

J. Provide all necessary routers and or repeaters to accomplish connection to the BAN via the panel-mounted port provided.

K. Provide two data jacks in control panels housing supervisory controllers and allocate 6”x6” for each data jack in the panel. The first jack will be used for connecting the supervisory controller to the BAN. The second jack will be used as a spare for connecting to the BAN by service personnel.

L. All tubing, cable and individual wiring is to be permanently tagged, with numbers corresponding with "Record Drawings", spares are to be labelled as "Spare".

M. Provide technician to work with air balancing contractor and/or provide balancing contractor with necessary hardware to over-ride DDC controllers for air balancing.

N. Provide documentation to demonstrate that all points, input and output, have been checked out and verified operational, note any points not operating properly with notation of reason.

3.03 OWNER TRAINING

A. All training provided for the Owner shall comply with the format, general content requirements and submission guidelines specified.

B. Contractor to provide factory authorized representative and/or field personnel knowledgeable with the operations, maintenance and troubleshooting of the system and/or components defined within this section for a minimum period of 4 hours.

C. Provide two follow-up visits for troubleshooting and instruction, one six months after substantial completion and the other at the end of the warranty period. Length of each visit to be not less than 2 hours or the time necessary to provide required information and complete troubleshooting and inspection activity for all controls installed under this section. Coordinate the visit with the Owner and provide an inspection report to the Owner of any deficiencies found.

END OF SECTION

SECTION 23 09 93
SEQUENCE OF OPERATION FOR HVAC CONTROLS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Scope. This section includes control sequences for HVAC equipment as well as equipment furnished by others that may need monitoring or control. Included are the following topics:

B. PART 1 - GENERAL
   1. Scope
   2. Related Work
   3. Reference
   4. Description of Work
   5. Submittals
   6. Operation and Maintenance Data
   7. Design Criteria

C. PART 2 - Products
   1. Not Applicable

D. PART 3 - EXECUTION
   1. General Control
   2. Boiler Control (B-1 & B-2)
   3. Heating Water Circulating Pump Control (CP-1 & CP-2)
   4. Boiler Control (B/BCP-3 thru B/BCP-9)
   5. Heating Water (& Chilled Water) Circulating Pump Control (CP-3 thru CP-5)
   6. Terminal Unit Control – DDC and Electric

1.02 RELATED WORK

A. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC – Coordination
B. Section 23 09 14 - Pneumatic and Electric Instrumentation and Control Devices for HVAC
C. Section 23 09 24 - Direct Digital Control System for HVAC
D. Division 23 - HVAC - Equipment provided to be controlled or monitored

1.03 REFERENCE

A. Section 23 09 14 work includes furnishing and installing all field devices, including electronic sensors for the DDC of this section, equipment, and all related field wiring, interlocking control wiring between equipment, pneumatic tubing, sensor mounting, etc., that is covered in that section.

B. Motorized control dampers and actuators, thermowells (temperature sensing wells), automatic control valves and their actuators are also covered in Section 23 09 14.

1.04 DESCRIPTION OF WORK

A. Control sequences are hereby defined as the manner and method by which automatic controls function. Requirements for each type of operation are specified in this section.

B. Operation equipment, devices and system components required for automatic control systems are specified in other Division 23 control sections of these specifications.

C. All temperature, humidity, and pressure sensing, and all other control signal transportation for the control sequences shall be furnished as specified under Section 23 09 14.

D. Sequences for equipment controlled by Direct Digital Controls (DDC) as specified are accomplished by hardware and software provided under Section 23 09 24. Sequences for equipment controlled by pneumatic or electric self-contained controls are accomplished by hardware provided under Section 23 09 14.

1.05 SUBMITTALS

A. Refer to Division 1, General Conditions, Submittals, Section 23 05 00 and Sections 23 09 24, and 23 09 14 for descriptions of what should be included in the submittals.

B. Shop drawings shall be provided by contractor(s) providing equipment under Sections 23 09 24 and 23 09 14. The contractor shall provide a complete narrative of the sequence of operations for equipment that is controlled through the DDC system or directly from the 23 09 14 equipment (without control logic through the DDC system). The narrative of the sequence of operation shall not be a verbatim copy of the sequences contained herein, but shall reflect the actual operation as applied by the contractor.

1.06 OPERATION AND MAINTENANCE DATA

A. All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

1.07 DESIGN CRITERIA

A. Reference Section 23 09 14.

PART 2 - PRODUCTS

2.01 NOT APPLICABLE

A. Reference Sections 23 09 24 and 23 09 14 for product descriptions.

PART 3 - EXECUTION

3.01 GENERAL CONTROL

A. BACNET OBJECTS: All hardwired points listed in 23 09 15 and any setpoints, timers, or other control elements that are specified to be adjustable (adj.) in the following control sequences shall be mapped as BACnet objects and be available on the user interface to be adjusted. Consult with the owner's HVAC and/or DDC personnel prior to programming to determine if there are any items that they do not want to have mapped as BACnet objects. This is especially important for DDC controlled items that are duplicative, i.e., air terminal units.

B. BACNET ADDRESSING: BACnet instance IDs shall be coordinated with the owner's established BACnet instance ID addressing scheme. If there is not such a scheme in place, the contractor(s) providing BACnet DDC controllers shall work with the agency to establish such a scheme and document this in the asbuilt control drawings. BACnet/IP addressing shall be coordinated with the agency prior to installation. BACnet MSTP addressing shall be addressed to provide for consecutive addressing to provide for the best speed of response. Max Master address shall be set appropriately for speed of response.

C. USER INTERFACE/FEATURE SOFTWARE: Consult with the owner's HVAC and/or DDC personnel prior to programming to determine BACnet object naming conventions, user views, graphic layout, security matrix, alarming, trending, and scheduling preferences desired by the agency. Failure to consult and come to agreement prior to programming shall require the DDC contractor to make changes in the above listed items as desired by the owner to the system at no cost. Section 23 09 15 feature software checkmarks are guides only and are not specific to what is required by the owner.

SETPOINTS: All setpoints indicated in the control specification are to be adjustable. The setpoints shall be readily available to be modified in the mechanical system software system summary (either textual or graphic based) and under the same software level as hardware points. Some less used setpoints may be provided on a lower software level, if requested by the owner for clarity. The setpoints indicated herein are only specified as a calculated starting point (or initial system operation). It is expected that setpoint adjustments and control loop tuning shall be required to provide optimum system operation based on requirements of the building. The control contractor shall work with the balancing contractor and the owner to provide the final system setpoint adjustments and control loop tuning after the system is in operation and building is in use. Document all final setpoints on the as-built control drawings. Any questions regarding the intended operation of the HVAC equipment and control systems shall be referred to the HVAC design engineer through the appropriate construction communication process.

D. ANTI-CYCLING: When HVAC equipment or a sequence is specified to be started and stopped by a temperature, humidity, pressure setpoint or any other controlled variable, there shall be an adjustable differential setpoint that shall be set to prevent short cycling of the systems and equipment due to minor changes in the controlled variable. Temperature differential setpoints shall be set at 2ºF and non-temperature setpoints shall be set at 10% of the controlled range unless otherwise specified. Setpoints shall indicate at when the process should be turned on. Heating and cooling differentials shall be set for above setpoint and will be used to turn the process off. For example, an economizer sequence called to switch at 68ºF, would turn on at 68ºF and off at 70ºF since it is a cooling function. A heating lockout setpoint of 50ºF would turn on heating control at 50ºF and off at 52ºF. Non-temperature differentials shall be set above setpoint if the setpoint is indicating a minimum value or below setpoint if the setpoint is indicating a maximum value. Provide minimum runtime timers for loads that are cycled to prevent over-cycling. Timers shall be set as specified or as needed to prevent damage or excessive wear to the equipment. Unless otherwise specified in the individual control sequences, fans and pumps shall have a minimum runtime on timers of 15 minutes (adj.) and off timers of 5 minutes (adj.). Safeties shall override runtime timers.

E. DEADBANDS: Provide deadbands for all DDC control loops to prevent constant hunting of output signals to controlled devices. Deadbands shall be set to provide adequate control around setpoint as follows unless otherwise specified in the individual control sequences:

- Temperature Control: ±0.5ºF

F. ALARMS:

1. Provide all alarmed points with adjustable time delays to prevent nuisance tripping under normal operation and on equipment start-up. For all commanded outputs that have status feedback, provide an alarm that will indicate the commanded output is not in its commanded state. Provide alarms on all points as indicated on point charts. For existing building automations systems, add/delete what is called on the point charts for after consultation with owner to provide consistent alarming throughout the automation system.

2. For devices that have form “C” contacts available for alarm monitoring, use closed contacts for the Normal condition and open contacts on Alarm condition. This shall provide a level of supervision by detecting a break in the wiring.

G. EQUIPMENT START/STOP FAILURE STATES: All start/stop points for equipment shall utilize normally open contacts unless called out specifically in the individual control sequences.

H. LEAD/LAG SEQUENCING: For sequences that call for lead/lag of equipment connected to building automation systems, the lead device shall be able to be chosen through a selectable day of the week and time of day through the building automation system. Coordinate with the owner for scheduling switchover and frequency. Unless otherwise directed, switchover shall occur at 10AM Tuesday and shall rotate the lead device on a weekly cycle rotating through all devices sequentially. For standalone lead/lag sequence controllers (non-DDC), the lead device shall be selected by a switch on the panel face.

I. VARIABLE FREQUENCY DRIVE (VFD) MOTOR RUN STATUS: Use the VFD programmable relay dry contact output specified to be provided with the VFD under Section 23 05 14 to prove motor run status and detect belt loss or coupling break. If a bypass contactor is provided with the VFD, provide an adjustable current switch and wire it in parallel with the VFD output for proving motor status.

J. VFD BYPASS & SAFETY INTERLOCKS: VFD's equipped with bypass starters shall be interlocked so that the start/stop and safety circuits that are called out for VFD operation shall be functional when the VFD is indexed to the bypass starter mode. Unless otherwise specified in the sequence below, the switch from inverter to bypass starter modes shall be through a manual switch provided on the VFD/bypass starter package.

K. VFD MINIMUM SPEED & RAMP TIMERS: The VFD start-up technician shall work with the DDC Temperature Control Contractor determine the minimum speed required for the motor controlled by the VFD to provide cooling of the motor as installed to prevent heat related problems. This minimum speed shall be set in the VFD controller. The VFD start-up technician shall work with the DDC Temperature Control Contractor to set the acceleration and deceleration timers in the VFD controller at 30 seconds for motors less than 40 HP and 60 seconds for motors 40 HP and greater.

L. CURRENT SWITCH SETUP: When current switches are used for proving fan or pump status, they shall be set up so that they will detect belt or coupling loss by the reduction in current draw on loss of coupled load. The current switch set up shall be redone by the 23 09 14 contractor after the balancer is complete.

M. THERMOSTATS AND SENSORS: All devices and equipment including terminal units, specified to be controlled in a control sequence by a thermostat or sensor, shall be provided with a thermostat or sensor, whether or not the device is indicated on the plans. Consult the HVAC design engineer for the thermostat or sensor location.

N. ORIGINAL EQUIPMENT MANUFACTURER (OEM) CONTROLLER DDC INTEGRATION: Provide DDC programming to define all equipment integral input/output points, setpoints, data points, calculations, etc. that are available through the manufacturer's communication interface. Consult with the owner's DDC operations personnel to determine if some of the points should be omitted (for clarity or lack of value). The following equipment shall be integrated into the DDC system:

- Boilers
- Circulating Pumps
- Variable Frequency Drives

3.02 BOILER CONTROL (B-1 & B-2)

A. The boiler system is comprised of multiple high efficiency boilers with modulating burner control and motorized isolation valves. The boiler standard control must allow interface with the building DDC system.

B. The boiler system shall reset hot water temperature based on outdoor temperature. Water temperature shall be 80°F at 60°F outside temperature, reset linearly to 180°F at 0°F outside temperature (adjustable). Contractor shall work with owner's representative to maximize boiler reset schedule.

C. After the lead hot water heating circulating pump is operating (see pump control below) and with the lead boiler isolation valve open, the boiler control system will modulate the lead boiler to increase the supply water temperature. The lead boiler will increase input as required until a preset adjustable percentage of input, normally 60% (adj.), is reached. At that point and after 10 continuous minutes (adj.) above 60% fire, the boiler control system will open the second isolation valve, start the second boiler, and decrease input on the lead boiler to equal the inputs. The boilers will continue to increase discharge temperature as required. The second boiler will modulate down in response to the control system in a reverse manner. The boiler will come off line and the isolation valve will close at the transfer setpoint to maximize condensing, and similarly for additional boilers. Allow isolation valve to remain open for 2 minutes (adj.) before closing to dissipate heat. All isolation valves shall be open when all boilers are off.

D. Provide and install manually operated remote shut-down switch(es) or circuit breaker(s) located just outside (or inside) of the boiler room door(s) and marked for easy identification. Coordinate exact location and requirements with local jurisdiction.

3.03 HEATING WATER CIRCULATING PUMP CONTROL (CP-1 & CP-2)

A. Start/Stop: The DDC system shall enable and disable circulating pumps. Hot water pumps shall be commanded on with a call for heat. Hot water pumps shall be commanded off if all building heating setpoints are satisfied and boilers are off, and the outside air temperature is above 50º F (adj.).

B. Lead / Lag Control: Integral to circulating pumps.

C. Speed Control: Integral differential pressure sensor supplied with pumps. The pumps integral controller shall control the operating pump VFD to maintain a setpoint as described below.

D. Constant Differential Pressure Setpoint Control: The operating pump VFD shall be modulated to maintain a constant setpoint of 10 psig (adj.) at the differential pressure sensor. Final setpoint shall be optimized by the Balancing Contractor.

3.04 BOILER CONTROL (B/BCP-3 THRU B/BCP-9)

A. The boiler system is comprised of multiple high efficiency boilers with modulating burner control and boiler circulating pumps. The boiler standard control must allow interface with the building DDC system.

B. The boiler system shall reset hot water temperature based on outdoor temperature. Water temperature shall be 80°F at 60°F outside temperature, reset linearly to 180°F at 0°F outside temperature (adjustable). Contractor shall work with owner's representative to maximize boiler reset schedule.

C. After the lead hot water heating circulating pump is operating (see pump control below), the boiler control system will start the lead boiler circulating pump and modulate the lead boiler to increase header (or buffer tank) temperature. The lead boiler will increase input as required until a preset adjustable percentage of input, normally 60-70%, is reached. At that point, the boiler control system will start the second boiler/pump and decrease input on the lead boiler to equal the inputs. The boilers will continue to increase discharge temperature as required. The second boiler/pump will modulate down in response to the control system in a reverse manner. The boiler/pump will come off line at the transfer setpoint to maximize condensing, and similarly for additional boilers.

3.05 HEATING WATER (& CHILLED WATER) CIRCULATING PUMP CONTROL (CP-3 thru CP-5)

E. Start/Stop: The DDC system shall enable and disable circulating pumps. In heating operation, pumps shall be commanded on with a call for heat and shall be commanded off if all building heating setpoints are satisfied and boilers are off, and the outside air temperature is above 50º F (adj.). In cooling operation, shall be commanded on with a call for cooling and shall be commanded off if all building cooling setpoints are satisfied and chiller is off, and outside air temperature is below 60 º F (adj.). Coordinate and modify control with current heating/cooling changeover process.

F. Lead / Lag Control: Integral to circulating pumps.

G. Speed Control: Integral differential pressure sensor supplied with pumps. The pumps integral controller shall control the operating pump VFD to maintain a setpoint as described below..

H. Constant Differential Pressure Setpoint Control: The operating pump VFD shall be modulated to maintain a constant setpoint of 10 psig (adj.) at the differential pressure sensor. Final setpoint shall be optimized by the Balancing Contractor.

3.06 TERMINAL UNIT CONTROL - DDC AND ELECTRIC

A. GENERAL: See the valve chart in Section 23 09 14 for requirements for type of valve, signal required, spring return requirements, and fail positions. The valve requirements specified in the Section 23 09 14 valve chart shall supersede what is called out in the terminal unit sequences.

B. UNIT HEATER CONTROL: Provide a DDC space temperature sensor to control the electronic control heating valve to maintain space temperature. When space temperature is below setpoint modulate the heating coil valve open. The reverse shall occur when space temperature is above setpoint. Provide a strap on aquastat mounted on the hot water return line set at 100ºF to control the unit fan when hot water temperature is above setpoint.

END OF SECTION

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SECTION 23 11 00
FACILITY FUEL PIPING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Scope. This section contains specifications for fuel pipe and fuel pipe fittings for this project. Included are the following topics:

B. PART 1 - GENERAL
   1. Scope
   2. Related Work
   3. Reference
   4. Reference Standards
   5. Quality Assurance
   6. Submittals
   7. Delivery, Storage, and Handling
   8. Design Criteria
   9. Welder Qualifications
   10. Natural Gas Service

C. PART 2 - Products
   1. Natural Gas
   2. Vents and Relief Valves
   3. Unions and Flanges

D. PART 3 - EXECUTION
   1. Erection
   2. Welded Pipe Joints
   3. Threaded Pipe Joints
   4. Natural Gas
   5. Vents and Relief Valves
   6. Unions and Flanges
   7. Piping System Leak Tests
   8. Piping System Test Report

1.02 RELATED WORK

A. Section 23 05 23 - General-Duty Valves for HVAC Piping
B. Section 23 05 15 - Piping Specialties
C. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment

1.03 REFERENCE

A. Applicable provisions of Division 1 govern work under this section.

1.04 REFERENCE STANDARDS

A. ANSI B16.3 Malleable Iron Threaded Fittings
B. ASTM A53 Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless
C. ASTM A74 Cast Iron Soil Pipe and Fittings
D. ASTM A234 Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures

1.05 QUALITY ASSURANCE

A. Order all Type E and Type S steel pipe with heat numbers rolled, stamped, or stenciled to each length or each bundle, depending on the size of the pipe, and in accordance with the appropriate ASTM specification.

B. Any installed material not meeting the specification requirements must be replaced with material that meets these specifications without additional cost to the Owner.

1.06 SUBMITTALS

A. Refer to Division 1, General Conditions, Submittals.

B. Contractor shall submit schedule indicating the ASTM specification number of the pipe being proposed along with its type and grade and sufficient information to indicate the type and rating of fittings for each service.

C. TYPE E OR S STEEL PIPE: Mill certification papers, also known as material test reports, for the pipe furnished for this project, in English. Heat numbers on these papers to match the heat numbers stenciled on the pipe. Chemical analysis indicated on the mill certification papers to meet or exceed the requirements of the referenced ASTM specification.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Promptly inspect shipments to ensure that the material is undamaged and complies with specifications.

B. Cover pipe to eliminate rust and corrosion while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade. Protect pipe, tube, and fitting ends so they are not damaged. Where end caps are provided or specified, take precautions so the caps remain in place.

C. Offsite storage agreements will not relieve the contractor from using proper storage techniques.

D. Storage and protection methods must allow inspection to verify products.

1.08 DESIGN CRITERIA

A. Use only new material, free of defects, rust and scale, and meeting the latest revision of ASTM specifications as listed in this specification.

B. Construct all piping for the highest pressures and temperatures in the respective system in accordance with ANSI B31, but not less than 125 psig unless specifically indicated otherwise.

C. Non-metallic piping will be acceptable only for the services indicated. It will not be acceptable in occupied spaces and ventilation plenum spaces, including plenum ceilings.

D. Where weld fittings or mechanical grooved fittings are used, use only long radius elbows having a centerline radius of 1.5 pipe diameters.

E. Where ASTM A53 grade A pipe is specified, ASTM A53 grade B pipe may be substituted at Contractor's option. Where the grade or type is not specified, Contractor may choose from those commercially available.

1.09 WELDER QUALIFICATIONS

A. Before any metallic welding is performed, the Contractor shall submit his Standard Welding Procedure Specifications, Procedure Qualification Records and Qualification Test Records for each Welder along with associated continuity records to demonstrate compliance with ASME Section IX, paragraph QW-322.

B. The Contractor shall maintain a complete set of welder qualification documents at the jobsite, including Test Records and Continuity Records for each welder.

C. Before any polyethylene fusion welding is performed, Contractor to submit certification that the welders to be used on this project have successfully demonstrated proper welding procedures in accordance with the Code of Federal Regulations, Title 49, Part 192, Section 192.285

D. The A/E reserves the right to test the work of any welder employed on the project, at the Contractor's expense. Testing will include a visual examination of the pipe and weld and may include radiography of any suspect welds. If the work of the welder is found to be unsatisfactory, the welder shall be prevented from doing further welding on the project. Any welds deemed unacceptable will be repaired at the contractor’s expense.

1.10 NATURAL GAS SERVICE

A. All charges for the gas service as shown on the plans, including the connection from the main in the street or other location to the gas meter, shall be paid by this Contractor, including setting of gas meter(s) and all work performed by the gas company.

PART 2 - PRODUCTS

2.01 NATURAL GAS

A. 2" and Smaller: ASTM A53, type E or S, standard weight (schedule 40) black steel pipe with ASTM A197/ANSI B16.3 class 150 black malleable iron threaded fittings or ASTM A234 grade WPB/ANSI B16.9 standard weight, seamless, carbon steel weld fittings.

B. 2-1/2" and Larger: ASTM A53, type E or S, standard weight black steel pipe with ASTM A234 grade WPB/ANSI B16.9 standard weight, seamless, carbon steel weld fittings.

2.02 VENTS AND RELIEF VALVES

A. Use pipe and pipe fittings as specified for the system to which the relief valve or vent is connected.

2.03 UNIONS AND FLANGES

A. 2" and Smaller: ASTM A197/ANSI B16.3 malleable iron unions with brass seats. Use black malleable iron on black steel piping and galvanized malleable iron on galvanized steel piping. Use unions of a pressure class equal to or higher than that specified for the fittings of the respective piping service but not less than 250 psi.

B. 2-1/2" and Larger: ASTM A181 or A105, grade 1 hot forged steel flanges of threaded, welding and of a pressure class compatible with that specified for valves, piping specialties and fittings of the respective piping service. Flanges smaller than 2-1/2" may be used as needed for connecting to equipment and piping specialties. Use raised face flanges ANSI B16.5 for mating with other raised face flanges on equipment with flat ring or full-face gaskets. Use ANSI B16.1 flat face flanges with full face gaskets for mating with other flat face flanges on equipment.

C. Provide ASTM A 193 B7 grade bolts and A 194 2H grade nuts & hardened washers for connections (Star washers for grounding.)

D. GASKETS:

1. Fuel Oil and Natural Gas Systems: Branded, compressed, non-asbestos sheet gaskets. Klingersil C4401, Garlock 3000, JM Clipper 978-C or approved equal.

PART 3 - EXECUTION

3.01 ERECTION

A. Carefully inspect all pipe, fittings, valves, equipment and accessories before installation. Any items that are unsuitable, cracked or otherwise defective shall be rejected and removed from the job site immediately. Excluding minor surface rust, piping that exhibits significant oxidation or corrosion will be rejected.

B. Exercise care at every stage of storage, handling, laying and erecting to prevent entry of foreign matter into piping, fittings, valves, equipment and accessories. Do not erect or install any item that is not clean.

C. Remove all lose dirt, scale, oil, chips, burrs and other foreign material from the internal and external surfaces of all pipe and piping components prior to assembly, including debris associated with cutting, threading and welding.

D. During fabrication and assembly, remove slag and weld spatter from internal pipe surfaces at all joints by peening, chipping and wire brushing.

E. During construction, until system is fully operational, keep all openings in piping and equipment closed except when actual work is being performed on that item of the system. Use plugs, caps, blind flanges or other items designed for this purpose.

F. Install all piping parallel to building walls and ceilings and at heights which do not obstruct any portion of a window, doorway, stairway, or passageway. Where interferences develop in the field, offset or reroute piping as required to clear such interferences. In all cases, consult drawings for exact location of pipe spaces, ceiling heights, door and window openings, or other architectural details before installing piping.

G. Mitered ells, notched tees, and orange peel reducers are not acceptable. On threaded piping, bushings are not acceptable.

H. "Weldolets" and "Threadolets" may be used for branch takeoffs up to one-half (1/2) the diameter of the main.

I. Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including the required service space for this equipment, unless the piping is serving this equipment

J. Install all valves, control valves, and piping specialties, including items furnished by others, as specified and/or detailed. Make connections to all equipment installed by others where that equipment requires the piping services indicated in this section.

3.02 WELDED PIPE JOINTS

A. Make all welded joints by fusion welding in accordance with ASME Codes, ANSI B31, and State Codes where applicable.

B. All pipe welding shall be completed by Qualified Welders in accordance with the Contractor's Procedure Specifications.

C. Contractor will ensure that these steps are followed where pipe sections will be joined by welding:

1. Cleaning – Welding surfaces will be clean and free of defects.

2. Alignment – Inside diameter of piping components will be aligned as accurately as possible. Internal misalignment shall not exceed 1/16".

3. Spacing – Pipe sections will be spaced to allow deposition of weld filler material through the entire weld joint thickness.

4. Girth Butt Welds:
   a. Girth butt welds shall be complete penetration welds.
   b. Concavity will not exceed 1/32"
   c. Under cuts will not exceed 1/32"
   d. As welded surfaces are permitted however surfaces will be free from coarse ripples, grooves, abrupt ridges and valleys.

D. Electrodes shall be Lincoln, or approved equal, with coating and diameter as recommended by the manufacturer for the type and thickness of work being done.

3.03 THREADED PIPE JOINTS

A. Use a Teflon based thread lubricant or Teflon tape when making joints; no hard setting pipe thread cement or caulking will be allowed.

3.04 NATURAL GAS

A. Pitch horizontal piping down 1" in 60 feet in the direction of flow. Install a 4" minimum depth dirt leg at the bottom of each vertical run and at each appliance. When installing mains and branches, cap gas tight each tee or pipe end which will not be immediately extended. All branch connections to the main shall be from the top or side of the main.

B. Do not install gas pipe in a ventilation air plenum.

C. If an above ground vent terminates in an area subject to snow accumulation, terminate the line at least five feet above grade.

D. Install a shut off valve at each appliance. Provide a valved connection at the main for equipment and appliances furnished by others.

E. Piping through a roof shall be run through an approved roof penetration with flashing and counter flashing.

F. Each gas pressure reducing valve vent and relief valve vent shall be run separately to a point outside of the building, terminated with a screened vent cap, and located according to gas utility regulations.

G. Clean all welded piping before all regulators and control valves. Test by placing target cloth over piping and blow with compressed air. Clean piping until target cloth is clean and free of debris.

3.05 VENTS AND RELIEF VALVES

A. Install vent and relief valve discharge lines as indicated on the drawings, as detailed, and as specified for each specific valve or piping specialty item. In no event is a termination to occur less than six feet above a roof line.

3.06 UNIONS AND FLANGES

A. Install a union or flange, as required, at each automatic control valve and at each piping specialty or piece of equipment which may require removal for maintenance, repair, or replacement. Where a valve is located at a piece of equipment, locate the flange or union connection on the equipment side of the valve. Concealed unions or flanges are not acceptable.

B. GASKETS:

1. Store horizontally in cool, dry location and protect from sunlight, water and chemicals. Inspect flange surfaces for warping, radial scoring or heavy tool marks. Inspect fasteners, nuts and washers for burrs or cracks. Replace defective materials.

2. Align flanges parallel and perpendicular with bolt holes centered without using excessive force. Center gasket in opening. Lubricate fastener threads, nuts and washers with lubricant formulated for application.

3. Draw flanges together evenly to avoid pinching gasket. Tighten fasteners in cross pattern sequence (12 – 6 o'clock, 3 – 9 o'clock, etc.), one pass by hand and four passes by torque wrench at 30% full torque, 60% full torque and two passes at full torque per ASME B16.5.

3.07 PIPING SYSTEM LEAK TESTS

A. Verify that the piping system being tested is fully connected to all components and that all equipment is properly installed, wired, and ready for operation. If required for the additional pressure load under test, provide temporary restraints at expansion joints or isolate them during the test. Verify that hangers can withstand any additional weight load that may be imposed by the test.

B. Provide all piping, fittings, blind flanges, and equipment to perform the testing.

C. Conduct pressure test with test medium of air unless specifically indicated. Minimum test time is indicated in the table below; additional time may be necessary to conduct an examination for leakage. Each test must be witnessed by the Owner or Owner's representative. If leaks are found, repair the area with new materials and repeat the test; caulking will not be acceptable.

D. For air tests, gradually increase the pressure to not more than one half of the test pressure; then increase the pressure in steps of approximately one-tenth of the test pressure until the required test pressure is reached. Examine all joints and connections with a soap bubble solution or equivalent method. The piping system exclusive of possible localized instances at pump or valve packing shall show no evidence of leaking. After testing is complete, slowly release the pressure in a safe manner.

System	Pressure	Medium	Duration
Natural Gas	100 psig	Air	24 hr

E. All pressure tests are to be documented on the form included in this specification.

3.08 PIPING SYSTEM TEST REPORT

Date Submitted: _____

Project Name: _____

Location: _____ **Project No:** _____

Contractor: _____

❑ HVAC ❑ Refrigeration ❑ Controls
❑ Power Plant ❑ Plumbing ❑ Sprinkler

Test Medium: ❑ Air ❑ Water ❑ Other _____

Test performed per specification section No. _____

Specified Test Duration _____ Hours **Specified Test Pressure** _____ psig

System Identification: _____

Describe Location: _____

_____

Test Date: _____

Start Test Time: _____ **Initial Pressure:** _____ psig

Stop Test Time: _____ **Final Pressure:** _____ psig

Tested By: _____ **Witnessed By:** _____

Title: _____ **Title:** _____

Signed: _____ **Signed:** _____

Date: _____ **Date:** _____

Comments: _____

_____

END OF SECTION

SECTION 23 21 13
HYDRONIC PIPING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Scope. This section contains specifications for all HVAC hydronic pipe and pipe fittings for this project. Included are the following topics:

B. PART 1 - GENERAL
   1. Scope
   2. Related Work
   3. Reference
   4. Reference Standards
   5. Quality Assurance
   6. Submittals
   7. Delivery, Storage, and Handling
   8. Design Criteria
   9. Welder Qualifications

C. PART 2 - Products
   1. Heating Hot Water
   2. Chilled Water
   3. Makeup Water
   4. Chemical Treatment
   5. Vents and Relief Valves
   6. Unions and Flanges
   7. Gaskets
   8. Mechanical Grooved Pipe Connections

D. PART 3 - EXECUTION
   1. Erection
   2. Welded Pipe Joints
   3. Threaded Pipe Joints
   4. Mechanical Grooved Pipe Connections
   5. Copper Pipe Joints
   6. Water Systems
   7. Makeup Water
   8. Vents and Relief Valves
   9. Unions and Flanges
   10. Gaskets
   11. Piping System Leak Tests
   12. Hydronic Piping System Flushing
   13. Initial Fill and Vent
   14. Piping System Test Report
   15. Piping System Flush Report

1.02 RELATED WORK

A. Section 23 05 23 - General-Duty Valves for HVAC Piping
B. Section 23 05 15 - Piping Specialties
C. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment
D. Section 23 07 00 - HVAC Insulation
E. Section 23 25 00 - HVAC Water Treatment

1.03 REFERENCE

A. Applicable provisions of Division 1 govern work under this section.

1.04 REFERENCE STANDARDS

A.	ANSI B16.3	Malleable Iron Threaded Fittings
B.	ANSI B16.4	Cast Iron Threaded Fittings
C.	ANSI B16.5	Pipe Flanges and Flanged Fittings
D.	ANSI B16.22	Wrought Copper and Wrought Copper Alloy Solder Joint Pressure Fittings
E.	ASME B16.51	Copper and Coper Alloy Press-Connect Pressure Fittings
F.	ASTM A53	Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless
G.	ASTM A74	Cast Iron Soil Pipe and Fittings
H.	ASTM A105	Forgings, Carbon Steel, for Piping Components
I.	ASTM A126	Gray Cast Iron Castings for Valves, Flanges, and Pipe Fittings
J.	ASTM A181	Forgings, Carbon Steel for General Purpose Piping
K.	ASTM A197	Cupola Malleable Iron
L.	ASTM A234	Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
M.	ASTM A380	Practice for Cleaning and Descaling Stainless Steel Parts, Equipment, and Systems
N.	ASTM B75	Seamless Copper Tube
O.	ASTM B88	Seamless Copper Water Tube
P.	ASTM F1476	Performance of Gasketed Mechanical Couplings for Use in Piping Applications

1.05 QUALITY ASSURANCE

A. Order all Type E and Type S steel pipe with heat numbers rolled, stamped, or stenciled to each length or each bundle, depending on the size of the pipe, and in accordance with the appropriate ASTM specification.

B. Any installed material not meeting the specification requirements must be replaced with material that meets these specifications without additional cost to the Owner.

C. All grooved joint couplings, fittings, valves, and specialties shall be of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.

D. All castings used for fittings, couplings, valve bodies, etc., shall include a cast date stamp for quality assurance and traceability.

E. Installers of Press-Connect Joints: Installers shall be certified by press-connect joint manufacturer as having been trained and qualified to join piping with press-connect pipe couplings and fittings.

F. Installer shall be a qualified installer, licensed within the jurisdiction, and familiar with the installation of press joint systems.

G. Press fittings shall be installed using proper tool, actuator, jaws, and rings as instructed by the press fitting manufacturer.

1.06 SUBMITTALS

A. Refer to Division 1, General Conditions, Submittals.

B. Contractor shall submit schedule indicating the ASTM specification number of the pipe being proposed along with its type and grade and sufficient information to indicate the type and rating of fittings for each service.

C. TYPE F STEEL PIPE: Statement from manufacturer on his letterhead that the pipe furnished meets the ASTM specification contained in this section.

D. TYPE E OR S STEEL PIPE: Mill certification papers, also known as material test reports, for the pipe furnished for this project, in English. Heat numbers on these papers to match the heat numbers stenciled on the pipe. Chemical analysis indicated on the mill certification papers to meet or exceed the requirements of the referenced ASTM specification.

E. COPPER TUBE: Statement from manufacturer on his letterhead that the pipe furnished meets the ASTM specification contained in this section.

F. Grooved joint couplings and fittings shall be referred to on drawings and product submittals and shall be identified by the manufacturer's style or series designation. Trade names and abbreviations are not acceptable.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Promptly inspect shipments to ensure that the material is undamaged and complies with specifications.

B. Cover pipe to eliminate rust and corrosion while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade. Protect pipe, tube, and fitting ends so they are not damaged. Where end caps are provided or specified, take precautions so the caps remain in place. Protect fittings, flanges, and unions by storage inside or by durable, waterproof, above ground packaging.

C. Offsite storage agreements will not relieve the contractor from using proper storage techniques.

D. Storage and protection methods must allow inspection to verify products.

1.08 DESIGN CRITERIA

A. Use only new material, free of defects, rust and scale, and meeting the latest revision of ASTM specifications as listed in this specification.

B. Construct all piping for the highest pressures and temperatures in the respective system in accordance with ANSI B31, but not less than 125 psig unless specifically indicated otherwise.

C. Where weld fittings or mechanical grooved fittings are used, use only long radius elbows having a centerline radius of 1.5 pipe diameters.

D. Where ASTM A53 type F pipe is specified, ASTM A53 grade A type E or S, or ASTM A53 grade B type E or S may be substituted at Contractor's option. Where ASTM A53 grade A pipe is specified, ASTM A53 grade B pipe may be substituted at Contractor's option. Where the grade or type is not specified, Contractor may choose from those commercially available.

E. Where ASTM B88, type L hard temper copper tubing is specified, ASTM B88, type K hard temper copper tubing may be substituted at Contractor's option.

1.09 WELDER QUALIFICATIONS

A. Before any metallic welding is performed, the Contractor shall submit his Standard Welding Procedure Specifications, Procedure Qualification Records and Qualification Test Records for each Welder along with associated continuity records to demonstrate compliance with ASME Section IX, paragraph QW-322.

B. The Contractor shall maintain a complete set of welder qualification documents at the jobsite, including Test Records and Continuity Records for each welder.

C. The A/E reserves the right to test the work of any welder employed on the project, at the Contractor's expense. Testing will include a visual examination of the pipe and weld and may include radiography of any suspect welds. If the work of the welder is found to be unsatisfactory, the welder shall be prevented from doing further welding on the project. Any welds deemed unacceptable will be repaired at the contractor’s expense.

PART 2 - PRODUCTS

2.01 HEATING HOT WATER

A. 2" and Smaller: ASTM A53, type F, standard weight (schedule 40) black steel pipe with ASTM A126/ANSI B16.4, class 125, standard weight cast iron threaded fittings or ASTM F3226 carbon steel press-connect fittings with EPDM or FKM sealing element, stainless steel separator and grip ring, and smart connect technology suitable for 200 psig working pressure at 250°F (Viega MegaPress).

B. 2-1/2" and Larger: ASTM A53, standard weight (schedule 40) black steel pipe with ASTM A234 grade WPB/ANSI B16.9 standard weight, seamless, carbon steel weld fittings or ASTM F3226 carbon steel press-connect fittings (2½" to 4") with EPDM or FKM sealing element, stainless steel separator and grip ring, and smart connect technology suitable for 200 psig working pressure at 250°F (Viega MegaPress).

C. Contractor may use ASTM B88 seamless, type L, hard temper copper tube in lieu of steel pipe for all sizes with ANSI B16.22 wrought copper solder-joint fittings or ASME B16.51/ASTM F3226 copper or bronze press-connect fittings (½" to 4") with EPDM sealing element, stainless steel separator and grip ring, and smart connect technology suitable for 300 psig working pressure at 250°F (Viega ProPress). Mechanically formed tee fittings may be used in lieu of wrought copper solder-joint tee fittings for branch takeoff up to one-half (1/2) the diameter of the main.

2.02 CHILLED WATER

A. 2" and Smaller: ASTM A53, type F, standard weight (schedule 40) black steel pipe with ASTM A126/ANSI B16.4, class 125, standard weight cast iron threaded fittings or ASTM F3226 carbon steel press-connect fittings with EPDM or FKM sealing element, stainless steel separator and grip ring, and smart connect technology suitable for 200 psig working pressure at 250°F (Viega MegaPress).

B. 2-1/2" and Larger: ASTM A53, standard weight (schedule 40) black steel pipe with ASTM A234 grade WPB/ANSI B16.9 standard weight, seamless, carbon steel weld fittings or ASTM F3226 carbon steel press-connect fittings (2½" to 4") with EPDM or FKM sealing element, stainless steel separator and grip ring, and smart connect technology suitable for 200 psig working pressure at 250°F (Viega MegaPress).

C. Contractor may use ASTM B88 seamless, type L, hard temper copper tube in lieu of steel pipe for all sizes with ANSI B16.22 wrought copper solder-joint fittings or ASME B16.51/ASTM F3226 copper or bronze press-connect fittings (½" to 4") with EPDM sealing element, stainless steel separator and grip ring, and smart connect technology suitable for 300 psig working pressure at 250°F (Viega ProPress). Mechanically formed tee fittings may be used in lieu of wrought copper solder-joint tee fittings for branch takeoff up to one-half (1/2) the diameter of the main.

2.03 MAKEUP WATER

A. Extend as shown on plans with the same materials.

2.04 CHEMICAL TREATMENT

A. Use pipe and pipe fittings as specified for the system to which the chemical treatment piping is connected.

2.05 VENTS AND RELIEF VALVES

A. Use pipe and pipe fittings as specified for the system to which the relief valve or vent is connected.

2.06 UNIONS AND FLANGES

A. 2" and Smaller: ASTM A197/ANSI B16.3 malleable iron unions with brass seats. Use black malleable iron on black steel piping and galvanized malleable iron on galvanized steel piping. Use ANSI B16.18 cast copper alloy unions on copper piping. Use unions of a pressure class equal to or higher than that specified for the fittings of the respective piping service but not less than 250 psi.

B. 2-1/2" and Larger: ASTM A181 or A105, grade 1 hot forged steel flanges of threaded, welding and of a pressure class compatible with that specified for valves, piping specialties and fittings of the respective piping service. Flanges smaller than 2-1/2" may be used as needed for connecting to equipment and piping specialties. Use raised face flanges ANSI B16.5 for mating with other raised face flanges on equipment with flat ring or full face gaskets. Use ANSI B16.1 flat face flanges with full face gaskets for mating with other flat face flanges on equipment.

C. Unions and flanges for servicing or disconnect are not required on installations using grooved joint couplings. The couplings shall serve as disconnect points.

2.07 GASKETS

A. Water and Glycol Systems: Branded, compressed, non-asbestos sheet gaskets. Klingersil C4401, Garlock 3000, JM Clipper 978 or approved equal.

2.08 MECHANICAL GROOVED PIPE CONNECTIONS

A. Manufacturers: Victaulic, Anvil Corp., or Tyco/Grinnell.

B. Mechanical grooved pipe couplings and fittings may be used with steel pipe on the systems indicated below. Either cut-groove or equivalent roll-groove products are acceptable providing the system temperature and pressure requirements are met. Where ductile iron fittings are indicated, they shall conform to ASTM A536. Where forged steel fittings are indicated, they shall conform to ASTM A234, Grade WPB. Where factory-fabricated steel fittings are indicated, they shall be manufactured from pipe conforming to ASTM A53, type F in sizes 3/4" through 1-1/2" and type E or S, grade B in sizes 2" through 20". Do not use fabricated fittings where malleable iron or forged steel fittings are available. Gaskets in all cases shall be EPDM suitable for temperatures to 230°F.

C. The following services may use mechanical grooved pipe connections within the building in mechanical spaces and above accessible ceilings. Mechanical chases are not considered accessible unless approved by the Engineer.

- Heating Hot Water
- Chilled Water

D. Mechanical grooved pipe connections shall not be used in below grade utility distribution systems.

E. Mechanical grooved pipe connections shall not be used in chilled water piping between the cooling coil and the isolation valve for that cooling coil.

F. Fittings and couplings must be suitable for the temperature and pressure involved. In no case is the final system to have a pressure rating of less than 250 psig at the design temperature of the fluid.

G. Acceptable fittings and couplings are listed below, based on Victaulic. When used on galvanized piping, fittings and couplings shall be galvanized. When used on black steel piping, fittings and couplings shall have an enamel coating.

1. Ductile iron standard couplings: Manufactured in two segments of cast ductile iron, conforming to ASTM A-536, Grade 65-45-12, with pressure-responsive elastomer gasket conforming to ASTM D-2000, and zinc-electroplated carbon steel bolts and nuts conforming to ASTM A-449 and ASTM A-183. Couplings shall comply with ASTM F1476.

2. Rigid Type: Coupling housings with offsetting, angle-pattern bolt pads shall be used to provide system rigidity and support and hanging in accordance with ANSI B31.1, and B31.9. Victaulic Style 107H/107N (Quick-Vic™). Installation ready rigid coupling for direct stab installation without field disassembly. Gasket shall be Grade “EHP” EPDM designed for operating temperatures from -30 deg F to +250 deg F.

3. Flexible Type: Use in locations where vibration attenuation and stress relief are required. Flexible couplings may be used in lieu of flexible connectors at equipment connections. Three couplings, for each connector, shall be placed in close proximity to the vibration source. Victaulic Installation-Ready Style 177 or Style 77.

4. Victaulic AGS Mechanical Couplings, 14 inch (DN350) through 60 inch (DN1500): Couplings shall consist of two housing segments with lead-in chamfer on the housing key, a wide elastomer pressure responsive FlushSeal gasket. Victaulic Style W07 (rigid) and Style W77 (flexible).

H. Couplings: Reducing couplings are not acceptable.

I. Flanges: Ductile iron Style 741 / W741 or 743 except at lug type butterfly valves where standard welding flanges shall be used.

J. Fittings: Ductile iron elbows and tees of the manufacturer's standard line may be used in all sizes except bullhead tees will not be accepted. Factory-fabricated steel fittings may be used in all sizes where fitting wall thickness conforms to standard weight pipe. Mechanical-T Style 920/920N fittings with ductile iron housings may be used for up to 2" outlet size.

PART 3 - EXECUTION

3.01 ERECTION

A. Carefully inspect all pipe, fittings, valves, equipment and accessories before installation. Any items that are unsuitable, cracked or otherwise defective shall be rejected and removed from the job site immediately. Excluding minor surface rust, piping that exhibits significant oxidation or corrosion will be rejected.

B. Exercise care at every stage of storage, handling, laying and erecting to prevent entry of foreign matter into piping, fittings, valves, equipment and accessories. Do not erect or install any item that is not clean.

C. Remove all lose dirt, scale, oil, chips, burrs and other foreign material from the internal and external surfaces of all pipe and piping components prior to assembly, including debris associated with cutting, threading and welding.

D. During fabrication and assembly, remove slag and weld spatter from internal pipe surfaces at all joints by peening, chipping and wire brushing.

E. During construction, until system is fully operational, keep all openings in piping and equipment closed except when actual work is being performed on that item of the system. Use plugs, caps, blind flanges or other items designed for this purpose.

F. Furnish and install all flanges, caps, bypasses, drains, valves, etc. required to facilitate flushing and draining all heating and cooling system piping.

G. Unions and flanges for servicing or disconnect are not required on installations using grooved joint couplings. The couplings shall serve as disconnect points.

H. Install all piping parallel to building walls and ceilings and at heights which do not obstruct any portion of a window, doorway, stairway, or passageway. Where interferences develop in the field, offset or reroute piping as required to clear such interferences. In all cases, consult drawings for exact location of pipe spaces, ceiling heights, door and window openings, or other architectural details before installing piping.

I. Mitered ells, notched tees, and orange peel reducers are not acceptable. On threaded piping, bushings are not acceptable.

J. "Weldolets" and "Threadolets" may be used for branch takeoffs up to one-half (1/2) the diameter of the main.

K. Install drains throughout the systems to permit complete drainage.

L. Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including the required service space for this equipment, unless the piping is serving this equipment

M. Install all valves, control valves, and piping specialties, including items furnished by others, as specified and/or detailed. Make connections to all equipment installed by others where that equipment requires the piping services indicated in this section.

3.02 WELDED PIPE JOINTS

A. Make all welded joints by fusion welding in accordance with ASME Codes, ANSI B31, and State Codes where applicable.

B. All pipe welding shall be completed by Qualified Welders in accordance with the Contractor's Procedure Specifications.

C. Contractor will ensure that these steps are followed where pipe sections will be joined by welding:

1. Cleaning – Welding surfaces will be clean and free of defects.

2. Alignment – Inside diameter of piping components will be aligned as accurately as possible. Internal misalignment shall not exceed 1/16".

3. Spacing – Pipe sections will be spaced to allow deposition of weld filler material through the entire weld joint thickness.

4. Girth Butt Welds:
   a. Girth butt welds shall be complete penetration welds.
   b. Concavity will not exceed 1/32"
   c. Under cuts will not exceed 1/32"
   d. As welded surfaces are permitted however surfaces will be free from coarse ripples, grooves, abrupt ridges and valleys.

D. Electrodes shall be Lincoln, or approved equal, with coating and diameter as recommended by the manufacturer for the type and thickness of work being done.

3.03 THREADED PIPE JOINTS

A. Use a Teflon based thread lubricant or Teflon tape when making joints; no hard setting pipe thread cement or caulking will be allowed.

3.04 MECHANICAL GROOVED PIPE CONNECTIONS

A. Use pipe factory grooved in accordance with the coupling manufacturer's specifications or field grooved pipe in accordance with the same specifications using specially designed tools available for the application.

B. Lubricate pipe and coupling gasket, align pipe, and secure joint in accordance with the coupling manufacturer's specifications.

C. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove.

D. Gaskets shall be verified as suitable for the intended service prior to installation. Gaskets shall be molded and produced by the coupling manufacturer.

E. The grooved coupling manufacturer’s factory trained representative shall provide on-site training for contractor’s field personnel in the use of grooving tools, application of groove, and installation of grooved joint products. The manufacturer’s representative shall periodically visit the jobsite and review installation. Contractor shall remove and replace any joints deemed improperly installed.

F. Support pipe as indicated in Section 23 05 29 of these specifications except as modified below. Support each horizontal pipe section at least once between couplings and whenever a change in direction of line flow takes place. Support vertical pipe at every other floor or every other pipe length, whichever is most frequent. Set the base of the riser or the base fitting on a pedestal or foundation.

G. Follow coupling manufacturer's installation recommendations if they are more stringent that the above requirements.

3.05 COPPER PIPE JOINTS

A. Remove all slivers and burrs remaining from the cutting operation by reaming and filing both pipe surfaces. Clean fitting and tube with emery cloth or sandpaper. Remove residue from the cleaning operation, apply flux, and assemble joint. Use 95-5 solder or brazing to secure joint as specified for the specific piping service.

B. Press-Connect Joints for Copper Tubing: Join copper tube and press-connect fittings with tools recommended by fitting manufacturer.

1. Pipe ends must be marked at the required location, using a manufacturer-supplied gauge, to ensure full insertion into the coupling or fitting during assembly.

2. Pipe shall be square cut, properly deburred, and cleaned.

3. Utilize press tool approved by fitting manufacturer.

C. Where mechanically formed tee fittings are allowed, form mechanically extracted collars in a continuous operation, consisting of drilling a pilot hole and drawing out the tube surface to form a collar having a height of not less than three times the thickness of the tube wall. Use an adjustable collaring device. Notch and dimple the branch tube. Braze the joint, applying heat properly so that pipe and tee do not distort; remove distorted connections.

3.06 WATER SYSTEMS

A. Run water mains level or pitch horizontal mains up 1 inch in 40 feet in the direction of flow. Install manual air vents at all high points where air may collect. If vent is not in an accessible location, extend air vent piping to the nearest code acceptable drain location with vent valve located at the drain.

B. Main branches and runouts to terminal equipment may be made at the top, top 45 degree, side, and/or bottom 45 degree of the main provided that there are drain valves suitably located for complete system drainage and manual air vents are located at all top and top 45 degree connections.

C. Use top or top 45 degree connection to main for upfeed risers and bottom 45 degree connection to main for downfeed risers.

D. Use a minimum of two elbows in each pipe line to a piece of terminal equipment to provide flexibility for expansion and contraction of the piping systems. Offset pipe connections at equipment to allow for service, such as removal of the terminal device.

E. Use eccentric fittings for changes in horizontal pipe sizes with the fittings installed for proper air venting. Concentric fittings may be used for changes in vertical pipe sizes.

3.07 MAKEUP WATER

A. Install where indicated and/or specified, including all valves, piping specialties and dielectric unions required for a functional system.

3.08 VENTS AND RELIEF VALVES

Install vent and relief valve discharge lines as indicated on the drawings, as detailed, and as specified for each specific valve or piping specialty item. In no event is a termination to occur less than six feet above a roof line.

3.09 UNIONS AND FLANGES

A. Install a union or flange, as required, at each automatic control valve and at each piping specialty or piece of equipment which may require removal for maintenance, repair, or replacement. Where a valve is located at a piece of equipment, locate the flange or union connection on the equipment side of the valve. Concealed unions or flanges are not acceptable.

3.10 GASKETS

A. Store horizontally in cool, dry location and protect from sunlight, water and chemicals. Inspect flange surfaces for warping, radial scoring or heavy tool marks. Inspect fasteners, nuts and washers for burrs or cracks. Replace defective materials.

B. Align flanges parallel and perpendicular with bolt holes centered without using excessive force. Center gasket in opening. Lubricate fastener threads, nuts and washers with lubricant formulated for application.

C. Draw flanges together evenly to avoid pinching gasket. Tighten fasteners in cross pattern sequence (12 – 6 o'clock, 3 – 9 o'clock, etc.), one pass by hand and four passes by torque wrench at 30% full torque, 60% full torque and two passes at full torque per ASME B16.5.

3.11 PIPING SYSTEM LEAK TESTS

A. Verify that the piping system being tested is fully connected to all components and that all equipment is properly installed, wired, and ready for operation. If required for the additional pressure load under test, provide temporary restraints at expansion joints or isolate them during the test. Verify that hangers can withstand any additional weight load that may be imposed by the test.

B. Provide all piping, fittings, blind flanges, and equipment to perform the testing.

C. Conduct pressure test with test medium of air or water unless specifically indicated. Minimum test time is indicated in the table below; additional time may be necessary to conduct an examination for leakage. Each test must be witnessed by the Owner or Owner's representative. If leaks are found, repair the area with new materials and repeat the test; caulking will not be acceptable.

D. Do not insulate pipe until it has been successfully tested.

E. For hydrostatic tests, use clean water and remove all air from the piping being tested by means of air vents or loosening of flanges/unions. Measure and record test pressure at the high point in the system.

F. For air tests, gradually increase the pressure to not more than one half of the test pressure; then increase the pressure in steps of approximately one-tenth of the test pressure until the required test pressure is reached. Examine all joints and connections with a soap bubble solution or equivalent method. The piping system exclusive of possible localized instances at pump or valve packing shall show no evidence of leaking. After testing is complete, slowly release the pressure in a safe manner.

System	Pressure	Medium	Duration
Heating Hot Water	100 psig	Water	8 hr
Chilled Water	100 psig	Water	8 hr

G. All pressure tests are to be documented on the form included in this specification.

3.12 HYDRONIC PIPING SYSTEM FLUSHING

A. All new chilled water and heating hot water system piping shall be flushed thoroughly before the systems are put in to operation. Subsequent to executing the chemical cleaning processes specified in Section 23 25 00 – HVAC WATER TREATMENT, and prior to adding scale and corrosion inhibitors, flush all piping and components with a clean source of water until the discharge from the system is clean. Discharge shall be from drains provided at all low points in the piping, ends of headers and as otherwise necessary to flush and drain the entire system.

B. Project specific procedures shall be established prior to flushing. Before beginning flushing operations, submit proposed flushing procedures to the Owner's Project Representative for review and approval. Provide sufficient notice to the Owner to allow the flushing operations to be observed.

C. A clean water source shall be tapped into the system downstream of the main circulation pump(s). Contractor shall identify proposed clean water source along with the method/location of drain discharge and review with the Owner and A/E prior to installing flushing connections to water source and drain outlets. Provide code required temporary backflow prevention for the clean water source if needed. Provide all temporary taps, valves, piping, bypasses and hoses as needed to accomplish flushing procedures.

D. Isolate all coils while flushing risers and mains. Flush the mains on each floor individually, starting at the top of the building and working down towards the basement level. After risers and mains have been flushed clean, individually open the drain valves in each branch circuit to discharge any debris that may have accumulated in the branch piping.

E. As directed by Owner, the Contractor will be required to open drain valves at selected locations in the system to verify the effectiveness of flushing procedures. If sediment or debris is identified in the system, it will be flushed again and reinspected at no expense to the Owner.

F. After flushing operations are complete, drain and/or blow out any residual water, clean and replace all strainers, and add scale and corrosion inhibitors as specified in Section 23 25 00. Leave flushing connections/valves in place and cap.

G. All flushing procedures shall be documented by completing and submitting the report form included at the end of this Section.

3.13 INITIAL FILL AND VENT

A. Fill hydronic systems with appropriate working fluids as specified. All system fluids shall be chemically treated as specified in Section 23 25 00 – HVAC WATER TREATMENT.

B. For closed piping systems, all air trapped at high points shall be relieved through the manual air vents prior to notifying T&B Contractor that the systems are ready to be tested and balanced.

3.14 PIPING SYSTEM TEST REPORT

Date Submitted: _____

Project Name: _____

Location: _____ **Project No:** _____

Contractor: _____

- ❑ HVAC
- ❑ Refrigeration
- ❑ Controls
- ❑ Power Plant
- ❑ Plumbing
- ❑ Sprinkler

Test Medium: ❑ Air ❑ Water ❑ Other
Test performed per specification section No.
Specified Test Duration Hours **Specified Test Pressure** psig
System Identification: _____

Describe Location: _____

_____

Test Date: _____

Start Test Time: _____ **Initial Pressure:** _____ psig

Stop Test Time: _____ **Final Pressure:** _____ psig

Tested By: _____ **Witnessed By:** _____

Title: _____ **Title:** _____

Signed: _____ **Signed:** _____

Date: _____ **Date:** _____

Comments: _____

_____

3.15 PIPING SYSTEM FLUSH REPORT

Date Submitted: _____

Project Name: _____

Location: _____ **Project No:** _____

Contractor: _____

System Identification (check one):

- ❑ Heating Hot Water
- ❑ Chilled Water
- ❑ Heat Pump Water
- ❑ Heat Reclaim
- ❑ Process Chilled Water
- ❑ Other

Describe Procedure: _____

_____

_____

Flush Date: _____ **Start Time:** _____ **Stop Time:** _____

Pressure of Water Source: _____ psig

Describe water source and method of connection to source: _____

_____

Flushed By: _____ **Witnessed By:** _____

Title: _____ **Title:** _____

Company: _____ **Company:** _____

Signed: _____ **Signed:** _____

Date: _____ **Date:** _____

Describe results: _____

_____

_____

END OF SECTION

SECTION 23 21 23
HYDRONIC PUMPS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Scope. This section includes specifications for water pumps used for HVAC applications. Included are the following topics:

B. PART 1 - GENERAL
   1. Scope
   2. Related Work
   3. Reference
   4. Quality Assurance
   5. Submittals
   6. Operation and Maintenance Data
   7. Design Criteria

C. PART 2 - Products
   1. Variable Speed Packaged Pumping System
   2. Vertical Multi-Stage Pumps
   3. Small In-Line Pumps
   4. Wet Rotor Circulators (ECM)

D. PART 3 - EXECUTION
   1. Installation
   2. Packaged Pumping System – Integral Sequence of Operation (For Reference Only. See 23 09 93)
   3. Packaged Pumping System Construction
   4. Packaged Pumping System Factory Testing

1.02 RELATED WORK

A. Section 23 05 13 - Common Motor Requirements for HVAC Equipment

1.03 REFERENCE

A. Applicable provisions of Division 1 govern work under this section.

1.04 QUALITY ASSURANCE

A. Refer to Division 1, General Conditions, Equals and Substitutions.

1.05 SUBMITTALS

A. Refer to Division 1, General Conditions, Submittals.

B. Include data concerning dimensions, capacities, materials of construction, ratings, weights, pump curves with net positive suction head requirements, manufacturer's installation requirements, manufacturer's performance limitations, and appropriate identification.

C. Pump curves shall identify design point of operation.

1.06 OPERATION AND MAINTENANCE DATA

A. All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

1.07 DESIGN CRITERIA

A. Pump sizes, capacities, pressures and operating characteristics shall be as scheduled.

B. Pumps shall meet or exceed operating efficiencies scheduled.

C. Provide all pumps with motors, impellers, drive assemblies, bearings, coupling guard, and other accessories specified. Statically and dynamically balance all rotating parts. Provide flanged connections on all pumps unless specified otherwise. Service or repair of base mounted pumps shall not require breaking piping connections or removal of motor.

D. Where a pump is specified for parallel operation, the scheduled conditions are for that pump with both pumps operating; i.e., total system flow rate is twice that scheduled for a single pump. When only one of the parallel pumps is operating, the operating point of that pump must fall within the manufacturer's recommended operating range.

E. Provide pump with a motor sized for non-overloading over the entire pump curve. Motors to be 1750 rpm unless specified otherwise.

F. Furnish each pump and motor with a nameplate giving the manufacturer's name, serial number of pump, capacity in GPM and head in feet at design condition, horsepower, voltage, frequency, speed and full load current.

G. Test all pumps, clean and paint before shipment. The manufacturer shall certify all pump ratings.

H. All pumps to operate without excessive noise or vibration.

I. After completion of balancing, provide replacement of impellers, or trim impellers to provide specified flow at actual pumping head, as installed.

J. Furnish one spare seal and casing gasket for each pump to Owner.

K. Provide bearing protection grounding rings for motors used on variable frequency drives as specified in Section 23 05 13.

PART 2 - PRODUCTS

2.01 VARIABLE SPEED PACKAGED PUMPING SYSTEM

A. Furnish and install a pre-fabricated and tested variable speed packaged pumping system to maintain a constant or variable differential pressure.

B. The packaged pump system shall be a standard product of a single pump manufacturer. The entire pump system including pumps and pump logic controller, shall be designed, built, and tested by the same manufacturer.

C. The complete packaged water booster pump system shall be certified and listed by UL (Category QCZJ – Packaged Pumping Systems) for conformance to U.S. Standards.

D. Pumps:
   1. The pumps shall be of the in-line vertical multi-stage design.

   2. The head-capacity curve shall have a steady rise in head from maximum to minimum flow within the preferred operating region. The shut-off head shall be a minimum of 20% higher than the head at the best efficiency point.

   3. Large (CR32 to CR155) In-line Vertical Multi-Stage Pumps (Nominal flows from 130 to 1070 gallons per minute) shall have the following features:

      a. The pump impellers shall be secured directly to the smooth pump shaft by means of a split cone and nut design.

      b. The suction/discharge base shall have ANSI Class 125 or Class 250 flange connections in a slip ring (rotating flange) design as indicated in the drawings or pump schedule.

      c. Pump Construction.

         Suction/discharge base, pump head: Ductile Iron (ASTM 70-50-05)
         Shaft couplings, flange rings: Ductile Iron (ASTM 70-50-05)
         Shaft 431: Stainless Steel
         Motor Stool: Cast Iron (ASTM Class 30)
         Impellers, diffuser chambers, outer sleeve: 304 Stainless Steel
         Impeller wear rings: 304 Stainless Steel
         Intermediate Bearing Journals: Silicon Carbide
         Intermediate Chamber Bearings: Leadless Tin Bronze
         Chamber Bushings: Graphite Filled PTFE
         O-rings: EPDM

      d. The shaft seal shall be a balanced O-ring cartridge type with the following features:

         Collar, Drivers, Spring: 316 Stainless Steel
         Shaft Sleeve, Gland Plate: 316 Stainless Steel
         Stationary Ring: Graphite embedded Silicon Carbide
         Rotating Ring: Graphite embedded Silicon Carbide
         O-rings: EPDM

e. Shaft seal replacement shall be possible without removal of any pump components other than the coupling guard, motor couplings, motor and seal cover. The entire cartridge shaft seal shall be removable as a one-piece component.

f. Pumps with motors equal to or larger than 15 hp (fifteen horsepower) shall have adequate space within the motor stool so that shaft seal replacement is possible without motor removal.

E. Variable Frequency Drive - Panel Mount (For Reference Only. Refer to 23 05 14):

1. The VFD shall convert incoming fixed frequency single-phase or three-phase AC power into a variable frequency and voltage for controlling the speed of three-phase AC induction fmotors. The VFD shall be a six-pulse input design, and the input voltage rectifier shall employ a full wave diode bridge; VFD's utilizing controlled SCR rectifiers shall not be acceptable. The output waveform shall closely approximate a sine wave. The VFD shall be of a PWM output design utilizing current IGBT inverter technology and voltage vector control of the output PWM waveform.

2. The VFD shall include a full-wave diode bridge rectifier and maintain a displacement power factor of near unity regardless of speed and load.

3. The VFD shall produce an output waveform capable of handling maximum motor cable distances of up to 1,000 ft. (unshielded) without tripping or derating.

4. The VFD shall utilize an output voltage-vector switching algorithm, or equivalent, in both variable and constant torque modes. VFD's that utilize Sine-Coded PWM or Look-up tables shall not be acceptable.

5. VFD shall automatically boost power factor at lower speeds.

6. The VFD shall be able to provide its full rated output current continuously at 110% of rated current for 60 seconds.

7. An empty pipe fill mode shall be available to fill an empty pipe in a short period of time, and then revert to the PID controller for stable operation.

8. Switching of the input power to the VFD shall be possible without interlocks or damage to the VFD at a minimum interval of 2 minutes.

9. Switching of power on the output side between the VFD and the motor shall be possible with no limitation or damage to the VFD and shall require no additional interlocks.

10. The VFD shall have temperature controlled cooling fans for quiet operation, minimized internal losses, and greatly increased fan life.

11. VFD shall provide full torque to the motor given input voltage fluctuations of up to +10% to -15% of the rated input voltage.

12. The VFD shall provide internal DC link reactors to minimize power line harmonics and to provide near unity power factor. VFD's without a DC link reactor shall provide a 5% impedance line side reactor.

13. VFD to be provided with the following protective features.

    VFD shall have input surge protection utilizing MOV's, spark gaps, and Zener diodes to withstand surges of 2.3 times line voltage for 1.3 msec.

    VFD shall include circuitry to detect phase imbalance and phase loss on the input side of the VFD.

    VFD shall include current sensors on all three-output phases to detect and report phase loss to the motor. The VFD will identify which of the output phases is low or lost.

    VFD shall auto-derate the output voltage and frequency to the motor in the presence of sustained ambient temperatures higher than the normal operating range, so as not to trip on an inverter temperature fault. The use of this feature shall be user- selectable and a warning will be exported during the event. Function shall reduce switching frequency before reducing motor speed.

    VFD shall auto-derate the output frequency by limiting the output current before allowing the VFD to trip on overload. Speed can be reduced, but not stopped.

    The VFD shall have the option of an integral RFI filter. VFD enclosures shall be made of metal to minimize RFI and provide immunity.

14. VFD to be provided with the following interface features:

    VFD shall provide an alphanumeric backlit display keypad, which may be remotely mounted using standard 9-pin cable. VFD may be operated with keypad disconnected or removed entirely. Keypad may be disconnected during normal operation without the need to stop the motor or disconnect power to the VFD.

    VFD shall display all faults in plain text; VFD's, which can display only fault codes, are not acceptable.

    All VFD's shall be of the same series, and shall utilize a common control card and LCP (keypad/display unit) throughout the rating range. The control cards and keypads shall be interchangeable through the entire range of drives used on the project.

    VFD keypad shall be capable of storing drive parameter values in non-volatile RAM uploaded to it from the VFD, and shall be capable of downloading stored values to the VFD to facilitate programming of multiple drives in similar applications, or as a means of backing up the programmed parameters.

    A red FAULT light, a yellow WARNING light and a green POWER-ON light shall be provided. These indications shall be visible both on the keypad and on the VFD when the keypad is removed.

    A start guide menu with factory preset typical parameters shall be provided on the VFD to facilitate commissioning.

VFD shall provide full galvanic isolation with suitable potential separation from the power sources (control, signal, and power circuitry within the drive) to ensure compliance with PELV requirements and to protect PLC's and other connected equipment from power surges and spikes.

All inputs and outputs shall be optically isolated. Isolation boards between the VFD and external control devices shall not be required.

There shall be three programmable digital inputs for interfacing with the systems external control and safety interlock circuitry. An additional digital input is preprogrammed for start/stop.

The VFD shall have two analog signal inputs. One dedicated for sensor input and one for external set point input.

One programmable analog output shall be provided for indication of a drive status.

The VFD shall provide two user programmable relays with selectable functions. Two form 'C' 230VAC/2A rated dry contact relay outputs shall be provided.

The VFD shall store in memory the last 5 faults with time stamp and recorded data.

The VFD shall be equipped with a standard RS-485 serial communications port for communication to the multi-pump controller. The bus communication protocol for the VFD shall be the same as the controller protocol.

VFD service conditions:

Ambient temperature operating range, -10 to 45ºC (14 to 113ºF) Continuous; 50ºC max temperature Intermittent.

0 to 95% relative humidity, non-condensing.

Elevation to 1000 meters (3,300 feet) without derating.

VFD's shall be rated for line voltage of 525 to 690VAC, 380 to 480VAC, or 200 to 240VAC; with +10% to -15% variations. Line frequency variation of ± 2% shall be acceptable.

No side clearance shall be required for cooling of the units.

F. Fixed Speed Motors:

1. Fixed Speed Motors are to be provided with the following basic features:

Designed for continuous duty operation, NEMA design B with a 1.15 service factor.

Totally Enclosed Fan Cooled or Open Drip Proof with Class F insulation.

Nameplate shall have, as a minimum, all information as described in NEMA Standard MG 1- 20.40.1.

Motors shall have a NEMA C-Flange for vertical mounting.

Drive end bearings shall be adequately sized so that the minimum L10 bearing life is 17,500 hours at the minimum allowable continuous flow rate for the pump.

G. Pump System Controller:

1. The pump system controller shall be a standard product developed and supported by the pump manufacturer.

2. The controller shall be microprocessor based capable of having software changes and updates via personal computer (notebook). The controller user interface shall have a color display with a minimum screen size of 3-1/2" x 4-5/8" for easy viewing of system status parameters and for field programming. The display shall have a back light with contrast adjustment. Password protection of system settings shall be standard.

3. Galvanic Isolation: The controller shall provide internal galvanic isolation to all digital and analog inputs as well as all fieldbus connections.

4. Backup Battery: The controller shall have the ability to be connected to a backup battery to supply power to the controller during periods of loss of supply power.

5. Home Status Screen: The controller shall display the following as status readings from a single display on the controller (this display shall be the default):

    - Current value of the control parameter, (differential pressure)
    - Most recent existing alarm (if any)
    - System status with current operating mode
    - Status of each pump with current operating mode and rotational speed as a percentage (%)
    - Actual flow-rate
    - One user defined measured parameter (i.e. power consumption)

6. Inputs/Outputs: The controller shall have as a minimum the following hardware inputs and outputs:

    - Three analog inputs (4-20mA or 0-10VDC)
    - Three digital inputs
    - Two digital outputs
    - Ethernet connection (built-in web server)
    - Field Service connection to PC for advanced programming, software and/or firmware upgrades and data logging

7. Pump system programming: As a minimum, the following parameters shall be available and/or field adjustable:

    - Sensor Settings: Suction, Discharge, Differential Pressure [analog supply/range]
    - PI Controller: Proportional gain (Kp) and Integral time (Ti)
    - Low suction: Pressure/level shutdown via digital contact
    - Limit Exceeding function: For low system, low suction warnings and shut down [via analog input]
    - Flow meter settings (if used, analog signal)

8. Pump Curve Data: The actual pump performance curves (5^{th} order polynomial) shall be loaded (software) into the pump system controller. Pump curve data shall be used for the following:

    a. Display and data logging of calculated flow rate
    b. Variable pressure control (quadratic or proportional)
    c. Pump outside of duty range protection
    d. Sequence pumps based on efficiency

9. Variable Pressure Control: The controller shall have variable pressure control to compensate for pipe friction loss by decreasing the pressure set-point at lower flow-rates and increasing the pressure set-point at higher flow-rates by using the actual flow rate or calculated flow rate. Variable pressure control that uses power consumption and speed only shall not be considered equal to variable pressure control that uses actual differential pressure measurement along with pump power and speed.

10. Multi-Sensor: The controller shall be able to control using up to six differential pressure (DP) sensors (zones). Each zone shall have a programmable maximum and minimum DP range. The controller shall be capable of an energy optimal mode where pump speed/energy shall be reduced until any of the zones reach the minimum DP setting.

11. Pulse flow meter: The system controller shall be able to receive pulse readings from a digital pulse meter and log/display accumulated flow.

12. DP Subtraction: The system controller shall be able to control off subtraction of two pressure or temperature sensors for differential pressure or differential temperature control.

13. Programmable Setpoints: The system controller shall be able to accept up to seven programmable set-points via a digital input, (additional input/output module may be required).

14. Setpoint Influence: The system pressure set-point shall be capable of being automatically adjusted by using an external set-point influence. The set-point influence function enables the user to adjust the control parameter (typically differential pressure) by measuring an additional parameter. (Example: Lower the system differential pressure set-point based on a flow or outdoor temperature measurement).

15. Remote Control: The controller shall be capable of receiving a remote analog set-point (4-20mA or 0-10 VDC) as well as a remote system on/off (digital) signal.

16. Setpoint Ramp: The controller shall be able to adjust the ramp time of a change in set point (increase and decrease).

17. Warnings and Alarms: The pump system controller shall store up to 24 warnings and alarms in memory. The time, date and duration of each alarm shall be recorded. A potential-free relay shall be provided for alarm notification to the building management system. The controller shall display the following alarm conditions:

Individual pump failure	Check valve failure
VFD trip/failure	Loss of sensor signal (4-20 mA)
Loss of remote set-point signal (4-20mA)	External Fault
Pump outside of duty range	Limit 1 and 2 exceeded*

*The controller shall be capable of monitoring two analog signals (i.e. suction pressure and discharge pressure) for additional pump or system protection.

18. Built-in data log: The controller shall have built-in data logging capability. Logged values shall be graphically displayed on the controller and shall be downloadable to a notebook/pc as a delimited text file. A minimum of 7200 samples per logged value shall be available for the following parameters:

    - Estimated flow-rate (or actual flow if flow sensor is connected)
    - Speed of pumps
    - Process Value/sensor feedback (usually differential pressure)
    - Power consumption
    - Controlling parameter (setpoint)
    - Inlet pressure (when remote differential pressure is the primary sensor)

19. Redundant Primary Sensor: The controller shall be capable of receiving a redundant sensor input to function as a backup to the primary sensor.

20. Secondary Sensor: Upon loss of signal from the remote sensor, the controller shall be capable of reverting control to the pump system mounted sensors with a programmable setpoint. The pumps shall maintain a constant, proportional or quadratic pressure across the system until the remote setpoint signal is restored.

21. Pump Test: The controller shall have a pump “Test Run” feature such that pumps are switched on during periods of inactivity (system is switched to the “off” position but with electricity supply still connected). The inoperative pumps shall be switched on for a period of three to four seconds every 24 hours, 48 hours or once per week and at a programmable time of day.

22. Reduced Operation: During backup generator operation, the controller shall be capable of reducing the power consumed by the pump system by either limiting the number of pumps in operation or by limiting the amount of power consumption (kW). The controller shall receive a digital input indicating backup generator operation.

23. Power and Energy Consumption: The controller shall be capable of displaying instantaneous power consumption (Watts or kilowatts) and cumulative energy consumption (kilowatt-hours).

24. Specific Energy: When a flow sensor is connected, the controller shall be capable of displaying instantaneous specific energy in Watt-hours per gallon (Wh/gal) or Watt-hours per 1,000 gallons (Wh/kgal).

25. Built-in Ethernet: The controller shall have an Ethernet connection with a built-in web server allowing for connection to a building computer network with read/write access to the controller via a web browser.

26. Service Contact Information: The controller shall have a programmable Service Contact Field that can be populated with service contact information including: contact name, address, phone number(s) and website.

H. Control Panel:

1. SCCR: The complete control panel assembly shall have a Short Circuit Current Rating of 100 kA.

2. BMS Integration: Standard shall be BACnet MS/TP.

3. The pump system controller shall be mounted in a UL Type 3R rated enclosure. A self-certified NEMA enclosure rating shall not be considered equal. The entire UL Type 3R control panel shall be UL 508 listed as an assembly. The control panel shall include a main disconnect, circuit breakers for each pump and the control circuit and control relays for alarm functions. The control panel shall include the following:

80 B System Fault Audible Alarm with push button to silence
Emergency/Normal Operation Switches (Control bypass)
Individual Service Disconnect Switches (accessible outside of panel)
Pump Run Lights
System Fault Light
Surge Arrestor

2.02 VERTICAL MULT-STAGE PUMPS

A. MANUFACTURERS: Armstrong, Bell and Gossett, Taco, Grundfos or approved equal.

B. TYPE: Pumps shall be vertical multistage inline type with 1 or more impellers (stages) with cast iron base with connections shall be ANSI Class 150, 250 or 300 flanges OR threaded NPT.

C. SHAFT & IMPELLERS: Stainless steel.

D. SEALS: Furnish cartridge type mechanical shaft seals with silicon carbide

2.03 SMALL IN-LINE PUMPS

A. Manufacturer: Armstrong, Bell and Gossett, Taco, Grundfos, or approved equal.

B. Type: Horizontal shaft, single stage, direct connected with permanently oil lubricated bearings or wet rotor pump for in-line mounting, for 125 psi maximum working pressure, 230°F maximum water temperature.

C. Casing: Cast iron, stainless steel or bronze with flanged pump connections.

D. Impeller, Shaft, Rotor: Stainless Steel or Non-Metallic.

E. Seal: For dry rotor pumps on water systems, mechanical with metal Impregnated carbon (graphite) and ceramic. For glycol systems, use tungsten or silicon carbide.

2.04 WET ROTOR CIRULATORS (ECM)

A. MANUFACTURER: Armstrong, Bell and Gossett, Taco, Grundfos or approved equal.

B. TYPE: Horizontal shaft, single stage, close coupled wet rotor pump for in-line mounting with EC (Permanent Magnet) motor and integrated speed controller.

C. CASING: Cast iron or stainless steel.

D. IMPELLER, SHAFT, ROTOR: Stainless Steel or Non-Metallic.

E. CONTROL MODES:

1. AUTOADAPT – During operation, the pump automatically reduces the factory-set setpoint and adjusts it to the actual system characteristic. Manual setting of the setpoint is not possible.

2. FLOWLIMIT - It shall be possible for the user to select a maximum flow that the pump shall not exceed in order to eliminate the need for additional throttling valves. The pump shall operate per selected control mode but will limit speed to not exceed the user specified flow limit.

3. FLOWADAPT – The pump shall operate in the AUTOADAPT control mode with FLOWLIMIT enabled.

4. Proportional Pressure – The head delivered shall be reduced from a manual setpoint linearly in accordance with decrease in flow demand in the system.

5. Constant Pressure – A manual set, constant head is maintained, irrespective of flow up to the maximum speed of the pump.

6. Constant Curve – The pump runs as an uncontrolled pump by the means of a set of pump curves. The pump curve adjustable between maximum and minimum from the control panel or through a wireless remote control.

7. Constant Temperature – the pump shall adjust speed to maintain a constant media temperature in the flow pipe in which the pump is installed.

8. Constant Differential Temperature - the pump shall adjust speed to maintain a constant temperature drop between the flow pipe in which the pump is installed and a user installed temperature sensor.

9. Alternating Operation – Two single head pumps or two heads of a dual head pump shall communicate wirelessly to one another. In alternating operation, only one pump shall operate at a time. The operation shall alternate based on time or energy to ensure even run time of both pumps. If a pump stops due to fault the other pump shall take over automatically.

10. Back-Up Operation – Two single head pumps or two heads of a dual head pump shall communicate wirelessly to one another. In Back-Up operation one pump shall operate continuously. If the duty pump stops due to fault, the back-up pump shall take over automatically.

11. Cascade Operation - Two single head pumps or two heads of a dual head pump shall communicate wirelessly to one another. Two pumps shall operate together in constant pressure control. The pump controller shall determine when to operate a single pump or both pumps to meet demands. While both pumps operate they shall run at the same speed.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install all pumps in strict accordance with manufacturer's instructions. Access/service space around pumps shall not be less than minimum space recommended by pump manufacturer.

B. Support piping adjacent to pump such that no weight is carried on pump casings.

C. Decrease from line size at pump connections with suction diffusers where specified, long radius reducing elbows or concentric reducers/increasers in the vertical piping, and eccentric reducers/increasers for horizontal piping. Install eccentric reducers/increasers with the top of the pipe level.

D. All valves and piping specialties must be full line size as indicated on the drawings.

E. Lubricate pumps before startup.

F. Install a full line size spring loaded check valve and balancing valve in the pump discharge piping. At contractor's option, combination shut-off, check, balancing valve may be substituted instead of separate valves. Reference section 23 05 23.

3.02 PACKAGED PUMPING SYSTEM – INTEGRAL SEQUENCE OF OPERATION (FOR REFERENCE ONLY. SEE 23 09 93):

A. The system controller shall operate equal capacity variable speed pumps to maintain a constant differential pressure (sensor feedback from remote DP sensor) or variable differential pressure setpoint [sensor feedback from local mounted sensor(s)]. The system controller shall receive an analog signal [4-20mA] from the factory installed pressure transducers on the discharge and suction manifolds, indicating the actual system pressure and inlet pressure. The controller shall be capable of controlling off the subtraction of discharge minus suction pressure for differential pressure across the manifolds.

Standard Cascade Control (Pumping Efficiency Based):
The pump system controller shall adjust pump speed as necessary to maintain system set-point pressure as flow demand changes. Utilizing the pump curve information (5^{th} order polynomial) combined with suction and discharge pressure measurements, the pump system controller shall stage on additional pumps when pump hydraulic efficiency is determined to be higher with additional pumps in operation. Exception: When the flow and head are outside the operating pumps allowable operating range, the controller shall switch on an additional pump, distributing flow and allowing all pumps to operate within their allowable operating range. When the system pressure is equal to the system set-point, all pumps in operation shall reach equal operating speeds.

B. The system controller shall be capable of switching pumps on and off to satisfy system demand without the use of flow sensors, flow switches, motor current monitors or temperature measuring devices.

C. All pumps in the system shall alternate automatically based on demand, time and fault. If flow demand is continuous (no flow shut-down does not occur), the system controller shall have the capability to alternate the pumps every 24 hours, every 48 hours or once per week. The interval and actual time of the pump change-over shall be field adjustable

3.03 PACKAGED PUMPING SYSETM CONSTRUCTION

A. Suction and discharge manifold construction shall be in way that ensures minimal pressure drops, and minimizes potential for corrosion. Manifold construction that includes sharp edge transitions or interconnecting piping protruding into the manifold is not acceptable.

B. The suction and discharge manifolds material shall be 316 stainless steel. Manifold connection sizes shall be as follows:

4 inch through 8 inch: ANSI Class 150 rotating flanges.

C. Isolation Valves: Pump Isolation valves shall be provided on the suction and discharge of each pump. Isolation valve sizes 3 inch and larger shall be a full lug style butterfly valve. The valve disk shall be of stainless steel. The valve seat material shall be EPDM and the body shall be cast iron, coated internally and externally with fusion-bonded epoxy.

D. Check Valves: A spring-loaded non-slam type check valve shall be installed on the discharge of each pump. The valve shall be a wafer style type fitted between two flanges. The head loss through the check valve shall not exceed 5 psi at the pump design capacity. Check valves 2” and larger shall have a body material of stainless steel or epoxy coated iron (fusion bonded) with an EPDM or NBR resilient seat. Spring material shall be stainless steel. Disk shall be of stainless steel or leadless bronze.

E. Pressure Transducers: Pressure transducers shall be factory installed on the suction and discharge manifolds. Pressure transducers shall be made of 316 stainless steel. Transducer accuracy shall be +/- 1.0% full scale with hysteresis and repeatability of no greater than 0.1% full scale. The output signal shall be 4-20 mA with a supply voltage range of 9-32 VDC.

F. Pressure Gauges: A bourdon tube pressure gauge, 2.5 inch diameter, shall be placed on the suction and discharge manifolds. The gauge shall be liquid filled and have copper alloy internal parts in a stainless steel case. Gauge accuracy shall be 2/1/2 %. The gauge shall be capable of a pressure of 30% above its maximum span without requiring recalibration.

G. Base Frame: The base frame shall be constructed of corrosion resistant 304 stainless steel for systems with multistage pumps with 4” connections and smaller (CR3 to CR64).

H. Control Panel Mounting: The control panel shall be mounted on a 304 stainless steel fabricated control cabinet stand attached to the system skid.

3.04 PACKAGED PUMPING SYSTEM FACTORY TESTING

A. The tester used for testing the pump system shall be constructed and calibrated according to the requirements of hydraulic test standard ISO 9906.

B. The entire pump station shall as a minimum be factory tested for functionality and documented results of functionality test supplied with pump station.

Functionality testing shall include the following parameters:

1. Complete System Hydrostatic Test – 1.5 times the nameplate maximum pressure
2. Water Shortage Test
3. Two-Point Setpoint Performance Test.

C. Water used for testing shall be treated with three different filtration systems to ensure only clean water is used for testing pump station.
1. 25 micron mechanical filter – removes solid parts from water
2. Activated carbon filter – keeps water clear and eliminates odor
3. Ultraviolet light system – kills all bacteria growth

D. Optional performance testing shall include:
1. Witnessed Verified Performance Test

END OF SECTION

SECTION 23 25 00
HVAC WATER TREATMENT

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Scope. This section includes specifications for chemical treatment of all water systems. Included are the following topics:

B. PART 1 - GENERAL
   1. Scope
   2. Reference
   3. Related Work
   4. Quality Assurance
   5. Submittals
   6. Operation and Maintenance Data
   7. Design Criteria
   8. Maintenance Service

C. PART 2 - Products
   1. Manufacturers
   2. System Cleaner
   3. System Inhibitor
   4. Closed Water System Treatment
   5. Treatment Equipment

D. PART 3 - EXECUTION
   1. Preparation
   2. Cleaning Sequence
   3. Closed Water Systems
   4. Pipe Cleaning and Treatment Report

1.02 REFERENCE

A. Applicable provisions of Division 1 shall govern work under this Section.

1.03 RELATED WORK

A. Section 23 05 15 - Piping Specialties

1.04 QUALITY ASSURANCE

A. Refer to Division 1, General Conditions, Equals and Substitutions.

1.05 SUBMITTALS

A. Refer to Division 1, General Conditions, Submittals.

B. Required for all equipment and chemicals specified including data concerning dimensions, capacities, materials of construction, weights, operating sequence, composite wiring diagrams and appropriate identification. Chemical data to include the description of the chemical, its composition, its function, and the associated material safety data sheet.

1.06 OPERATION AND MAINTENANCE DATA

A. Provide for the services of the manufacturer's trained representative to approve the installation and instruct the Owner in the operation of each system.

B. Include data on chemical feed pumps, agitators, and other equipment including spare parts lists, procedures, and treatment programs. Include step by step instructions on test procedures including target concentrations.

1.07 DESIGN CRITERIA

A. Recommend a periodic test procedure and chemical treatment program for each system.

B. Treat the following systems:
- Chilled water
- Hot water

C. Provide the initial chemical treatment for all systems based on a complete system fluid analysis prior to the equipment installation. The initial chemical treatment supply of chemicals for each system shall be adequate for the start-up and testing period, for the time the systems are being operated by the Contractor for temporary heating and cooling, and for one year after start-up of the system.

D. The chemicals used in the condenser water treatment system shall use only liquid chemicals and shall contain no phosphates or chromates.

E. Provide electrical devices, motors, wiring and conduit in accordance with the applicable sections of the Electrical Specifications.

1.08 MAINTENANCE SERVICE

A. Furnish service and maintenance of treatment systems for one year from date of substantial completion.

B. Provide monthly technical service visits to perform field inspections and make water analysis on site. Detail findings in writing on proper practices, chemical treating requirements, and corrective actions needed. Submit two copies of field service report after each visit.

C. Provide laboratory and technical assistance services for the warranty period.

D. Include two hour training course for operating personnel, instructing them on installation, care, maintenance, testing, and operation of the treatment systems. Arrange course at startup of systems.

E. Provide site inspection of equipment during scheduled shutdown to evaluate success of the treatment program. Make recommendations in writing based on these inspections.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Betz Entac, Dearborn Div. - W. R. Grace & Co., Fremont Industries, Mitco Water Labs, Mogul Corporation, Nalco Chemical Co., Rhomar Water Management, Western Water Management, or approved equal.

2.02 SYSTEM CLEANER

A. Blend of organic alkaline penetrants, emulsifiers, surfactants and corrosion inhibitors that remove grease and petroleum products from the interior of piping systems. Cleaners that contain trisodium phosphate are specifically not acceptable.

2.03 SYSTEM INHIBITOR

A. Scale and corrosion inhibitor consisting of boron nitrite, benzol thiazol, benzotriazole, mercapto-benzo-thiazole, and tolyltrizole silicates.

2.04 CLOSED WATER SYSTEM TREATMENT

A. Sequestering agent to reduce deposits and adjust pH: polyphosphate.

B. Corrosion inhibitors: boron-nitrite, sodium nitrite and borax, sodium totyltriazole, low molecular weight polymers, phosphonates, sodium molybdate, or sulphites.

C. Conductivity enhancers: phosphates or phosphonates.

2.05 TREATMENT EQUIPMENT

A. Bypass Feeder: 5 gallon minimum capacity, 125 psig working pressure, either a screw type cover or a valved funnel opening to feed chemical into the system, prime coat of paint.

B. Water Meter: Displacement type cold water meter with sealed, tamper-proof magnetic drive, bronze housing, 125 psig minimum working pressure, impulse contact register when required by the sequence, single pole double throw dry contact switch. Meters must be capable of being used with remote readout heads and capable of being sealed to prevent tampering.

PART 3 - EXECUTION

3.01 PREPARATION

A. Prior to cleaning, verify that systems are operational, filled, started, and vented. Use water meter to record capacity in each system.

B. Place terminal control valves in the full-open position.

3.02 CLEANING SEQUENCE

A. General:

1. Systems are to be cleaned before they are used for any purpose except conduct pressure test before cleaning. Add cleaner to closed systems at concentrations as recommended by the manufacturer. Remove water filter elements from the system before starting circulation. For steam systems, fill boilers only, using the water and cleaner solution.

2. Use neutralizer agents on recommendation of the system cleaner supplier and approval of the Architect/Engineer.

3. Flush open systems with clean water for one hour minimum. Drain completely and refill.

4. Remove, clean, and replace strainer screens.

5. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.

6. Use the form included in this specification to document system cleaning, flushing, and proper startup.

B. Hot Water Heating Systems: Add cleaner to the system water until the M alkalinity value is 250 above that of the initial fill water. Verify the M alkalinity level before and after the addition of the cleaner by means of chemical tests that are observed by the Owner's construction representative; include results of all tests in the Operating and Maintenance manuals. Apply heat while circulating, slowly raising temperature to 160°F and maintain for 12 hours minimum; vent all high points to assure 100% system circulation. Remove heat and circulate to 100°F or less; drain system as quickly as possible and refill with clean water. Circulate for 6 hours at design temperature, vent air at all high points, then drain. Refill with clean water and repeat until the system cleaner is removed and the M alkalinity level returns to normal. Remove and clean all strainers. Re-vent the system and install clean filter elements in water filters. Treat with scale and corrosion inhibitors before using the system for building heating.

C. Chilled Water Systems: Add cleaner to the system water until the M alkalinity value is 250 above that of the initial fill water. Verify the M alkalinity level before and after the addition of the cleaner by means of chemical tests that are observed by the Owner's construction representative; include results of all tests in the Operating and Maintenance manuals. Circulate for 48 hours, then drain system as quickly as possible. Refill with clean water, circulate for 24 hours, then drain. Refill with clean water and repeat until system cleaner is removed and the M alkalinity level returns to normal. Remove and clean all strainers. Re-vent the system and install clean filter elements in water filters. Treat with scale and corrosion inhibitors before using the system for building cooling.

3.03 CLOSED WATER SYSTEMS

A. Install a separate bypass type feeder at the pumps for each closed hot water heating and chilled water cooling system. Provide a separate set of supply and return lines from each pump in the system and install ball valves in each of these lines. Locate the system connection that supplies the feeder upstream of the discharge shutoff valve for the pump. Locate the system connection that returns treatment back to the system at a convenient point downstream of the pump discharge shutoff valve. Provide a drain valve at the bottom of the feeder.

B. Install a water meter upstream of the pressure reducing valve in the makeup line to each closed system. Locate the meter on the domestic water side of the pressure reducing valve and in such a manner that the meter can be easily read.

3.04 PIPE CLEANING AND TREATMENT REPORT

Project Number: _____

Date Submitted: _____

Project Name: _____

Location: _____

Contractor: _____

System Tested:

❑ Hot Water ❑ Glycol Water ❑ Chilled Water ❑ Fuel Oil
❑ Condenser Water ❑ Steam ❑ Condensate

System Volume: _____

Materials Used (Provide MSDS for each)

Cleaner: _____ Quantity Used: _____
Inhibitor: _____ Quantity Used: _____
Sequestering Agent: _____ Quantity Used: _____
Algaecide: _____ Quantity Used: _____
Neutralizer: _____ Quantity Used: _____
Glycol: _____ Quantity Used: _____
Glycol Sol. Water Source: _____ % Glycol by Vol: _____

M Alkalinity

Prior to Cleaning: _____ During Cleaning: _____ After Flushing: _____

System Temperature

Prior to Cleaning: _____ During Cleaning: _____

Duration	***Date/Time Start***	***Date/Time Stop***
Initial Circulation		
Drain-down		
System Refill		
Final Circulation		
Heating System Warm-up		

Component Checklist (Describe procedures performed at each)

Filters _____
Vents: _____
Drains: _____
Traps: _____
Branch Lines: _____
Terminal Units: _____
Boilers: _____
Chillers: _____

Comments: _____

END OF SECTION

SECTION 23 51 00
BREECHINGS, CHIMNEYS, AND STACKS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Scope. This section includes specifications for all breechings, chimneys, stacks, emergency generator exhaust pipe, and automatic vent dampers. Included are the following topics:

B. PART 1 - GENERAL
   1. Scope
   2. Related Work
   3. Reference
   4. Reference Standards
   5. Quality Assurance
   6. Submittals
   7. Design Criteria
   8. Welder Qualifications

C. PART 2 - Products
   1. Vents for Condensing Appliances
   2. Double Wall Positive Pressure Vents and Breeching

D. PART 3 - EXECUTION
   1. Installation
   2. Cleaning and Protection

1.02 RELATED WORK

A. Section 23 07 00 - HVAC Insulation

1.03 REFERENCE

A. Applicable provisions of Division 1 govern work under this section.

1.04 REFERENCE STANDARDS

A.	UL 103	Safety Factory-Built Chimneys for Residential Type and Building Heating Appliances
B.	UL 378	Draft Equipment
C.	UL 441	Gas Vents
D.	UL 959	Medium Heat Appliance Factory-Built Chimneys
E.	UL 1738	Venting Systems for Gas-Burning Appliances, Categories II, III, and IV
F.	UL 2561	1400 Degree Fahrenheit Factory-Built Chimneys
G.	ANSI/ASTM C64	
H.	ANSI/ASTM C105	
I.	ANSI/ASTM A525	Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dipped Process
J.	ASTM A527	Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dipped Process, Lock-Forming Quality

K. ASTM A53 Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless

L. ASTM A234 Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures

M. NFPA 211 Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances

1.05 QUALITY ASSURANCE

A. Refer to Division 1, General Conditions, Equals and Substitutions.

1.06 SUBMITTALS

A. Refer to Division 1, General Conditions, Submittals.

B. Include materials of construction, dimensions, weight, support and layout of breechings. Where factory built units are used, submit layout drawings indicating plan view and elevations. Identify all methods of support and building structural members utilized for such support.

C. Submit manufacturer's installation instructions including required clearance to combustible materials.

D. If project includes new boilers and venting, the venting shall be provided and/or approved by the boiler representative.

1.07 DESIGN CRITERIA

A. Follow the requirements of NFPA 211 and State codes.

B. Factory built vents and chimneys used for venting natural draft appliances shall comply with NFPA 211 and be UL listed and labelled.

1.08 WELDING QUALIFICATIONS

A. Before any metallic welding is performed, the Contractor shall submit his Standard Welding Procedure Specifications, Procedure Qualification Records and Qualification Test Records for each Welder along with associated continuity records to demonstrate compliance with ASME Section IX, paragraph QW-322.

B. The Contractor shall maintain a complete set of welder qualification documents at the jobsite, including Test Records and Continuity Records for each welder.

C. The A/E reserves the right to test the work of any welder employed on the project, at the Contractor's expense. Testing will include a visual examination of the pipe and weld and may include radiography of any suspect welds. If the work of the welder is found to be unsatisfactory, the welder shall be prevented from doing further welding on the project. Any welds deemed unacceptable will be repaired at the contractor’s expense.

PART 2 - PRODUCTS

2.01 VENTS FOR CONDENSING APPLIANCES

A. CPVC: Schedule 40 CPVC for use on condensing appliances or pressurized venting systems serving Category II, III or IV appliances and as allowed by the equipment manufacturer. The material used in the manufacture of the pipe shall be a rigid chlorinated polyvinyl chloride (CPVC) compound, Type IV Grade 1, with a Cell Classification of 23447 as defined in ASTM D1784, and be light gray in color. Size vents in strict accordance with appliance manufacturer's requirements.

B. Manufacturer: Enervex, Selkirk Metalbestos, Metal-Fab, Jeremias, Air-Jet, Hart & Cooley, General Products Co., or approved equal.

C. Double Wall Positive Pressure Vent: Double-wall, factory-built type for use on condensing appliances or pressurized venting systems serving Category II, III or IV appliances or as specified by the equipment manufacturer. Tested to UL 1738 and rated for a maximum temperature of 550°F continuously, with positive or negative flue pressure of 20” w.c. and in compliance with NFPA 211. Vent shall be constructed with an inner and outer wall, with a 1” annular insulating air space. Joints shall have a leakage rate less than 5 ppm at 60” w.c. pressure and be designed and guaranteed to be leak-proof for a minimum of five years. The inner wall (vent) shall be constructed of AL29-4C or ASTM A276 type 316L-PCM stainless steel. The outer wall (casing) shall be constructed of aluminized steel.

D. All connections to common breechings shall be 45 degree lateral tees and the connection to a common vertical section shall be 87 degree tee. Common breeching shall have a 3 degree pitch and must have a drain at the lowest point(s).

E. Accessories: UL-listed and labeled tees, adjustable lengths, variable lengths, elbows, increasers, connectors, dampers, baffles, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly. Adjustable and variable lengths must be specifically listed to handle the same temperature and pressure as straight sections. Dampers and baffles must be listed to UL378 for 1000 deg F continuously.

F. Discharge Assembly: Provide the following discharge assembly to comply with the manufacturer’s listed assembly:

   1. Provide exit cone with drain section incorporated into riser.

2.02 DOUBLE WALL POSITIVE PRESSURE VENTS AND BREECHING

A. Manufacturers: Enervex, Selkirk Metalbestos, Metal-Fab, Jermias, Van Packer, Stacks Inc., Security Chimney, General Products Co., Z-Vent, or approved equal.

B. Stack, breeching, and accessory fittings to be double wall type with minimum 1" air space between walls for use with building heating equipment burning gas, solid, or liquid fuels as described in NFPA 211. U.L. listed for 1000°F continuously and 60” w.c. positive pressure.

C. Inner pipe to be type 304 stainless steel of 0.035" minimum thickness for sizes through 36" ID and minimum thickness of 0.048" for sizes over 36" ID.

D. Construct outer jacket of aluminized steel where located inside building, and Type 304 stainless steel where located outside building. Minimum thickness of outer jacket to be 24 gauge for sizes 10" to 24" and 20 gauge for sizes 28" to 48".

E. Join sections with high temperature acid-resistance joint cement or sealed graphite gasket, with U-band or V-band. Stacks to be self-supporting and mounted on a concrete foundation. Allow for expansion of stacks from -20°F to 1100°F.

F. Provide all necessary accessories including flashing, counter-flashing, cable guys where required, cleanout, drain, exit cone, roof thimble and necessary supports. U.L. listed and labeled tees, adjustable lengths, variable lengths, elbows, increasers, draft hood connectors, dampers, baffles, metal cap with bird barrier, adjustable roof flashing, storm collar, support assembly, thimbles, fire stop spacers, and fasteners fabricated of similar materials and designs as vent pipe straight sections. Adjustable and variable lengths must be listed to handle the same temperature and pressure as straight stack lengths. Dampers and baffles must be listed to UL378 for 1000°F continuously. Coat all external welded joints and seams with galvanized paint. Provide expansion guides for stacks over 40' in height.

PART 3 - EXECUTION

3.01 INSTALLATION

A. CPVC:

1. Provide vents, fittings, and accessories in accordance with appliance manufacturer's recommendations.

2. Size vents in strict accordance with appliance manufacturer's requirements. Use CPVC only on appliances allowed by the manufacturer and where the appliance operating conditions allow its use.

3. Pitch exhaust vents up from appliance to point of termination outside building. Provide drain points as indicated and per the manufactures recommendation to allow proper draining of condensate. Provide Flue Gas Condensate pH Neutralization at each drain piping termination point.

4. Locate exhaust termination and combustion air intake in accordance with appliance manufacturer's recommendations to prevent re-entry of products of combustion.

5. Termination of exhaust within 10 feet of operable windows, other building openings, or air intakes will not be accepted

6. Pitch combustion air vents from intake down toward appliance connection.

7. All joints of combustion air and exhaust vents shall be solvent welded and leak tight. Provide drain connection at base of exhaust vent, and pipe to nearest open site drain.

B. Double Wall Positive Pressure Vent:

1. Install stack, breeching, and accessories in accordance with the manufacturer's recommendations, maintaining minimum clearances from combustibles specified in UL listing.

2. Support breechings from building structure with suitable ties, braces, hangers and anchors to hold shape and prevent buckling. Minimum support for vertical sections shall be at all floor penetrations. Support from floor structure, roof structure, or adjacent structural surfaces. Verify load bearing capacity of support points with Architect/Engineer.

3. Install breechings with a minimum of joints. Align connections accurately and maintain smooth internal surfaces.

4. Install concrete inserts for support of breechings, chimneys, and stacks in coordination with formwork.

5. Maintain UL listed minimum clearances from combustibles.

6. Install stacks plumb. Pitch breeching upward from fuel fired equipment to chimney or stack.

7. Provide drain points as shown and per the manufactures recommendation to allow proper draining of condensate. Provide Flue Gas Condensate pH Neutralization at each drain piping termination point.

8. Clean breechings, chimneys, and stacks during installation, removing dust and debris.

9. At appliances, provide slip joints to allow removal of appliances without removal or dismantling of breechings, chimneys, or stacks.

10. Seal all joints of positive pressure stacks and breeching in accordance with manufacturer's recommendations, using only sealants recommended by stack manufacturer.

3.02 CLEANING AND PROTECTION

A. Clean breeching internally during installation to remove dust and debris. Clean external surfaces to remove welding slag and mill film.

B. At ends of breeching and chimneys which are not completed or connected to equipment, provide temporary closure which will prevent entrance of dust and debris until final connections are made.

END OF SECTION

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SECTION 23 52 00
HEATING BOILERS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Scope. This section includes specifications for hot water heating equipment. Included are the following topics:

B. PART 1 - GENERAL
   1. Scope
   2. Related Work
   3. Reference
   4. Reference Standards
   5. Quality Assurance
   6. Energy Efficiency
   7. Submittals
   8. Operation and Maintenance Data
   9. Registration
   10. Warranty

C. PART 2 - Products
   1. Sealed Combustion Boiler, Condensing, Hi-efficiency
   2. Sealed Combustion Boiler, Condensing, Hi-efficiency, 399MBH and Below

D. PART 3 - EXECUTION
   1. Installation
   2. Boilers
   3. Owner Training

1.02 RELATED WORK

A. Section 23 05 23 - General-Duty Valves for HVAC Piping
B. Section 23 21 13 - Hydronic Piping
C. Section 23 51 00 - Breeching, Chimneys and Stacks

1.03 REFERENCE

A. Applicable provisions of Division 1 govern work under this section.

1.04 REFERENCE STANDARDS

A. ASME CSD-1 Control and Safety Devices for Automatically Fired Boilers
B. ASME Boiler and Pressure Vessel Code I - Rules of Construction of Power Boilers
C. ASME Boiler and Pressure Vessel Code VIII - Rules for Construction of Pressure Vessels
D. ASME Boiler and Pressure Vessel Code IX - Welding and Brazing Qualifications
E. ASME Boiler and Pressure Vessel Code I V - Rules for Construction of Heating Boilers
F. UL 296 Oil Burners
G. UL 795 Commercial Industrial Gas Heating Equipment
H. NFPA 70 Electrical wiring and devices
I. National Electric Code

1.05 QUALITY ASSURANCE

A. Refer to Division 1, General Conditions, Equals and Substitutions.

1.06 ENERGY EFFICIENCY

A. All boilers with a capacity of less than 300,000 btu/hr input must be labeled as Energy Star by its manufacturer.

B. All boilers with a capacity of 300,000 btu/hr input must meet the efficiencies specified. Minimum boiler efficiencies are based on Federal Energy Management Program (FEMP) recommendations.

1.07 SUBMITTALS

A. Refer to Division 1, General Conditions, Submittals.

B. Include data concerning dimensions, capacities, and material of construction, ratings, weights, manufacturer's installation requirements and performance limitations.

C. Submit manufacturer's installation instructions including required clearance to combustible materials.

1.08 OPERATION AND MAINTENANCE DATA

A. All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

1.09 REGISTRATION

A. Complete Boiler and Unfired Pressure Vessel (UPV) Installation Registration and forward to the Department of Safety and Professional Services in accordance with the Wisconsin Administrative Code Chapter SPS 341.24.

1.10 WARRANTY

A. 400 MBH and Larger: 10-year Boiler pressure vessel warranty against leakage due to defective workmanship. Lifetime thermal shock warranty. All other boiler, burner and control parts warranted for one year from startup. 2-year warranty against boiler control panel failure.

B. 399 MBH and Under: Sealed combustion boiler, condensing, hi-efficiency, (modular,) helical heat exchanger/combustion chamber design that will be self-supporting, and warranted for a period of 10 years to withstand thermal shock. Heat exchanger shall be warranted against leakage for a period of 10 years.

C. Sealed combustion boiler, non-condensing, modular helical heat exchanger/combustion chamber design that will be self-supporting, and warranted for a period of (5)(10)(20) years to withstand thermal shock. Heat exchanger shall be warranted against leakage for a period of (5)(10) years.

PART 2 - PRODUCTS

2.01 SEALED COMBUSION BOILER, CONDENSING, HI-EFFICIENCY

A. Manufacturer: Aerco BMK, or Approved Equal.

B. Provide units with capacity and operating characteristics indicated on schedules.

C. Boiler ASME stamped for 160 psig and designed per ASME section IV. Furnish a relief valve in compliance with ASME section IV, and set at 50 psig. All internal combustion chamber, and internal burner components, shall be manufactured with materials suitable to withstand constant operation under condensing conditions. Combustion chamber shall have a condensate drain to discharge any condensate buildup.

D. Boiler efficiency 90%+ per ANSI Z21.13a, and operation in the condensing mode with inlet temperatures as low as 90°F.

E. Combustion air intake capable of accepting either free mechanical room air, or direct outside air through a sealed intake pipe of the length and diameter shown on drawings. Provide inlet/outlet combustion vent temperature fittings with direct outside air application.

F. Category IV flu vent connection, condensing positive pressure, for both horizontal and sidewall venting. The vent outlet shall be compatible with, and used only with, type AL29-4C vent material.

G. Baked enamel finish boiler sheet metal jacket with removal panels for maintenance access.

H. Inlet and outlet temperature gauge to monitor inlet and outlet water temperatures.

I. Provide each boiler with a low water cutout operationally testable, manually reset on loss of low-water and auto-rest on loss of power in accordance with ASME Section IV and CSD-1.

J. Provide each boiler with dual over temperature protection, including manual reset, in accordance with ASME Section IV and CSD-1.

K. Provide and install a manually operated remote shut-down switch or circuit breaker located just outside of the Boiler Room door and marked for easy identification.

L. Provide remote fault alarm contact for flame sensor and high temperature limit failure.

M. Provide single point wiring for controls and fan.

N. Manufacturer provided isolation control valve.

O.

P. Natural gas-fired burners, forced draft power type with a positive pressure at the boiler discharge. Stainless steel burner mixer. Maximum Nox emissions under 20 PPM.

Q. Furnish units with fuel trains and operating controls conforming to the latest UL or equivalent agency approval, CSD-1 requirements. Boiler/burner package shall be factory assembled, wired, mounted, and factory fire tested.

R. Provide an integral multiple boiler sequencing panel (BMS) capable of staging boilers to maintain peak seasonal efficiency. BMS shall include a sensor to monitor main loop system temperature, and a sensor to monitor outside air temperature. BMS shall be capable of outdoor reset, loop temperature span, and set loop temperature. BMS shall have the capability to stage boilers based on loop temperature and outdoor reset for highest operating seasonal efficiencies. BMS shall be capable of starting and stopping the system based on a remote contact closure, and have the ability to change setpoint from a remote location.

S. BMS panel shall be equipped to communicate with the building automation system via BACnet MS/TP protocol.

2.02 SEALED COMBUSTION BOILER, CONDENSING, HI-EFFICIENCY, 399 MBH AND BELOW

A. Manufacturer: Triangle Tube Prestige Solo, NTI, Viessman Vitodens, IBC Technologies, Riello Condexa, or Lochinvar Knight.

B. Provide units with capacity and operating characteristics indicated on schedules.

C. Boiler ASME 'H' stamped and designed per ASME. Furnish a relief valve in compliance with ASME section IV, and set at 30 psig. All internal combustion chamber, and internal burner components, shall be manufactured with materials suitable to withstand constant operation under condensing conditions. Combustion chamber shall have a condensate drain to discharge any condensate buildup.

D. Boiler efficiency 90%+ per ANSI Z21.13, and operation in the condensing mode with inlet temperatures as low as 90°F.

E. Combustion air intake capable of accepting either free mechanical room air, or direct outside air through a sealed intake pipe of the length and diameter shown on drawings. Provide inlet/outlet combustion vent temperature fittings with direct outside air application.

F. Baked enamel finish boiler sheet metal jacket with removal panels for maintenance access.

G. Inlet and outlet temperature gauge to monitor inlet and outlet water temperatures.

H. Provide each boiler with a low water cutout operationally testable, manually reset on loss of low-water and auto-rest on loss of power in accordance with ASME Section IV and CSD-1.

I. Provide each boiler with dual over temperature protection, including manual reset, in accordance with ASME Section IV and CSD-1.

J. Provide remote fault alarm contact for flame sensor and high temperature limit failure.

K. Provide single point wiring for controls and fan.

L. Natural gas-fired burners, forced draft power type with a positive pressure at the boiler discharge. Stainless steel burner mixer. Maximum Nox emissions under 20 PPM.

M. Furnish units with fuel trains and operating controls conforming to the latest UL or equivalent agency approval. Boiler/burner package shall be factory assembled, wired, mounted, and factory fire tested.

N. Provide integral control capable of staging boilers to maintain peak seasonal efficiency. Control shall include a sensor to monitor main loop system temperature, and a sensor to monitor outside air temperature. Control shall be capable of outdoor reset, loop temperature span, and set loop temperature. Control shall have the capability to stage boilers based on loop temperature and outdoor reset for highest operating seasonal efficiencies. Control shall be capable of starting and stopping the system based on a remote contact closure, and have the ability to change setpoint from a remote location.

O. Boiler shall be equipped to communicate with the building automation system via BACnet MS/TP protocol.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install units as shown on plans, as detailed, and according to manufacturer's installation instructions.

B. Set units on concrete housekeeping pads.

C. Install all items shipped loose by equipment manufacturer under supervision of equipment manufacturer's field service personnel.

3.02 BOILERS

A. Pipe vents from gas train to atmosphere. Size of each vent shall not be less than connection size to device.

B. Pipe boiler drains to nearest floor drains.

C. Install gas pressure gauges at downstream of gas pressure regulators.

D. If remote control panels are used, install all interconnecting wiring and pneumatic tubing if used between panels and units.

E. Provide factory start-up. If start-up is provided at a time that the conditions do not call for heating, a follow-up start-up shall be provided in October of that year. Factory shall provide a one year check-up to verify that boiler system is operating at optimum conditions.

3.03 OWNER TRAINING

A. Contractor to provide factory authorized representative and/or field personnel knowledgeable with the operations, maintenance and troubleshooting of the system and/or components defined within this section for a minimum period of 4 hours.

END OF SECTION

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SECTION 23 73 12
AIR HANDLING UNIT COILS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Scope. This section contains specifications for coils used in all air handling units. Included are the following topics:

B. PART 1 - GENERAL
   1. Scope
   2. Reference
   3. Reference Standards
   4. Quality Assurance
   5. Submittals
   6. Operation and Maintenance Data
   7. Design Criteria

C. PART 2 - Products
   1. Manufacturers
   2. Hot Water Coils

D. PART 3 - EXECUTION
   1. Hot Water Coils

1.02 REFERENCE

A. Applicable provisions of Division 1 govern work under this section.

1.03 REFERENCE STANDARDS

A. ARI 410 Forced Circulation Air-Cooling and Air-Heating Coils

1.04 QUALITY ASSURANCE

A. Refer to Division 1, General Conditions, Equals and Substitutions.

1.05 SUBMITTALS

A. Refer to Division 1, General Conditions, Submittals.

B. Including data concerning dimensions, capacities, flow rate, pressure drop, materials of construction, ratings, weights, and appropriate identification at the same time that the air handling equipment in which the coils will be located are submitted.

1.06 OPERATION AND MAINTENANCE DATA

A. All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

1.07 DESIGN CRITERIA

A. Select coil sizes, capacities, configuration, and operating characteristics as shown on the plans and/or as scheduled. Coil capacity ratings shall be ARI 410 certified.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Aerofin, Carrier, Daikin, RAE Corporation, Trane, JCI, Marlo, Wing, Dunham Bush, or Control Air.

2.02 HOT WATER COILS

A. Use galvanized steel casing, end supports, top channel, and bottom channel to produce a rigid frame with allowance for expansion and contraction of the finned tube section.

B. Construct coils of 0.025 inch tube wall seamless copper tubes of 5/8 inch maximum outside diameter with maximum of 8 aluminum fins per inch suitable for working pressures to 125 psig and temperatures to 250°F. Coil fins may be the continuous serpentine or plate fin type. If more than two rows are required to meet the needed heating capacity at 8 fins per inch, then the fins may be increased up to 12 fins per inch as needed to keep the rows at two maximum.

C. Coil headers may be constructed of cast iron, steel, or seamless copper. Where cast iron headers are used, expand tubes into the headers. Where steel or copper headers are used braze tubes to header.

D. Provide coils with bronze spring turbulators where required to provide the capacities indicated.

PART 3 - EXECUTION

3.01 HOT WATER COILS

A. Install in central station air handling unit casings or on structural support frames for field erected units, making allowance for pitching as recommended by the manufacturer. Mount coils in field erected units to allow for individual removal.

B. Comb bent or crushed fins after installation. Clean dust and debris from each coil to ensure its cleanliness.

C. Install a separate air vent and drain valve for each coil header in such a manner that the vent and drain valves are located outside of air handling unit casing. Provide offsets in piping to facilitate coil removal.

D. Unless otherwise specified, pipe coils for counter flow arrangement.

END OF SECTION

SECTION 23 82 00
HEATING AND COOLING TERMINAL UNITS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Scope. This section includes specification for heating and cooling terminal equipment using water and electricity as the source. Included are the following topics:

B. PART 1 - GENERAL
   1. Scope
   2. Related Work
   3. Reference
   4. Reference Standards
   5. Quality Assurance
   6. Submittals
   7. Operation and Maintenance Data
   8. Design Criteria

C. PART 2 - Products
   1. Unit Heaters

D. PART 3 - EXECUTION
   1. Installation
   2. Unit Heaters

1.02 RELATED WORK

A. Section 23 05 23 - General-Duty Valves for HVAC Piping
B. Section 23 05 13 - Common Motor Requirements for HVAC Equipment

1.03 REFERENCE

A. Applicable provisions of Division 1 govern work under this section.

1.04 REFERENCE STANDARDS

A. ARI 210 Standard for Unitary Air-Conditioning Equipment
B. ARI 410 Standard for Forced-Circulation Air-Cooling and Air-Heating Coils
C. CS 140
D. NEMA
E. NEC

1.05 QUALITY ASSURANCE

A. Refer to Division 1, General Conditions, Equals and Substitutions.

1.06 SUBMITTALS

A. Refer to Division 1, General Conditions, Submittals.

B. Include dimensions, capacities, materials of construction, ratings, weights, wiring diagrams, and appropriate identification for all equipment in this section. Include color selection chart where applicable.

1.07 OPERATION AND MAINTENANCE DATA

A. All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

1.08 DESIGN CRITERIA

A. Forced Circulation Coils: Ratings certified in accordance with ARI 410.

B. Electrical Equipment and heaters shall be UL listed for the service specified.

C. Electrical components and work must be in accordance with National Electrical Code.

PART 2 - PRODUCTS

2.01 UNIT HEATERS

A. Manufacturers: Airedale, Modine, McQuay, Trane, Rittling, Sterling, Sigma, Airtherm, or approved equal.

B. Construct casing of 18 gauge steel with baked enamel finish and heating elements of copper tubing with aluminum fins. Use aluminum fan blades, balanced for quiet operation. Provide safety guard for fan/drive assembly. Test coils units at 200 psig.

C. Furnish adjustable horizontal discharge louvers for units with horizontal discharge. Provide an adjustable cone diffuser for projection units with vertical discharge.

D. Furnish motors with characteristics as scheduled. Single phase, 120 volt motors to be permanently lubricated and provided with thermal overload protection.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install units in accordance with manufacturer's installation instructions.

B. Install branch water or steam/condensate piping to each unit with a minimum of three elbows to allow for expansion and contraction of the piping system.

C. Coordinate location of units with other trades to assure correct recess size for recessed units.

D. After installation, provide protective covers to prevent accumulation of dirt on units during balance of construction.

3.02 UNIT HEATERS

A. Suspend units from building structure and as high as possible to maintain headroom beneath units; supporting from piping systems will not be accepted.

B. Install a drain valve on the coil side of the shutoff valves for each hot water unit heater.

END OF SECTION

SECTION 31 20 00
EARTH MOVING

PART 1 - GENERAL

SUMMARY

Section Includes: Excavating and backfilling trenches for utilities and pits for buried utility structures.

DEFINITIONS

Backfill: Soil material used to fill an excavation.

Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.

Final Backfill: Backfill placed over initial backfill to fill a trench.

Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.

Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

Fill: Soil materials used to raise existing grades.

Utilities: On-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.

PREINSTALLATION MEETINGS

Preinstallation Conference: Conduct preexcavation conference at Project site.

INFORMATIONAL SUBMITTALS

Material test reports.

FIELD CONDITIONS

Utility Locator Service: Notify utility locator service for area where Project is located before beginning earth-moving operations.

PART 2 - PRODUCTS

SOIL MATERIALS

General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D2487 Groups A-1, A-2-4, A-2-5, and A-3 according to AASHTO M 145, or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve.

Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.

ACCESSORIES

Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility; colored to comply with local practice or requirements of authorities having jurisdiction.

Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored to comply with local practice or requirements of authorities having jurisdiction.

PART 3 - EXECUTION

PREPARATION

Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth-moving operations.

Protect and maintain erosion and sedimentation controls during earth-moving operations.

EXCAVATION, GENERAL

Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

EXCAVATION FOR UTILITY TRENCHES

Excavate trenches to indicated gradients, lines, depths, and elevations.

Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.

Clearance: 12 inches each side of pipe or conduit.

Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

UTILITY TRENCH BACKFILL

Place backfill on subgrades free of mud, frost, snow, or ice.

Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

Initial Backfill: Place and compact initial backfill of satisfactory soil, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.

Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

Final Backfill: Place and compact final backfill of satisfactory soil to final subgrade elevation.

Warning Tape: Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

COMPACTION OF SOIL BACKFILLS AND FILLS

Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

Place backfill and fill soil materials evenly on all sides of structures to required elevations and uniformly along the full length of each structure.

Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D698 or ASTM D1557:

Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 85 percent.

For utility trenches, compact each layer of initial and final backfill soil material at 85 percent.

GRADING

General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to elevations required to achieve indicated finish elevations, within the following subgrade tolerances:

Turf or Unpaved Areas: Plus or minus 1 inch.

PROTECTION

Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

DISPOSAL OF SURPLUS AND WASTE MATERIALS

Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION

SECTION 32 92 00
TURF AND GRASSES

PART 1 - GENERAL

SUMMARY
Section Includes: Seeding.

DEFINITIONS
Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

PREINSTALLATION MEETINGS
Preinstallation Conference: Conduct conference at Project site.

INFORMATIONAL SUBMITTALS
Certification of grass seed.
Product certificates.

DELIVERY, STORAGE, AND HANDLING
Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.

PART 2 - PRODUCTS

SEED
Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Rules for Testing Seeds" for purity and germination tolerances.

Seed Species:
Quality, State Certified: State-certified seed of grass species as listed below for solar exposure.
Quality, Non-State Certified: Seed of grass species as listed below for solar exposure, with not less than 85 percent germination, not less than 95 percent pure seed, and not more than 0.5 percent weed seed:

Grass-Seed Mix: Proprietary seed mix suitable for the site and sun/shad conditions.

FERTILIZERS
Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

Composition: 1 lb/1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.

MULCHES
Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

PART 3 - EXECUTION

TURF AREA PREPARATION
General: Prepare planting area for soil placement and mix planting soil.

Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

SEEDING

Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph.

Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.

Do not use wet seed or seed that is moldy or otherwise damaged.

Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.

Sow seed at a total rate of 3 to 4 lb/1000 sq. ft..

Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.

Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch to form a continuous blanket 1-1/2 inches in loose thickness over seeded areas. Anchor straw mulch by crimping into soil with suitable mechanical equipment.

SATISFACTORY TURF

Turf installations shall meet the following criteria as determined by Architect:

Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.

Use specified materials to reestablish turf that does not comply with requirements, and continue maintenance until turf is satisfactory.

END OF SECTION