PROJECT MANUAL

FOR

BOILER CONVERSION

AT

MARATHON COUNTY

LAKE VIEW PROFESSIONAL PLAZA (LVPP) FACILITY

1200 LAKE VIEW DRIVE
WAUSAU, WISCONSIN 54403

Owner Contact:
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Email: troy.torgerson@co.marathon.wi.us

Consultant Contact:
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DCE PROJECT #2005
JUNE 23, 2020

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M0.0: Symbols & Abbreviations
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M1.0: First Floor New Work Plans
M2.0: Details
M3.0: Schedules

PLUMBING

P1.0: First Floor New Work Plan

ELECTRICAL

E0.0: Symbols & Abbreviations
ED1.0: First Floor Demolition Plans
E1.0: First Floor New Work Plans

END OF SECTION 00 01 10

SECTION 00 11 16
INVITATION TO BID

1.1 PROJECT INFORMATION

A. Project Identification: Marathon County Lake View Professional Plaza (LVPP) Facility Boiler Conversion.
B. Project Location: 1200 Lake View Drive, Wausau, WI 54403.
C. Owner: Marathon County.
D. Engineer: Dynamic Consulting Engineers LLC.
E. Project Description: Project consists of demolishing the existing steam system serving LVPP and converting the heating system to hot water. A new hot water system will be provided with two (2) hot water condensing boilers.
F. Construction Contract: Single Prime Contract (all trades).

1.2 BID SUBMITTAL & OPENING

A. Owner will receive sealed bids to secure a company or organization (Contractor) to provide the services identified in the Contract Documents.
B. Bids will be accepted until the bid time and date at the location given below. Owner will consider bids prepared in compliance with the Instructions to Bidders and delivered as follows:
   1. Bid Date: July 16, 2020.
   2. Bid Time: 2:00 PM.
C. Bids received after the above hour and date will be rejected.
D. Bids shall be mailed or hand delivered to Marathon County as noted in Section 00 21 13.
E. Bids will be publicly opened thereafter and read aloud.

1.3 BIDDER'S QUALIFICATIONS

A. Bidders must be prequalified by Owner.
B. Bidders must be properly licensed under the laws governing their respective trades and be able to obtain insurance and bonds required for the Work.
C. The Owner reserves the right to reject any bidder who is determined to be unqualified.

1.4 CONTRACT REQUIREMENTS

A. The successful Contractor is expected to sign an AIA contract within ten (10) days after award.

1.5 PROPOSED CONSTRUCTION SCHEDULE

A. The undersigned Bidder proposes and agrees hereby to commence the Work of the Contract Documents on a date specified in a written Notice to Proceed and shall fully complete the Work based on the proposed construction schedule.
B. The undersigned Bidder shall complete the Work within the Contract Time.
C. The proposed construction schedule is as follows:
   1. Bids Due: July 16, 2020.
   2. Select Contractor: July 30, 2020.
   3. Start Construction: August, 2020.
   4. Substantial Completion: November 1, 2020.

1.6 ALLOWANCES

A. There are no allowances for this Project.

1.7 OTHER INFORMATION

A. The Owner is not liable for any costs incurred in replying to the Invitation to Bid.
B. Division 01 General Requirements: Requirements of Sections in Division 00 and 01 apply to the Work of all Sections in the Specifications.

END OF SECTION 00 11 16

SECTION 00 21 13
INSTRUCTIONS TO BIDDERS

1. SUMMARY

1.1 WORK IDENTIFIED IN THE CONTRACT DOCUMENTS

A. The Work shall be completed under a single prime lump sum contract.

1.2 CONTRACT TIME

A. The construction shall begin immediately upon execution of the Contract Documents.
B. Due to daily usage of the Project area throughout the duration of the Project, performance of the Work under this Contract must be done in accordance of the defined Project
schedule.
C. The project shall be Substantially Completed no later than ninety (90) days after Award, inclusive of lead times for materials ordered for the Project.

2. BID DOCUMENTS & CONTRACT DOCUMENTS

2.1 DEFINITIONS

A. Bid Documents: Contract Documents supplemented with Invitation to Bid, Instructions to Bidders, and Bid Form identified herein.
B. Contract Documents: Defined in General Conditions. Includes all documents, contract forms, Specifications, and Drawings indicated in Section 00 01 10 of the Project Manual.
C. Bid, Offer, or Bidding: Act of submitting a Bid.
D. Bid Sum: Monetary sum identified by the Bidder in the Bid Form.

2.2 CONTRACT DOCUMENTS IDENTIFICATION

A. The Contract Documents are identified by the project name "**Marathon County Lake View Professional Plaza (LVPP) Facility Boiler Conversion**" as prepared by the Owner, Marathon County Facilities & Capital Management Department, 1000 Lake View Drive, Suite 300, Door #27, Wausau, WI 54403 and are enumerated in the Project Manual.

2.3 AVAILABILITY

A. Bid Documents may be reviewed at the office of the Owner.
B. Electronic sets of Bid Documents can be obtained by each Bidder from the Marathon County website.
C. Contract Documents Identification:
   1. Project Name: Marathon County Lake View Professional Plaza (LVPP) Facility Boiler Conversion.
   2. Project Number: 2005.
   3. Date: June 23, 2020.
   4. Prepared By: Dynamic Consulting Engineers LLC.
D. Bid Documents are made available only for the purpose of obtaining Bids for this Project. Their use does not grant a license for other purposes.

2.4 EXAMINATION

A. Bid Documents may be viewed at the office of the Owner.
B. Upon receipt of Bid Documents verify that documents are complete. Notify Owner should the documents be incomplete.
C. Immediately notify the Owner upon finding discrepancies or omissions in the Bid Documents.

2.5 QUERIES/ADDENDA

A. Direct questions by e-mail only (verbal answers are not binding on any party) to the following:
   1. Engineer: David Grassl, PE – david.grassl@dynamicmke.com
B. Addenda may be issued during the Bidding period. All Addenda become part of the Contract Documents. Include resultant costs in the Bid Sum.
C. Clarifications and requests for determination of equal products must be received by Owner and Engineer in writing not less than four (4) days before date set for receipt of Bids. The written reply, if any, will be in the form of an Addendum issued to all appropriate Bidders.

2.6 PRODUCT/SYSTEM SUBSTITIONS

A. Substitute products will be considered if submitted ***prior*** to the time listed in 2.5.C - four (4) days prior to bid date to be reviewed by the Owner and noted as “approved equal”.
B. The submittal shall provide sufficient information to determine acceptability of such products.
C. Provide complete information on required revisions to other Work to accommodate each substitution, the value of additions to or reductions from the Bid Sum, including revisions to other Work.
D. Provide Products as specified unless substitutions are submitted in this manner and subsequently accepted.

2.7 REPRESENTATIONS

A. By submitting a bid, the Bidder represents that:
   1. Bidder has visited the Project Site and is familiar with the conditions at the site which affect the Contract Sum and the performance of the Work.
   2. All Bid Sums are based on the materials, products, requirements, equipment, and systems required by the Contract Documents, unless any exceptions or deviations are indicated on the Bid Form.
   3. Bidder agrees to comply with provisions related to conflicts, as specified in the General Conditions, unless any exceptions or deviations are indicated on the Bid Form.

3. SITE ASSESSMENT

3.1 SITE EXAMINATION

A. The Contractor shall visit the Project site before submitting a Bid and carefully examine the Contract Documents and their relationship to existing conditions to become thoroughly familiar with the requirements of the Work.
B. A scheduled pre-bid meeting is set for Tuesday, July 7th, 2020 at 10 AM at 1200 Lake View Drive, Wausau, WI 54403. Meet at the Marathon County Facilities & Capital Management Department at 1000 Lake View Drive, Suite 300, Door #27.

C. The Contractor will not be allowed extra compensation for work required by existing conditions for which thorough and careful examination of the site by the Contractor could have become informed prior to submitting a Bid.
D. The pre-bid meeting is mandatory.

3.2 SUBCONTRACTORS/SUPPLIERS/OTHERS

A. The Owner reserves the right to reject a proposed Subcontractor for reasonable cause.
B. The Contractor shall consult the Specifications for each Division of the Work to ascertain the extent of the Contractor's work. The Contractor, and the Subcontractors, shall confer and cooperate to serve the best interest of the Work as a whole.

4. BID ENCLOSURES/REQUIREMENTS

4.1 WITHDRAWAL OF BIDS

A. Bidders may withdraw, modify, or cancel submitted Bids only before the date and time established for the receipt of Bids. Submitted Bids may not be withdrawn, modified, or canceled after such date and time.

4.2 BID FORM REQUIREMENTS

A. Bidders shall be solely responsible for the delivery of their bids in the manner and time prescribed.
B. Complete all requested information in the Bid Form.
C. Submit one (1) copy of the executed offer on the Bid Form provided, signed in a closed opaque envelope, clearly identified with bidder's name, project name, and Owner's name on the outside.
D. Submit one (1) copy of the Alternates form addressing all alternates.
E. Submit one (1) copy of the Affidavit of Non-Collusion.
F. Refer to Section 00 72 00 – General Conditions.
G. Refer to Section 00 73 10 – Procurement Policy for insurance requirements.
H. Bids must be received by the deadline provided. Any bids delivered after the bid time will be rejected.

4.3 FEES FOR CHANGES IN THE WORK

A. Include in the Bid Form, the fees proposed for changes (both additions and deductions) in the Work.

5. BID ACCEPTANCE/REJECTION

5.1 DURATION OF BIDS

A. Bids shall remain open to acceptance by the Owner for a period of time after the Bid closing date as identified on the Bid Form.

5.2 ACCEPTANCE OF BIDS

A. The Contract, if awarded, will be awarded to the lowest responsible and responsive Bidder on the basis of the Base Bid, and full consideration of the selected Alternates, as may be in the best interest of the Owner. In determining responsibility, the Owner will consider the scope of the work involved, time of delivery, competency of Bidder, his ability to render satisfactory service, and past performance.

B. The Owner reserves the right to reject any or all Bids, or parts thereof, and to award to the Bidder who, in the judgment of the Owner, will best serve the County. A bid which has not been prepared according to the instructions set forth in the Instructions to Bidders, or which does not include a price which is both adequate and reasonable on each and every item named in the bid, may be subject to rejection. Bids may be withdrawn or modified only as allowed pursuant to Section 3.05(1) (g) of the Marathon County Procurement Code.

C. If two (2) or more Bidders submit identical Bids, the Owner may make award to that Bidder of his choice, and such decision shall be final.

D. Awards will not be made to any Bidder in default of a Contract with the Owner or to any Bidder having as his agent or employee any individual previously in default or guilty of misrepresentation.

E. Bid results may be published in construction periodicals.

5.3 BID BOND

A. Bids shall be accompanied by a security deposit in the form of a Bid Bond or certified check in the amount of no less than ten percent (10%) of the Bid Sum. Endorse the Bid Bond or certified check in the name of the Owner as obligee, signed, and sealed by the Contractor as principal and the Surety.

B. After a Bid has been accepted, all securities will be returned to the respective Bidders. For the accepted Bidder, the security deposit will be returned after execution of the Contract. If no contract is awarded, all security deposits will be returned. Include the cost of the Bid Bond on the Bid Form.

5.4 PERFORMANCE BOND

A. Bids shall be accompanied by a security deposit in the form of a Performance Bond or certified check in the amount of no less than ten percent (10%) of the Bid Sum. Endorse the Performance Bond or certified check in the name of the Owner as obligee, signed, and sealed by the Contractor as principal and the Surety.

B. After a Bid has been accepted, all securities will be returned to the respective Bidders. For the accepted Bidder, the security deposit will be returned after execution of the Contract. If no contract is awarded, all security deposits will be returned. Include the cost of the Performance Bond on the Bid Form.

END OF SECTION 00 21 13

SECTION 00 41 13
BID FORM

1.1 SUBMISSION OF BID

Contractor: _____

Address: _____

Phone Number: _____

Fax Number: _____

Email: _____

Authorized Signature: _____

Printed Name: _____

Title: _____

Date: _____

1.2 CERTIFICATIONS & BASE BID

A. The undersigned Bidder, having carefully examined the Procurement and Contracting Requirements, Conditions of the Contract, Drawings, Specifications, and all subsequent Addenda, as prepared by Dynamic Consulting Engineers LLC (Engineer) and the Engineer's 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, necessary to complete the construction of the Project, according to the requirements of the Procurement and Contracting Documents, for the stipulated sum of:

Base Bid: $_____

Total in Words: _____

1.3 BID BOND

A. The undersigned Bidder agrees to execute a contract for this Work in the above amount and to furnish surety as specified within ten (10) days after a written Notice of Award, if offered within sixty (60) days after receipt of bids. Upon failure to do so, the Contractor 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 ten percent (10%) of the Base Bid amount above:

Bid Bond: $_____

Total in Words: _____

B. In the event the 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.

1.4 PERFORMANCE BOND

A. The undersigned Bidder agrees to execute a contract for this Work in the above amount and to furnish surety as specified within ten (10) days after a written Notice of Award, if offered within sixty (60) days after receipt of bids. Upon failure to do so, the Contractor 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 ten percent (10%) of the Performance Bid amount above:

Performance Bond: $_____

Total in Words: _____

B. In the event the 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.

1.5 CONTACTORS MARK-UP PERCENTAGE

A. The Contractor shall provide, as a percentage, their mark-up to be used on this Project for all change orders:

Mark-Up Percentage: _____

Total in Words: _____

1.6 SUBCONTRACTORS

A. The following companies will execute subcontracts for the portions of the Work as indicated:

Contractor: _____

Type of Construction: _____

Address: _____

Name of Contact: _____

Phone Number: _____

Fax Number: _____

Email: _____

Contractor: _____

Type of Construction: _____

Address: _____

Name of Contact: _____

Phone Number: _____

Fax Number: _____

Email: _____

Contractor: _____

Type of Construction: _____

Address: _____

Name of Contact: _____

Phone Number: _____

Fax Number: _____

Email: _____

Contractor: _____

Type of Construction: _____

Address: _____

Name of Contact: _____

Phone Number: _____

Fax Number: _____

Email: _____

1.7 ACKNOWLEDGEMENT OF ADDENDA

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

Addendum #_____ Date: _____

Addendum #_____ Date: _____

Addendum #_____ Date: _____

Addendum #_____ Date: _____

END OF SECTION 00 41 13

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SECTION 00 43 23
ALTERNATES

1.1 BID FORM SUPPLEMENT

A. This form is required to be attached to the Bid Form.

1.2 DESCRIPTION

A. The undersigned Bidder proposes the amount below be added to or deducted from the Base Bid if the respective alternates are accepted by the Owner. Amounts listed for each alternate include costs of related coordination, modification, or adjustment.
B. If the alternate does not affect the Contract Sum, the Bidder shall indicate "NO CHANGE."
C. If the alternate does not affect the Work of this Contract, the Bidder shall indicate "NOT APPLICABLE."
D. The Bidder shall be responsible for determining from the Contract Documents the effects of each alternate on the Contract Time and the Contract Sum.
E. Owner reserves the right to accept or reject any alternate, in any order, and to award or amend the Contract accordingly within sixty (60) days of the Notice of Award unless otherwise indicated in the Contract Documents.
F. Acceptance or non-acceptance of any alternates by the Owner shall have no effect on the Contract Time unless the Alternate Bid Impact Article below provides a formatted space for the adjustment of the Contract Time.
G. It is mandatory that all alternate bids be quoted below by each Bidder and submitted with the Bid Form.

1.3 SUBMISSION OF ALTERNATE BID

Contractor: _____

Address: _____

Authorized Signature: _____

Printed Name: _____

Title: _____

Date: _____

1.4 ALTERNATE BID LIST

A. Alternate H-1 | Canvas jackets on ductwork and equipment:
   1. Provide canvas jackets on the combustion air ductwork and equipment as identified in the Contract Documents.
B. Alternate H-2 | Paint natural gas piping:
   1. Provide two (2) coats of paint on new gas piping as identified in the Contract Documents.
C. Alternate H-3 | Variable frequency drives for pumps:
   1. Provide new variable frequency drives in lieu of relocating and reusing the existing variable frequency drives as identified in the Contract Documents.
D. Alternate H-4 | Gas flow meter:
   1. Provide a gas flow meter, FM-2, for sub-metering the gas consumption for the LVPP facility as identified in the Contract Documents.

1.5 ALTERNATE BID IMPACT

A. Alternate H-1:

Add ☐ Deduct ☐ No Change ☐ Not Applicable ☐

Add ☐ Deduct ☐ _____ Calendar days to adjust the Contract Time for this alternate

Alternate H-1: $_____

Total in Words: _____

B. Alternate H-2:

Add ☐ Deduct ☐ No Change ☐ Not Applicable ☐

Add ☐ Deduct ☐ _____ Calendar days to adjust the Contract Time for this alternate

Alternate H-2: $_____

Total in Words: _____

C. Alternate H-3:

Add ☐ Deduct ☐ No Change ☐ Not Applicable ☐

Add ☐ Deduct ☐ _____ Calendar days to adjust the Contract Time for this alternate

Alternate H-3: $_____

Total in Words: _____

D. Alternate H-4:

Add ☐ Deduct ☐ No Change ☐ Not Applicable ☐

Add ☐ Deduct ☐ _____ Calendar days to adjust the Contract Time for this alternate

Alternate H-4: $_____

Total in Words: _____

END OF SECTION 00 43 23

SECTION 00 45 00
AFFIDAVIT OF NON-COLLUSION

STATE OF _____

COUNTY OF _____

I Hereby swear (or affirm) under the penalty of perjury:

1) That I am the Bidder (if the Bidder is an individual), a partner of the Bidder company (if the Bidder is a partnership), or an officer or employee of the Bidder corporation having authority to sign on its behalf (if the Bidder is a corporation);

2) That the attached bid or bids have been arrived at by the Bidder individually and have been submitted without collusion with, and without any agreement, understanding or planned common course of action with any other vendor of materials, supplies, equipment, or services described in the Invitation to Bid designed to limit individual bidding or competition;

3) That the contents of the bid or bids have not been communicated by the Bidder or its employees or agents to any person not an employee or agent of the Bidder or its surety on any bond furnished with the bid or bids, and will not be communicated to any such person, prior to any official opening of the bid or bids; and

4) That I have fully informed myself regarding the accuracy of the statements made in this affidavit.

Subscribed and sworn to before me this

day of _____, 20___

Notary Seal

Bidders Signature

_____

Printed Name

_____

Title

_____

Company

_____

END OF SECTION 00 45 00

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SECTION 00 72 00
GENERAL CONDITIONS

ARTICLE 1 - GENERAL PROVISIONS

1.1 THE CONTRACT
The Contract represents the entire and integrated agreement between the parties and supersedes prior negotiations, representations or agreements, either written or oral. The Contract may be amended or modified only by a written modification.

1.1.1 The Contractor's completed Bid Form shall be included in the Contract Documents.

1.2 THE WORK
The term "Work" means the construction and services required by the Contract Documents, and includes all other labor, materials, equipment, and services provided by the Contractor to fulfill the Contractor's obligations.

1.3 THE INTENT
The intent of the Contract Documents is to include all items necessary for the proper execution and completion of the Work by the Contractor. The Contract Documents are complementary, and what is required by one (1) shall be as binding as if required by all.

1.3.1 All Work shown and specified is intended to be included in the Contract. Therefore, Work shown on the Drawings and not specified shall be included in the Contract, and Work identified in the Specifications and not shown on the Drawings shall be included in the Contract.

1.3.2 It shall be the responsibility of the Contractor to establish the extent of the Work of each Subcontractor and each trade.

1.3.3 If a conflict in Contract Documents occurs the following shall apply:

1.3.3.1 Addenda or modifications of any nature to the Drawings and Specifications take precedence over the original Contract Documents.
1.3.3.2 Where a conflict occurs in the Documents, not reconciled by Addenda, the installation of greater quantity and better quality shall be provided.
1.3.3.3 Where a conflict occurs between the Specifications and the Drawings, not reconciled by Addenda, the installation of greater quantity and better quality shall be provided.
1.3.3.4 Where work or materials are shown or specified in more than one (1) location in the Contract Documents which results in a duplication of work by more than one (1) Contractor, the Contractors shall include the cost for such work or materials in their contracts and the Owner shall determine which Contractor shall provide the work or materials and which Contractor shall provide a credit to the Owner.

1.3.4 Drawings are in part diagrammatic, intended to convey the scope of the work, and indicate general arrangement of materials and equipment. Drawings are not necessarily to scale and the printed dimensions should be used, not scaled measurements. Each Contractor shall become familiar with all conditions affecting the Contractor's work and shall consult all construction Drawings and Specification Sections.

1.3.5 All details and notes on the Drawings shall be considered to be typical and what is shown or noted in one (1) instance shall apply to all similar and related instances whether or not the detail or note is repeated.

1.3.6 Small details and related material not usually drawn or specified, but necessary for the proper installation and completion of the Work, shall be furnished and installed by the Contractor without extra charge, the same as if specified in the Project Manual or shown on the Drawings.

1.3.7 These Drawings and Specifications are intended for use only for this Project on this site and should not be used for other projects on the same or different site.

1.4 THE OWNER

The Owner as referenced in the Contract Documents is Marathon County, also referred to elsewhere in the Contract Documents as "The County". The Agent or Owner's Representative for the County is the Marathon County Facilities & Capital Management Department.

1.5 THE CONTRACTOR

The term "Contractor" when used in any section of the specifications, means the Contractor who has a contract directly with the Owner.

ARTICLE 2 - OWNER

2.1 INFORMATION & SERVICES REQUIRED OF THE OWNER

Except for permits and fees which are the responsibility of the Contractor under the Contract Documents, the Owner shall obtain and pay for other necessary approvals, easements, assessments, and charges.

2.2 OWNER'S RIGHT TO STOP THE WORK

If the Contractor fails to correct Work which is not in accordance with the Contract Documents, the Owner may direct the Contractor in writing to stop the Work until the correction is made.

2.3 OWNER'S RIGHT TO CARRY OUT THE WORK

If the Contractor defaults or neglects to carry out the Work in accordance with the Contract Documents and fails within a seven (7) day period after receipt of written notice from the Owner to correct such default or neglect with diligence and promptness, the Owner may, without prejudice to other remedies, correct such deficiencies. In such case, a Change Order shall be issued deducting the cost of correction from payments due the Contractor.

2.4 OWNER'S RIGHT TO PERFORM CONSTRUCTION & TO AWARD SEPARATE CONTRACTS

2.4.1 The Owner reserves the right to perform construction or operations related to the Project with the Owner's own forces, and to award separate contracts in connection with other portions of the Project.

2.4.2 The Contractor shall coordinate and cooperate with separate contractors employed by the Owner.

2.4.3 Costs caused by delays or by improperly timed activities or defective construction shall be borne by the party responsible therefore.

ARTICLE 3 - CONTRACTOR

3.1 EXECUTION OF THE CONTRACT

Execution of the Contract by the Contractor is a representation that the Contractor has visited the site, become familiar with local conditions under which the Work is to be performed and correlated personal observations with requirements of the Contract Documents.

3.2 REVIEW OF CONTRACT DOCUMENTS & FIELD CONDITIONS BY CONTRACTOR

The Contractor shall carefully study and compare the Contract Documents with each other and with information furnished by the Owner. Before commencing activities, the Contractor shall: (1) take field measurements and verify field conditions; (2) carefully compare this and other information known to the Contractor with the Contract Documents; and (3) promptly report errors, inconsistencies or omissions discovered to the Owner.

3.3 SUPERVISION & CONSTRUCTION PROCEDURES

3.3.1 The Contractor shall supervise and direct the Work, using the Contractor's best skill and attention. The Contractor shall be solely responsible for and have control over construction means, methods, techniques, sequences and procedures, and for coordinating all portions of the Work.

3.3.2 The Contractor, shall furnish in writing to the Owner the names of subcontractors or suppliers for each portion of the Work. The Owner will promptly reply to the Contractor in writing if the Owner, after due investigation, has reasonable objection to the subcontractors or suppliers listed.

3.3.3 The Contractor shall have a qualified superintendent on the construction site at all times while work on the Project is being performed. The Owner shall have the right to review the qualifications of the Contractor's superintendent and reject the superintendent at Owner's discretion.

3.4 LABOR & MATERIALS

3.4.1 Unless otherwise provided in the Contract Documents, the Contractor shall provide and pay for labor, materials, equipment, tools, utilities, transportation, and other facilities and services necessary for proper execution and completion of the Work.

3.4.2 The Contractor shall deliver, handle, store, and install materials in accordance with manufacturers' instructions.

3.5 WARRANTY

3.5.1 The Contractor warrants to the Owner that: (1) materials and equipment furnished under the Contract will be new and of good quality unless otherwise required or permitted by the Contract Documents; (2) the Work will be free from defects not inherent in the quality required or permitted; and (3) the Work will conform to the requirements of the Contract Documents.

3.5.2 Where warranties are specified in the individual Specification Sections for products, materials, systems, and equipment, provide the specified warranties from the supplier of the products, materials, systems, and equipment. In the event the specified warranties are not available from the suppliers, the Contractor shall provide the specified warranties unless the Contractor has stated an exception in the Bid Form.

3.6 PERMITS, FEES, & NOTICES

3.6.1 The Contractor shall obtain and pay for the building permit and other permits and governmental fees, licenses, and inspections necessary for proper execution and completion of the Work.

3.6.2 The Contractor shall comply with and give notices required by agencies having jurisdiction over the Work. If the Contractor performs Work knowing it to be contrary to laws, statutes, and ordinances, building codes, and rules and regulations without notice to the Owner, the Contractor shall assume full responsibility for such Work and shall bear the attributable costs. The Contractor shall promptly notify the Owner in writing of any known inconsistencies in the Contract Documents with such governmental laws, rules, and regulations.

3.7 SUBMITTALS

The Contractor shall promptly review, approve in writing, and submit to the Owner Shop Drawings, Product Data, Samples, and similar submittals required by the Contract Documents. Shop Drawings, Product Data, Samples, and similar submittals are not Contract Documents.

3.8 USE OF SITE

The Contractor shall confine operations at the site to areas permitted by law, ordinances, permits, the Contract Documents, and the Owner.

3.9 CUTTING & PATCHING

The Contractor shall be responsible for cutting, fitting, or patching required to complete the Work or to make its parts fit together properly.

3.10 CLEANING UP

The Contractor shall keep the premises and surrounding area free from accumulation of debris and trash related to the Work.

3.11 INDEMNIFICATION

To the fullest extent permitted by law, the Contractor agrees to release, indemnify, defend, and hold harmless Marathon County, their officials, officers, employees, and agents from and against all judgments, damages, penalties, losses, costs, claims, expenses, suits, demands, debts, actions, and/or causes of action of any type or nature whatsoever, including actual and reasonable attorney's fees, which may be sustained or to which they may be exposed, directly or indirectly, by reason of personal injury, death, property damage, or other liability, alleged or proven, resulting from or arising out of the performance of contractor, its officers, officials, employees, agent, or assigns. Marathon County does not waive, and specifically reserves its right to assert any and all affirmative defenses and limitations of liability as specifically set forth in Wisconsin Statutes, Chapter 893 and related statutes.

ARTICLE 4 - OWNER'S ADMINISTRATION OF CONTRACT

4.1 The Owner will provide administration of the Contract as described in the Contract Documents.

4.2 The Owner will visit the site at intervals appropriate to the stage of construction to become generally familiar with the progress and quality of the Work.

4.3 The Owner will not have control over or charge of and will not be responsible for construction means, methods, techniques, procedures, or for safety precautions and programs in connection with the Work, since these are solely the Contractor's responsibility. The Owner will not be responsible for the Contractor's failure to carry out the Work in accordance with the Contract Documents.

4.4 Based on the Owner's observations and evaluations of the Contractor's Applications for Payment, the Owner will review and certify the amounts due the Contractor.

4.5 The Owner will have authority to reject Work that does not conform to the Contract Documents.

4.6 The Owner will promptly review and approve or take appropriate action upon Contractor's submittals such as Product Data and Samples, but only for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents.

4.7 The Owner will promptly interpret and decide matters concerning performance under and requirements of the Contract Documents on written request of the Contractor.

4.8 Interpretations and decisions of the Owner will be consistent with the intent of and reasonably inferable from the Contract Documents and will be in writing or in the form of drawings.

ARTICLE 5 - CHANGES IN THE WORK

5.1 After execution of the Contract, changes in the Work may be accomplished by Change Order or by order for a minor change in the Work. The Owner, without invalidating the Contract, may order changes in the Work within the general scope of the Contract consisting of additions, deletions, or other revisions, with the Contract Sum and Contract Time being adjusted accordingly.

5.2 A Change Order shall be a written order to the Contractor signed by the Owner to change the Work, Contract Sum, or Contract Time.

5.3 The Owner will have authority to order minor changes in the work not involving changes in the Contract Sum or the Contract Time and not inconsistent with the intent of the Contract Documents. Such changes shall be written orders and shall be binding on the Owner and Contractor. The Contractor shall carry out such written orders promptly.

5.4 If concealed or unknown physical conditions are encountered at the site that differ materially from those indicated in the Contract Documents or from those conditions ordinarily found to exist, the Contract Sum and Contract Time shall be subject to equitable adjustment.

ARTICLE 6 - TIME

6.1 Time limits stated in the Contract Documents are of the essence of the Contract.

6.1.1 Contract time and schedule is identified in Section 00 21 13 – Instructions to Bidders and Section 00 11 16 – Invitation to Bid.

6.2 If the Contractor is delayed at any time in progress of the Work by changes ordered in the Work, or by labor disputes, fire, unusual delay in deliveries, unavoidable casualties, or other causes beyond the Contractor's control, the Contract Time shall be extended by Change Order for such reasonable time as the Owner may determine.

ARTICLE 7 - PAYMENTS & COMPLETION

7.1 CONTRACT SUM

The Contract Sum stated in the Agreement, including authorized adjustments, is the total amount payable by the Owner to the Contractor for performance of the Work under the Contract Documents.

7.2 APPLICATIONS FOR PAYMENT

7.2.1 At least thirty (30) days before the date established for each progress payment, the Contractor shall submit to the Owner an itemized Application for Payment for operations completed in accordance with the Agreement. Such application shall be supported by such data substantiating the Contractor's right to payment as the Owner may reasonably require and reflecting retainage if provided for elsewhere in the Contract Documents.

7.2.2 The Contractor warrants that title to all Work covered by an Application for Payment will pass to the Owner no later than the time of payment. The Contractor further warrants that upon submittal of an Application for Payment, all Work for which Certificates for Payments have been previously issued and payments received from the Owner shall, to the best of the Contractor's knowledge, information and belief, be free and clear of liens, claims, security interests, or other encumbrances adverse to the Owner's interests.

7.2.2.1 Submit two (2) copies of each Application for Payment.

7.3 PROGRESS PAYMENTS

7.3.1 The Owner shall make payment in the manner provided in the Contract Documents.

7.3.2 The Contractor shall promptly pay each Subcontractor and material supplier, upon receipt of payment from the Owner, out of the amount paid to the Contractor on account of such entities' portion of the Work.

7.3.3 The Owner shall not have responsibility for the payment of money to a Subcontractor or material supplier.

7.3.4 A progress payment, or partial or entire use or occupancy of the Project by the Owner shall not constitute acceptance of Work not in accordance with the requirements of the Contract Documents.

7.4 SUBSTANTIAL COMPLETION

7.4.1 Substantial Completion is the state in the progress of the Work when the work or designated portion thereof is sufficiently complete in accordance with the Contract Documents so that the Owner can occupy or utilize the Work for its intended use.

7.4.1.1 At the stated Substantial Completion of the Work, a Punch list comprised of the Contractor's list of Work to be completed and the Owner's additions to the list shall be issued.

7.5 FINAL COMPLETION & FINAL PAYMENT

7.5.1 Upon receipt of a final Application for Payment, the Owner will inspect the Work. When the Owner finds the Work acceptable and the Contract fully performed, Owner will promptly issue a final Payment.

7.5.1.1 Completion or correction of all items on the punch list by the Contractor shall not waive the Owner's right to have other omissions and defects corrected at the Contractor's expense when such omissions and defects are discovered after completion of the Punch list items.

7.5.2 Final payment shall not become due until the Contractor submits to the Owner data establishing payment or satisfaction of obligations, such as receipts, claims, security interests, or encumbrances arising out of the Contract.

7.5.3 Acceptance of final payment by the Contractor, a Subcontractor, or material supplier shall constitute a waiver of claims by that payee except those previously made in writing and identified by that payee as unsettled at the time of final Application for Payment.

ARTICLE 8 - PROTECTION OF PERSONS & PROPERTY

8.1 SAFETY PRECAUTIONS & PROGRAMS

The Contractor shall be responsible for initiating, maintaining, and supervising all safety precautions and programs, including all those required by law in connection with performance of the Contract. The Contractor shall promptly remedy damage and loss of property caused in whole or in part by the Contractor, or by anyone for whose acts the Contractor may be liable.

ARTICLE 9 - CORRECTION OF WORK

9.1 The Contractor shall promptly correct Work rejected by the Owner as failing to conform to the requirements of the Contract Documents. The Contractor shall bear the cost of correcting such rejected Work.

9.2 In addition to the Contractor's other obligations including warranties under the Contract, the Contractor shall, for a period of one (1) year after Substantial Completion, correct work not conforming to the requirements of the Contract Documents.

9.3 If the Contractor fails to correct nonconforming Work within a reasonable time, the Owner may correct it and the Contractor shall reimburse the Owner for the cost of correction.

ARTICLE 10 - MISCELLANEOUS PROVISIONS

10.1 ASSIGNMENT OF CONTRACT

Neither party to the Contract shall assign the Contract as a whole without written consent of the other.

10.2 TESTS & INSPECTIONS

10.2.1 Tests, inspections, and approvals of portions of the Work required by the Contract Documents or by laws, ordinances, rules, regulations, or orders of public authorities having jurisdiction shall be made at an appropriate time.

10.2.2 If the Owner requires additional testing, the Contractor shall perform these tests.

10.2.3 The Owner shall pay for tests except for testing Work found to be defective for which the Contractor shall pay.

10.3 GOVERNING LAW

The Contract shall be governed by the law of the State of Wisconsin.

ARTICLE 11 - TERMINATION OF THE CONTRACT

11.1 TERMINATION BY THE CONTRACTOR

If the Owner fails to make payment when due or substantially breaches any other obligation of this Contract, following seven (7) days written notice to the Owner, the Contractor may terminate the Contract and recover from the Owner payment for Work executed and for proven loss with respect to materials, equipment, tools, construction equipment and machinery, including reasonable overhead, profit, and damages.

11.2 TERMINATION BY OWNER

11.2.1 The Owner may terminate the Contract if the Contractor:

11.2.1.1 persistently or repeatedly refuses or fails to supply enough properly skilled workers or proper materials;

11.2.1.2 fails to make payment to Subcontractors for materials or labor in accordance with the respective agreements between the Contractor and the Subcontractors;

11.2.1.3 persistently disregards laws, ordinances, or rules, regulations, or orders of a public authority having jurisdiction; or

11.2.1.4 is otherwise guilty of substantial breach of a provision of the Contract Documents.

11.2.2 When any of the above reasons exist, the Owner, may without prejudice to any other rights or remedies of the Owner and after giving the Contractor and the Contractor's survey, if given seven (7) days written notice, terminate employment of the Contractor and may:

11.2.2.1 take possession of the site and of all materials thereon owned by the Contractor; or

11.2.2.2 finish the Work by whatever reasonable method the Owner may deem expedient.

11.2.3 When the Owner terminates the Contract for one (1) of the reasons stated in Subparagraph 11.2.1, the Contractor shall not be entitled to receive further payment until the Work is finished.

11.2.4 If the unpaid balance of the Contract Sum exceeds costs of finishing the Work, such excess shall be paid to the Contractor. If such costs exceed the unpaid balance, the Contractor shall pay the difference to the Owner. This obligation for payment shall survive termination of the Contract.

11.2.5 The Contract may also be terminated by the Owner according to the provisions set forth in "Marathon County Procurement Policy" included in the Project Manual.

ARTICLE 12 - INSURANCE

12.1 CONTRACTOR'S INSURANCE

12.1.1 The Contractor shall purchase and maintain, in a company or companies lawfully authorized to do business in the jurisdiction in which the Project is located, insurance as set forth in Section 00 73 10 - Marathon County Procurement Policy in the Project Manual.

END OF SECTION 00 72 00

SECTION 00 73 10
PROCUREMENT POLICY
(MARATHON COUNTY STANDARD TERMS & CONDITIONS)

1.0 SPECIFICATIONS: The Specifications in any request for bids or proposal which forms the subject of this contract are the minimum acceptable. When specific manufacturer and model numbers are used, they are to establish a design, type of construction, quality, functional capability, and/or performance level desired. When alternates are bid/proposed/provided, they must be identified by manufacturer, stock number, and such other information necessary to establish equivalency. Marathon County shall be the sole judge of equivalency. Contractors are cautioned to avoid bidding/proposing alternates to the specifications which may result in rejection of their bid/proposal.

2.0 DEVIATIONS & EXCEPTIONS: Deviations and exceptions from original text, terms, conditions, or specifications shall be described fully, on the Contractor's letterhead, signed, and attached to the response to request. In the absence of such statement, the bid/proposal shall be accepted as in strict compliance with all terms, conditions, and specifications and the Contractor shall be held liable.

3.0 ACCEPTANCE-REJECTION OF BIDS OR PROPOSALS: Marathon County reserves the right to accept or reject any or all bids/proposals, to waive any technicality in any bid/proposal submitted, and to accept any part of a bid/proposal as deemed to be in the best interests of Marathon County. Bids/proposals MUST be date and time stamped by the office of the soliciting purchasing agent on or before the date and time that the bid/proposal is due. Bids/proposals date and time stamped in another office will be rejected. Receipt of a bid/proposal by the mail system does not constitute receipt of a bid/proposal by the purchasing agent’s office.

4.0 METHOD OF AWARD: Award of bids shall be made to the lowest responsible, responsive bidder unless otherwise specified. Award of proposals shall be subject to criteria set for in the request for proposal.

5.0 QUALITY: Unless otherwise indicated in the request, all material shall be first quality. Items which are used, demonstrators, obsolete, seconds, or which have been discontinued are unacceptable without specific prior written approval by Marathon County.

6.0 WARRANTY: Unless otherwise specifically stated by the bidder/proposer, equipment purchased as a result of this request shall be warranted against defects by the bidder/proposer for one (1) year from date of receipt. The equipment manufacturer's standard warranty shall apply as a minimum and must be honored by Contractor.

7.0 DELIVERY: Deliveries shall be F.O.B. destination freight prepaid and included unless otherwise specified. Failure of the Vendor to adhere to delivery schedules as specified or to promptly replace rejected materials shall render Contractor liable for all costs in excess of the contract price when alternate procurement is necessary. Excess costs shall include the administrative costs.

8.0 ORDERING: Purchase orders shall be placed directly to Contractor by authorized departments or purchasing agents who have issued the request for bids or proposal. No other purchase orders are authorized.

9.0 PAYMENT TERMS & INVOICING: Marathon County normally will pay properly submitted Contractor invoices within thirty (30) days of receipt providing goods and/or services have been delivered, installed (if required), and accepted as specified.

9.1 Invoices presented for payment must be submitted in accordance with instructions contained on the purchase order including reference to purchase order number and submittal to the correct address for processing.

9.2 A good faith dispute creates an exception to prompt payment.

10.0 TAXES: Marathon County and its departments are exempt from payment of all federal tax and Wisconsin state and local taxes on its purchases except Wisconsin excise taxes as described below. Marathon County, including all its departments, is required to pay the Wisconsin excise or occupation tax on its purchase of beer, liquor, wine, cigarettes, tobacco products, motor vehicle fuel, and general aviation fuel. However, it is exempt from payment of Wisconsin sales or use tax on its purchases. Marathon County may be subject to other states' taxes on its purchases in that state depending on the laws of that state. Contractors performing construction activities are required to pay state use tax on the cost of materials.

11.0 CONTRACT INTEGRATION: These Standard Terms and Conditions shall apply to any contract or order awarded as a result of a request except where special requirements are stated elsewhere in the request; in such cases, the special requirements shall apply. The documents constituting the contract between Marathon County and Contractor are intended to be complementary so that what is required by any one (1) of them shall be as binding as if called for by all of them. In the event of any conflicting provisions or requirements within the several parts of the Contract Documents, they shall take precedence in the following order: Change Orders (with the most recent taking precedence); Contract Document Amendments; the Contract Document as described in this signed Agreement; Request for Proposal Addenda; Request for Proposal; and Firm's Proposal. Any terms of any other documents concerning this agreement are superseded by the terms set forth herein.

12.0 APPLICABLE LAW & COMPLIANCE: This contract shall be governed under the laws of the State of Wisconsin. Contractor shall at all times comply with and observe all federal and state laws, local laws, ordinances, and regulations which are in effect during the period of this contract and which in any manner affect the work or its conduct. Marathon County reserves the right to cancel this contract if Contractor fails to follow the requirements of s. 77.66, Wis. Stats., and related statutes regarding certification for collection of sales and use tax.

13.0 SAFETY REQUIREMENTS: All materials, equipment, and supplies provided to Marathon County must comply fully with all safety requirements as set forth by the Wisconsin Administrative Code and all applicable OSHA Standards.

13.1 Contractor shall execute and maintain its work so as to avoid injury or damage to any persons or property. Contractor shall comply with the requirements and specifications relating to safety measures applicable in particular operations or kinds of work. In carrying out its work, Contractor shall, at all times, exercise all necessary precautions for the safety of employees appropriate to the nature of the work and the conditions under which the work is to be performed and be in compliance with all applicable federal, state, and local statutory and regulatory requirements including Wisconsin Labor Code and the U.S. Department of Transportation Omnibus Transportation Employee Testing Act, including the obligation to conduct safety inspections to verify said compliance by its employees, agents, and/or subcontractors.

13.2 Contractor is specifically notified that it is subject to federal requirements listed under Title 29, Chapter 15 of the United States Code (Occupational Health and Safety Act) by virtue of its contract with Marathon County, a public entity. Contractor shall provide a similar notice to all its subcontractors.

13.3 SAFETY DATA SHEET: If any item(s) on an order(s) resulting from this award(s) is a hazardous chemical, as defined under 29CFR 1910.1200, provide one (1) copy of a Material Safety Data Sheet for each item with the shipped container(s) and one (1) copy with the invoice(s).

14.0 INSURANCE REQUIREMENTS: Contractor shall not commence work under this contract until all insurance required under this paragraph is obtained, and such insurance has been approved Marathon County, nor shall Contractor allow any subcontractor to commence work on their subcontract until all similar insurance requirements have been obtained and approved.

14.1 Maintain worker's compensation insurance as required by Wisconsin Statutes, for all employees engaged in the Work. In case any work is sublet, Contractor shall require the subcontractor similarly to provide statutory Workers' Compensation Insurance for all of the latter's employees, unless such employees are covered by the protection afforded by Contractor.

14.2 **General Liability, Professional Liability, & Property Damage Insurance.** Contractor shall secure and maintain in force throughout the duration of this contract such General Liability, Professional Liability (if necessary), and Property Damage Insurance as shall protect itself and any subcontractor performing work covered by this contract from claims for damages for personal injuries including accidental death, as well as from claims for property damage, which may arise from operations under this contract, whether such operations be by Contractor, or by any subcontractor or by anyone directly or indirectly employed by either of them; and the amount of such insurance shall be as follows:

- Comprehensive General Liability $1,000,000 per occurrence and $2,000,000 in aggregate for bodily injury and Property Damage.
- Professional Liability Coverage, $1,000,000 per occurrence and $2,000,000 in aggregate.
- Automobile Liability $1,000,000 per occurrence and $2,000,000 in aggregate for bodily injury and property damage.
- Excess Liability Coverage, $1,000,000 over the General Liability and Automobile Liability Coverage.
- If aircraft are used in conjunction with this Project, $2,000,000 per occurrence and in aggregate for bodily injury and property damage.

14.3 Marathon County reserves the right to require higher or lower limits where warranted.

14.4 Marathon County reserves the right to require additional security, including, but not limited to, bid bonds or performance bonds as specifically set forth in its request for bids or proposals.

14.5 PROOF OF INSURANCE: Contractor shall furnish the County with a Certificate of Insurance countersigned by a Wisconsin Resident Agent or Authorized Representative of the insurer indicating that Contractor meets the insurance requirements identified above. The Certificates of Insurance shall include a provision prohibiting cancellation of said policies except upon thirty (30) days prior written notice to the County and specify the name of the contract or project covered. The Certificate of Insurance shall be delivered to the Authorized Purchasing Agent, with a copy of the Certificate of Insurance to be delivered to the Marathon County Risk Manager for approval prior to the execution of this contract. Upon renewal of the required insurance, and annually thereafter, the County shall receive a new Certificate of Insurance for three (3) years after completion of the Project. The Certificates shall name Marathon County as an additional insured and describe the contract by name and or identification number in the "Description of Operations" section of the form.

15.0 CANCELLATION / TERMINATION: Marathon County reserves the right to:

15.1 NONAPPROPRIATION OF FUNDS. Cancel any contract in whole or in part without penalty due to non-appropriation of funds or for failure of the Contractor to comply with terms, conditions, and specifications of this contract.

15.2 Terminate this contract, for the County's convenience, at any time by a notice in writing from the County to Contractor by certified mail. If the Contract is terminated by the County as provided herein, Contractor shall be paid an amount which bears the same ratio to the total compensation as the services actually performed bear to the total services of Contractor covered by this Contract, unless payments of compensation have previously been made.

16.0 CONTRACT MODIFICATIONS: The scope of the services to be performed under this Contract may be amended or supplemented by mutual written agreement between the parties to the Contract. This amendatory provision shall not operate to prevent Marathon County from exercising its reserved right to establish reasonable time schedules for any of the work or services to be performed by or deliveries to be received from Contractor hereunder. Furthermore, this amendatory provision shall not operate to prevent the County from cancelling any of the services not yet performed or any deliveries not yet made at the time notice is given to Contractor of the cancellation of such services or portion of the work to be performed hereunder.

17.0 ASSIGNMENT: No right or duty in whole or in part of the scope of work under this contract may be assigned or delegated without the prior written consent of Marathon County.

18.0 PATENT INFRINGEMENT: The Contractor selling articles to Marathon County as described herein guarantees the articles were manufactured or produced in accordance with applicable federal labor laws. Further, that the sale or use of the articles described herein will not infringe any United States patent. The Contractor covenants that it will at its own expense defend every suit which shall be brought against Marathon County (provided that such contractor is promptly notified of such suit, and all papers therein are delivered to it) for any alleged infringement of any patent by reason of the sale or use of such articles, and agrees that it will pay all costs, damages, and profits recoverable in any such suit.

19.0 PUBLIC RECORDS ACCESS: Marathon County is a political subdivision of the State of Wisconsin and as such is subject to the Wisconsin Public Records Law. It is the policy of Marathon County to maintain an open and public process in the solicitation, submission, review, and approval of procurement activities. Bid openings are public unless otherwise specified.

Evaluations of responses to requests for proposals are subject to further discussion, clarification, and negotiation. Records of bids and responses to requests for proposal will not be available for public inspection prior to issuance of the award of the contract.

20.0 PROPRIETARY INFORMATION: Any restrictions on the use of data contained within a response to request, must be clearly stated in the bid/proposal itself. Proprietary information submitted in response to a request will be handled in accordance with the Wisconsin Public Records Law. Proprietary restrictions normally are not accepted. However, when accepted, it is Contractor's responsibility to defend the determination in the event of an appeal or litigation.

20.1 Data contained in a bid/proposal, all documentation provided therein, and innovations developed as a result of the contracted commodities or services cannot be copyrighted or patented. All data, documentation, and innovations become the property of Marathon County.

20.2 Any material submitted by Contractor in response to Marathon County's request that the vendor considers confidential and proprietary information and which qualifies as a trade secret, as provided in s. 19.36(5), Wis. Stats., or material which can be kept confidential under the Wisconsin Public Records Law, must be identified and include citation to the specific provisions of law that preclude disclosure and any factual or background information necessary to establish that the identified provisions of the law apply to that particular information. Bid/proposal prices cannot, under any circumstances, be held confidential.

20.3 In the event Marathon County becomes involved in litigation due to Contractor's refusal of permission to release information identified as confidential or proprietary, Contractor agrees to indemnify, defend, and hold harmless Marathon County for any costs associated with said litigation.

21.0 CONFIDENTIALITY OF MARATHON COUNTY'S DATA: In the event work conducted under this contract requires Contractor to have access to Marathon County's database via Internet, direct contact or other connection to allow the provision of installation, support and maintenance services, Contractor agrees to keep all such data confidential and to execute any reasonable agreement to assure Marathon County that Contractor will comply with all state and federal confidentiality laws and/or regulations. These restrictions herein shall survive the termination of this contract, regardless of the reason for termination, and shall continue in full force and effect and shall be binding upon Contractor or its agents, employees, successors, assigns, or subcontractors. Contractor shall defend and incur all costs, if any, for actions that arise as a result of noncompliance by Contractor, its agents, employees, successors, assigns, and subcontractors regarding the confidentiality restrictions herein.

22.0 PROMOTIONAL ADVERTISING / NEWS RELEASES: Reference to or use of Marathon County, any of its departments, agencies or other subunits, or any county official or employee for commercial promotion is prohibited. News releases pertaining to this procurement shall not be made without prior approval of Marathon County. Release of broadcast e-mails pertaining to this procurement shall not be made without prior written authorization of Marathon County's purchasing agent.

23.0 MUTUAL HOLD HARMLESS / INDEMNIFICATION: Contractor hereby agrees to release, indemnify, defend, and hold harmless Marathon County, its officials, officers, employees and agents from and against all judgments, damages, penalties, losses, costs, claims, expenses, suits, demands, debts, actions and/or causes of action of any type or nature whatsoever,

including actual and reasonable attorney's fees, which may be sustained or to which they may be exposed, directly or indirectly, by reason of personal injury, death, property damage, or other liability, alleged or proven, which is determined to be caused by the negligent or intentional acts or omissions of Contractor 's officers, officials, employees, agents, or assigns. Marathon County hereby agrees to release, indemnify, defend, and hold harmless Contractor, its officials, officers, employees, and agents from and against all judgments, damages, penalties, losses, costs, claims, expenses, suits, demands, debts, actions, and/or causes of action of any type or nature whatsoever, including actual and reasonable attorney's fees, which may be sustained or to which they may be exposed, directly or indirectly, by reason of personal injury, death, property damage, or other liability, alleged or proven, which is determined to be caused by the negligent or intentional acts or omissions of Marathon County's officers, officials, employees, agents, or assigns. Marathon County does not waive, and specifically reserves, its rights to assert any and all affirmative defenses and limitations of liability as specifically set forth in Wisconsin Statutes, Chapter 893 and related statutes.

24.0 FORCE MAJEURE: Neither party shall be in default by reason of any failure in performance of this Agreement in accordance with reasonable control and without fault or negligence on their part. Such causes may include, but are not restricted to, acts of nature or the public enemy, acts of the government in either its sovereign or contractual capacity, fires, floods, epidemics, quarantine restrictions, strikes, freight embargoes, and unusually severe weather, but in every case the failure to perform such must be beyond the reasonable control and without the fault or negligence of the party.

25.0 GRATUITIES & KICKBACKS: It shall be unethical for any person to offer, give, or agree to give any elected official, employee or former employee, or for any elected official, employee or former employee to solicit, demand, accept, or agree to accept from another person, a gratuity or an offer for employment in connection with any decision, approval, disapproval, recommendation, preparation, or any part of a program requirement or a purchase request, influencing the contents of any specification or procurement standard, rendering of advice, investigation, auditing, or in any other advisory capacity in any proceedings or application, request for ruling, determination, claim or controversy, or other particular matter, pertaining to any program requirement or a contract or subcontract, or to any solicitation or proposal therefore. It shall be unethical for any payment, gratuity, or offer of employment to be made by or on behalf of a subcontractor under a contract to the prime contractor or a higher tier subcontractor or any person associated therewith, as an inducement for the award of a subcontract, or order.

26.0 DISPUTE RESOLUTION: This Contract and the performance of the parties' obligations hereunder will be governed by and construed and enforced in accordance with the laws of the State of Wisconsin, including conflict of law provisions. Contractor consents to personal jurisdiction in the State of Wisconsin. The venue of any action hereunder shall be in Marathon County, Wisconsin. If a dispute related to this agreement arises, all parties shall attempt to resolve the dispute through direct discussions and negotiations. If the dispute cannot be resolved by the parties, and if all parties agree, it may be submitted to either mediation or arbitration. If the matter is arbitrated, the procedures of Chapter 788 of the Wisconsin Statutes or any successor statute shall be followed. If the parties cannot agree to either mediation or arbitration, any party may commence an action in court as set forth above. If a lawsuit is commenced, the parties agree that the dispute shall be submitted to alternate dispute resolution pursuant to §802.12, Wis. Stats., or any successor statute. Unless otherwise provided in this Contract, the parties shall continue to perform according to the terms and conditions of the contract during the pendency of any litigation or other dispute resolution proceeding.

27.0 INDEPENDENT CONTRACTOR STATUS: The parties hereto agree that Contractor, its officers, agents and employees, in the performance of this Contract, shall act in the capacity of an independent contractor and not as an officer, employee, or agent of Marathon County. The Contractor shall not be entitled to any of the rights, benefits, salaries, wages, or fringe benefits which employees of Marathon County are eligible to receive. No federal, state, or local taxes or social security deductions or contributions shall be made by Marathon County on behalf of the Contractor. Neither Marathon County nor Contractor will represent itself as the agent or legal representative of the other or as partner or joint venture for any purpose whatsoever, and neither shall have any right to create or assume any obligation of any kind, express or implied, for or on behalf of the other in any way whatsoever. Furthermore, Contractor agrees to take such steps as are necessary to ensure that each of its subcontractors, if any, will not be considered to be an agent, servant, joint venture with, or partner of, Marathon County.

28.0 NON-DEBARMENT CLAUSE: Contractor hereby certifies that neither it nor any of its principal officers or officials has ever been suspended or debarred, for any reason whatsoever, from doing business or entering into contractual relationships with any governmental entity. Contractor further agrees and certifies that this clause shall be included in any subcontract of this Contract. Marathon County also reserves the right to cancel this contract with any federally debarred contractor or a contractor that is presently identified on the list of parties excluded from federal or State of Wisconsin procurement and non-procurement contracts.

29.0 STATEMENT OF COMPLIANCE: Contractor has carefully reviewed Marathon County's required contract language, as set forth in the Request for Proposal/Bid pertaining to termination of contract, change orders, gratuities and kickbacks, non-appropriation of funds, hold harmless/indemnification, insurance requirements/proof of insurance, dispute resolutions, and non-debarment, and is in full compliance with all statements and requirements.

30.0 WAIVER / SEVERABILITY: No waiver of any default hereunder shall be deemed as a waiver of any prior or subsequent default of the same or other provisions of this Contract. If any provision of this Contract is held invalid by a court of competent jurisdiction, such invalidity shall not affect the validity or operation of any other provision and said provision shall continue to apply to the extent allowed by said court or, if not so allowed, be deemed severed from this Contract entirely.

END OF SECTION 00 73 10

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SECTION 01 10 00
SUMMARY OF WORK

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Project description.
B. Phased construction.
C. Access to site.
D. Coordination with occupants.
E. Work restrictions.
F. Guarantees and warranties.

1.2 PROJECT DESCRIPTION

A. The Work of the Project is defined by the Contract Documents and consists of the Work indicated here within.
B. Type of Contract:
   1. Project will be constructed under a single prime contract.
C. Project Coordinator:
   1. The Mechanical Contractor shall act as the Project Coordinator on this Project.
   2. The Mechanical Contractor shall be responsible for scheduling the Work of all trades on this Project.
D. Scope of Work:
   1. Mechanical:
      a. Demolish existing steam to hot water heat exchanger and condensate pump in the existing Mechanical Room with associated steam and condensate piping. Turn over condensate pump to the Owner.
      b. Provide new hot water system including boilers, pumps, and hydronic accessories.
      c. Fill the hot water system with water.
      d. Coordinate water treatment of the system.
      e. Install all control valves and sensor wells provided by the Temperature Controls Contractor.
      f. Responsible for scheduling of all work.
      g. Provide and maintain outdoor trash dumpsters for all works and trades on the Project during the entire construction period.
      h. All HVAC work indicated in the Contract Documents.
   2. Plumbing:
      a. Provide new floor drains and hub drains in the Mechanical Room connected to the existing sanitary sewer system.
   3. Electrical:
      a. Demolition of the existing hot water pumps and condensate pump.
      b. Relocate the existing variable frequency drives.
      c. Installation of new equipment for the hot water system.
      d. All electrical work indicated in the Contract Documents.
   4. Temperature Controls:
      a. Demolish all existing controls serving the hot water system.
      b. Provide new controls and control valves for the hot water system.
      c. Fully integrated all new controls into the existing Johnson Controls direct digital control system.
      d. Maintain all existing controls for the entire facility during the construction period. All existing equipment not designated to be demolished shall remain fully functional and operational.

e. Provide new system graphics for the hot water system.

5. General Construction:
   a. Patch all wall openings as part of the new and demolition work to match the existing conditions.
   b. Patch all wall and floor openings in the Mechanical Room to provide a fire rated room.
   c. Provide concrete housekeeping pads for the equipment.

1.3 PHASED CONSTRUCTION

A. The Work shall be conducted in multiple phases with each phase substantially complete and ready for occupancy prior to proceeding with the next phase.

B. Before commencing Work of each phase, submit an updated copy of Contractor's construction schedule showing the sequence, commencement, and completion dates for all phases of the Work.

C. The Project will consist of three (3) phases:
   1. Installation of the boiler and hot water system components in the Mechanical Room to the maximum extent possible.
   2. Drain the existing hot water system, connect the new hot water system to the existing distribution system, install dielectric fittings in two (2) locations as directed by the Owner, and fill and treat the water in the new system.
   3. Demolish the existing steam heating system and associated equipment.

1.4 ACCESS TO SITE

A. General: Contractor shall have limited use of Project site for construction operations as indicated on the Drawings by the Contract limits and as indicated by requirements of this Section.

B. Use of Site: Limit use of Project site to areas within the Contract limits indicated for each phase. Do not disturb portions of Project site beyond areas in which the Work is indicated. If access is required outside of the Contract limits, discuss with Owner for access requirements.
   1. Driveways, Walkways, & Entrances: Keep driveways, loading areas, 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.
      a. Schedule deliveries to minimize use of driveways and entrances by construction operations.
      b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on site.

C. Condition of Existing Building: Maintain portions of existing building affected by construction operations in a weathertight condition throughout construction period. Repair damage caused by construction operations.

D. Condition of Existing Grounds:
   1. Maintain portions of existing grounds, landscaping, and hardscaping affected by construction operations throughout construction period.
   2. Patch and/or clean existing improvements and restore damage caused by construction operations including but not limited to lawns, walks, curbs, pavements, roadways, structures, and utilities which are cut or damaged by operations and not designated for removal in the course of construction.
   3. Document existing conditions and provide written acceptance of restoration work by Owner.

E. Building Access: The Contractor’s will be provided card access to the building during the Project.

1.5 COORDINATION WITH OCCUPANTS

A. Owner Occupancy: Owner will occupy the site and building during the entire construction period. Cooperate with Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with Owner's day-to-day operations. Maintain existing exits unless otherwise indicated.
   1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from Owner and approval of authorities having jurisdiction.
   2. Notify Owner not less than two (2) days in advance of activities that will affect Owner's operations.

1.6 WORK RESTRICTIONS

A. Work Hours: Limit work in the building to normal business working hours of 6:00 AM to 5:00 PM, Monday through Friday, unless special arrangements are made with the Owner.
B. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner without written permission. Notify the Owner two (2) days in advance of proposed utility interruptions.
C. Noise, Vibration, & Odors: Coordinate operations that may result in high levels of noise and vibration, odors, or other disruption to Owner occupancy with Owner.
D. Restricted Substances: Use of tobacco products and other controlled substances is not permitted on the Project site.
E. Employee Identification: Provide identification tags for Contractor personnel working on Project site. Require personnel to use identification tags at all times.
F. Parking: Construction personnel may park only in the areas designated by the Owner.
G. Job Trailers: Not allowed.
H. Equipment Storage:
   1. Confine stockpiling of materials or equipment to the location as directed by the Owner.
   2. If additional storage is required and not allowed by the Owner, obtain and pay for such storage offsite.

1.7 GUARANTEES & WARRANTIES

A. Guarantee in writing that all work installed shall be free from defects in workmanship and materials; that all apparatus shall develop capacities and characteristics specified; and that if during the period of one (1) year (or as otherwise specified) from the date of Substantial Completion, any defects in workmanship, material or performance appear, the Contractor shall remedy such defects within a reasonable time as specified in notice from the Owner's Representative without cost to the Owner.
B. In default thereof, the Owner shall have the work done and charge the cost of the work to the Contractor.
C. Furnish guarantees and manufacturer written warranties for all equipment, stating effective date of Warranty, in the Operation and Maintenance manual.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 01 10 00

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SECTION 01 25 00
SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Administrative and procedural requirements for substitutions.

1.2 DEFINITIONS

A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.
   1. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
   2. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

1.3 SUBMITTALS

A. Substitution Requests: Submit each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
   1. Substitution Request Form: Use Contractor's standard form on letterhead.
   2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
      a. Statement indicating why specified product or fabrication or installation method cannot be provided, if applicable.
      b. Coordination of information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.
      c. Detailed comparison of significant qualities of proposed substitutions with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes, such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
      d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
      e. Certificates and qualification data, where applicable or requested.
      f. List of similar installations for completed projects, with project names and addresses as well as names and addresses of Engineers and Owners, where applicable or requested.
      g. Material test reports from a qualified testing agency, indicating and interpreting test results for compliance with requirements indicated.
      h. Detailed comparison of Contractor's construction schedule using proposed substitutions with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.

i. Cost information, including a proposal of change, if any, in the Contract Sum.
j. Contractor's certification that proposed substitution complies with requirements in the Contract Documents, except as indicated in substitution request, is compatible with related materials and is appropriate for applications indicated.
k. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

3. Engineer's Action: If necessary, Engineer will request additional information or documentation for evaluation within five (5) days of receipt of a request for substitution. Engineer will notify Contractor of acceptance or rejection of proposed substitution within ten (10) days of receipt of request, or ten (10) days of receipt of additional information or documentation, whichever is later.
   a. Forms of Acceptance: Change Order, Construction Change Directive, or Construction Bulletin for minor changes in the Work.
   b. Use product specified if Engineer rejects substitution request or does not issue a decision on use of a proposed substitution within time allocated.

1.4 PROCEDURES

A. Coordination: Revise or adjust affected work as necessary to integrate work of the approved substitutions.

1.5 SUBSTITUTIONS

A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than fifteen (15) days prior to time required for preparation and review of related submittals.
   1. Conditions: Engineer will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Engineer will return requests without action, except to record noncompliance with these requirements:
      a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
      b. Substitution request is fully documented and properly submitted.
      c. Requested substitution will not adversely affect Contractor's construction schedule.
      d. Requested substitution has received necessary approvals of authorities having jurisdiction.
      e. Requested substitution is compatible with other portions of the Work.
      f. Requested substitution has been coordinated with other portions of the Work.
      g. Requested substitution provides specified warranty.
      h. If requested substitution involves more than one (1) Contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

B. Substitutions for Convenience: Engineer will consider requests for substitution if received four (4) days prior to Submittal of Bids. Requests received after that time may be considered or rejected at discretion of Engineer.
   1. Conditions: Engineer will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Engineer will return requests without action, except to record noncompliance with these requirements:

a. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Engineer for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
b. Items listed above in Substitution for Cause.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 01 25 00

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SECTION 01 26 00
CONTRACT MODIFICATION PROCEDURES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Request for information.
B. Proposal requests.
C. Construction change directive.
D. Change order procedures.

1.2 REQUEST FOR INFORMATION (RFI)

A. General: Immediately on discovery of the need for additional information, clarification, or interpretation of the Contract Documents.
   1. Prime Contractor shall collect, distribution, manage, and submit all RFIs. Engineer will return without response those RFIs submitted by other entities controlled by the Prime Contractor.
   2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.
B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
   1. Date.
   2. RFI number, numbered sequentially.
   3. RFI subject.
   4. Specification Section number and title and related paragraphs, as appropriate.
   5. Drawing number and detail references, as appropriate.
   6. Field dimensions and conditions, as appropriate.
   7. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
C. RFI Forms: Contractor shall prepare and submit the RFI on the Contractor’s standard form in electronic format with all attachments bound in a single PDF file.
D. Engineer’s Action: Engineer will review each RFI, determine action required, and respond. Allow five (5) working days for Engineer’s response for each RFI. RFIs received by Engineer after 1:00 PM will be considered as received the following working day.
   1. The following Contractor generated RFIs will be returned without action:
      a. Requests for approval of submittals.
      b. Requests for approval of substitutions.
      c. Requests for approval of Contractor's means and methods.
      d. Requests for coordination information already indicated in the Contract Documents.
      e. Requests for adjustments in the Contract Time or the Contract Sum.
      f. Incomplete RFIs or inaccurately prepared RFIs.
   2. Engineer’s action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit a Change Proposal.
      a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Engineer in writing within five (5) working days of receipt of the RFI response.
E. RFI Log: Engineer will prepare and maintain a log of RFIs organized by the RFI number.

1.3 PROPOSAL REQUESTS

A. Owner Initiated Proposal Requests: Engineer will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
   1. Work Change Proposal Requests are not instructions either to stop work in progress or to execute the proposed change.
   2. Within ten (10) working days after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.
      a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
      b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
      c. Include costs of labor and supervision directly attributable to the change.
      d. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship if a change in Contract Time is required. Use available total float before requesting an extension of the Contract Time.
      e. Quotation Form: Use forms acceptable to the Engineer providing justification for the proposed Contract Sum and Contract Time impacts to the Project.

B. Contractor Initiated Proposals: If latent or changed conditions require modifications to the Contract, Contractor may initiate a claim by submitting a request for a change to the Engineer.
   1. Provide a complete description of the proposed change, including a statement outlining reasons for the change and the effect of the change on the Work.
   2. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.
   3. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
   4. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
   5. Include costs of labor and supervision directly attributable to the change.
   6. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship if a change in Contract Time is required. Use available total float before requesting an extension of the Contract Time.
   7. Comply with requirements in Section 01 25 00 if the proposed change requires substitution of a product or system for a product or system specified.
   8. Proposal Request Form: Use forms acceptable to the Engineer providing justification for the proposed Contract Sum and Contract Time impacts to the Project.

1.4 CONSTRUCTION CHANGE DIRECTIVE

A. Construction Change Directive: Engineer may issue a Construction Change Directive that instructs the Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.
   1. Construction Change Directive contains a complete description of change in the Work. It also designates method to be followed to determine change in the Contract Sum or the Contract Time.

B. Documentation: Maintain detailed records on time and material work required by the Construction Change Directive.
   1. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

1.5 CHANGE ORDER PROCEDURES

A. On Owner's approval of a Work Change Proposal Request or Construction Change Directive, Engineer will issue a Change Order for signatures of Owner and Contractor.
B. Proposal Requests are not authorized until complete execution of a Change Order.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 01 26 00

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SECTION 01 31 00
PROJECT MANAGEMENT & COORDINATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. General coordination procedures.
B. Coordination drawings.
C. Digital project management procedures.
D. Project meetings.

1.2 GENERAL COORDINATION PROCEDURES

A. Coordination: Each Contractor shall cooperate with the Project Coordinator who shall coordinate its construction operations with those of other Contractors and entities to ensure efficient and orderly installation of each part of the Work. Each Contractor shall coordinate its own operations with operations included in different Sections that depend on each other for proper installation, connection, and operation.
   1. Schedule construction operations in sequence required to obtain the best results where installation of one (1) part of the Work depends on installation of other components, before or after its own installation.
   2. Coordinate installation of different components with other contractors to ensure maximum performance and accessibility for required maintenance, service, and repair.
   3. Make adequate provisions to accommodate items scheduled for later installation.
B. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities, scheduled activities of other contractors, and direction of Project coordinator to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
   1. Preparation of construction schedule.
   2. Installation and removal of temporary facilities and controls.
   3. Delivery and processing of submittals.
   4. Contract modification procedures.
   5. Progress meetings.
   6. Pre-installation conferences.
   7. Project closeout activities.
   8. Startup and adjustment of systems.

1.3 COORDINATION DRAWINGS

A. Coordination Drawings: Contractors shall prepare Coordination Drawings as determined necessary by the Project Coordinator for coordination between other trades 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 a single entity.
   1. 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:
      a. Use applicable Drawings as a basis for preparation of Coordination Drawings. Prepare sections, elevations, and details as needed to describe relationship of various systems and components.

b. Coordinate the addition of trade specific information to Coordination Drawings by multiple contractors in a sequence that best provides for coordination of the information and resolution of conflicts between installed components before submitting for review.
c. Indicate functional and spatial relationships of components of architectural, structural, mechanical, and electrical systems.
d. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
e. Show location and size of access doors required for access to concealed dampers, valves, and other controls.
f. Indicate required installation sequences.
g. 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 Engineer indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

1.4 DIGITAL PROJECT MANAGEMENT PROCEDURES

A. Use of Engineer's Digital Data Files: Digital data files of Engineer's design model and/or CAD drawings can be provided by the Engineer, if requested, for the Contractor's use during construction.
1. Digital data files may be used by Contractor in preparing Coordination Drawings, Shop Drawings, and Project Record Drawings.
2. Engineer makes no representations as to the accuracy or completeness of digital data files as they relate to the Contract Drawings. Contractor accepts the model and/or CAD files as is and assumes all risk in use of the Engineer's digital data files.

1.5 PROJECT MEETINGS

A. Pre-Construction Conference: Engineer will schedule and conduct a pre-construction conference before starting construction, at a time convenient to the Owner, Engineer, and Prime Contractor.
1. Attendees: Authorized representatives of Owner, Engineer, Prime Contractor and its superintendent; major subcontractors; and other concerned parties.
2. Agenda: Discuss items of significance that could affect progress, including the following:
a. Construction schedule.
b. Phasing.
c. Critical work sequencing and long lead items.
d. Lines of communications.
e. Procedures for contract modification procedures.
f. Submittal procedures.
g. Preparation of Record Documents.
h. Use of the premises and existing building.
i. Work restrictions.
j. Working hours.
k. Owner's occupancy requirements.
l. Temporary facilities and controls.
m. Procedures for disruptions and shutdowns.
n. Construction waste management and recycling.
o. Parking availability.
p. Office, work, and storage areas.
q. Project closeout.
3. Minutes: Engineer will record and distribute meeting minutes.

B. Progress Meetings: Engineer and Project Coordinator will conduct progress meetings at appropriate intervals.
   1. Attendees: Authorized representatives of Owner, Engineer, Prime Contractor and its superintendent; major subcontractors; and other concerned parties.
   2. Agenda:
      a. Resolution of coordination conflicts.
      b. Status of submittals.
      c. Field observations and status of correction of deficient items.
      d. Status of RFIs.
      e. 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.
      f. Status of Contract modifications.
      g. Next meeting scheduled.
   3. Minutes: Engineer will record and distribute meeting minutes.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 01 31 00

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SECTION 01 33 00
SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Administrative and procedural requirements for submittals.

1.2 SUBMITTAL SCHEDULE

A. Submit a list of submittals within ten (10) days after award of Contract in conjunction with a list of proposed suppliers for the Project.
B. Arrange submittals in chronological order by dates required by construction schedule.
C. Provide adequate submittal processing time to allow completion of the review, revision by Contractor, and review of resubmittal if required.
D. Coordinate submittal schedule with subcontractors and Contractor's construction schedule.
E. Include submittals required during the first sixty (60) days of construction. List those submittals required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.

1.3 SUBMITTAL REQUIREMENTS

A. Prepare and submit submittals required by individual Specification Sections.
B. Submittal Information: Include the following information in each submittal:
    1. Project name.
    2. Date.
    3. Name of Contractor.
    4. Name of firm or entity that prepared submittal.
    5. Names of subcontractor, manufacturer, and supplier.
    6. Unique submittal number, including revision identifier. Include Specification Section number with sequential alphanumeric identifier; and alphanumeric suffix for resubmittals.
    7. Number and title of Specification Section, with paragraph number and generic name for each of multiple items.
    8. Remarks.
    9. Signature of transmitter.
C. Format: Assemble each submittal into a single, separate, PDF package, and transmit to Engineer via email. Include PDF transmittal form as a cover page in the submittal.
    1. Identify features of the submittal which may not be in conformance with the Contract Documents.
    2. Name file sequentially with submittal number as described above.
    3. Submittals shall be on 8-1/2” by 11” sheets unless 11” by 17” is required to show sufficient detail.
D. Submittal Data: Prepare and collect Project specific information for each element of construction and type of product or equipment.
    1. Mark each copy of each submittal to show which products and options that are applicable by highlighting selections. Specifically identify selections by crossing out items not applicable to the equipment submitted.
    2. Use product identification tags to designate equipment selections.
    3. Include the following information, as applicable:
        a. Manufacturer's catalog cuts.
        b. Manufacturer's product specifications.
        c. Standard color charts.

d. Dimensions.
e. Materials of construction.
f. Statement of compliance with specified referenced standards.
g. Testing by recognized testing agency.
h. Application of testing agency labels and seals.
i. Notation of coordination requirements.
j. Schedules.

4. For equipment, include the following in addition to the above, as applicable:
   a. Wiring diagrams that show factory installed wiring.
   b. Printed performance and operating criteria, ratings, and curves.
   c. Operational range diagrams.
   d. Clearances required to other construction.
   e. Location of utility inlets or outlets.

E. Deviations & 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 Engineer on previous submittals.

F. Certificates:
   1. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents as specified.
   2. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.

G. Test Reports:
   1. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.

1.4 SUBMITTAL PROCEDURES

A. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
   1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
   2. Submit all submittal items required for each Specification Section concurrently unless partial submittals are required for scheduling purposes.
   3. Coordinate transmittal of submittals for related parts of the Work specified in different Sections so processing will not be delayed because of need to review submittals concurrently for coordination.

B. Processing Time: Allow time for submittal review, including time for resubmittals. Time for review shall commence on Engineer’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.
   1. Initial Review: Allow five (5) days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Engineer will advise Contractor when a submittal being processed must be delayed for coordination.
   2. Resubmittal Review: Allow five (5) days for review of each resubmittal.
   3. Concurrent Consultant Review: Where the Contract Documents indicate that submittals may be transmitted to Engineer and to Engineer’s consultants, allow ten (10) days for review of each submittal. Submittal will be returned to Engineer before being returned to Contractor.

4. Next Day: Submittals received by Engineer after 1:00 PM will be considered as received the following working day.

C. Resubmittals: Make resubmittals in the same form as the initial submittal.
   1. Mark revised submittals with the original number and include the letter R and a number indicating the resubmittal number.
   2. Note date and content of previous submittal.
   3. Note date and content of revision on company letterhead and clearly indicate extent of revision.
   4. Address the previous shop drawing comments and identify any changes made since the previous submittal.

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

E. Use for Construction: Retain complete approved copies of submittals on Project site.

1.5 CONTRACTOR'S REVIEW

A. 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. Make corrections necessary for coordination and compliance prior to submitting to Engineer.

B. Contractor's Approval: Indicate Contractor's approval for each submittal with an approval stamp before sending to Engineer. 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.

1.6 ENGINEER’S REVIEW

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

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

C. Engineer will return without review submittals received from sources other than Prime Contractor.

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

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 01 33 00

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SECTION 01 50 00
TEMPORARY FACILITIES & CONTROLS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Requirements for temporary utilities, support facilities, and security and protection of facilities.

1.2 USE CHARGES

A. General: Installation and removal 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.
B. Electric Power Service from Existing System: Electric power from Owner's existing system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.
C. Gas Service from Existing System: Natural gas heat from Owner's existing system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.

PART 2 - PRODUCTS

2.1 TEMPORARY FACILITIES

A. Field Offices: Not allowed. The Project Coordinator shall coordinate with the Owner if meeting space is required.
B. Sanitary Facilities: Contractors are permitted to use the Owner’s indoor sanitary facilities.

2.2 EQUIPMENT

A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.
B. HVAC Equipment: Not required.

PART 3 - EXECUTION

3.1 TEMPORARY FACILITIES

A. 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.

3.2 TEMPORARY UTILITY INSTALLATION

A. Water Service: Not required.
B. Sanitary Facilities: Use of Owner's existing toilet facilities will be permitted, as long as facilities are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore these facilities to condition existing before initial use.
C. Isolation of Work Areas in Occupied Facilities: Prevent dust, fumes, and odors from entering occupied areas. Isolate HVAC system in area of work to maximum extent practical during construction.

D. Electric Power Service: Connect to Owner's existing electric power service. Maintain equipment in a condition acceptable to Owner.

3.3 SUPPORT FACILITIES INSTALLATION

A. Traffic Controls: Comply with requirements of authorities having jurisdiction.
   1. Protect existing site improvements to remain including curbs, pavement, and utilities.
   2. Maintain access for firefighting equipment and access to fire hydrants.
B. Parking: Use designated areas of Owner's existing parking areas for construction personnel.
C. Waste Disposal Facilities: Provide waste collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction. Provide cleaning at regular intervals.

3.4 SECURITY & PROTECTION FACILITIES INSTALLATION

A. 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.
B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.
C. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.
D. Construction Barriers: Provide cones and caution tape to create a barrier for the construction zone from building occupants.

3.5 OPERATION, TERMINATION, & REMOVAL

A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.
B. Maintenance: Maintain facilities in good operating condition until removal.
C. Termination & 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.

END OF SECTION 01 50 00

SECTION 01 60 00
PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Administrative and procedural requirements for selection of products.
B. Product delivery, storage, and handling.
C. Manufacturer's warranties.

1.2 DEFINITIONS

A. Products: Items obtained for incorporating into the Work, whether purchased for the Project or taken from previously purchased stock. The term product includes the terms material, equipment, system, and terms of similar intent.
   1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.
   2. New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.

1.3 QUALITY ASSURANCE

A. Compatibility of Options: If Contractor is given option of selecting between two (2) or more products for use on the Project, select product compatible with products previously selected, even if previously selected products were also options.
   1. Each Contractor is responsible for providing products and construction methods compatible with products and construction methods of other contractors.
B. Identification of Products: Except for required labels and operating data, do not attach or imprint manufacturer or product names or trademarks on exposed surfaces of products or equipment that will be exposed to view in occupied spaces or on the exterior.
   1. Labels: Locate required product labels and stamps on a concealed surface, or, where required for observation following installation, on a visually accessible surface that is inconspicuous.
   2. Equipment Nameplates: Provide a permanent nameplate on each item of service connected or power operated equipment. Locate on a visually accessible but inconspicuous surface. Include information essential for operation, including the following:
      a. Name of product and manufacturer.
      b. Model and serial number.
      c. Capacity.
      d. Speed.
      e. Ratings.
   3. Provide additional identification of equipment as specified in Divisions 23 and 26.

1.4 PRODUCT DELIVERY, STORAGE, & HANDLING

A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with the manufacturer's instructions.

B. Delivery & Handling:
   1. Schedule delivery to minimize long term storage at Project site and to prevent overcrowding of construction spaces.
   2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
   3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
   4. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged, quantities are correct, comply with the requirements, and are properly protected.

C. Storage:
   1. Store products to allow for inspection and measurement of quantity or counting of units.
   2. Store materials in a manner that will not endanger Project structure.
   3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
   4. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
   5. Comply with product manufacturer's instructions for temperature, humidity, ventilation, and weather protection requirements for storage.
   6. Protect stored products from damage and liquids from freezing.
   7. Provide a secure location and enclosure at Project site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner.
   8. For exterior storage of products, do not store materials directly on grade.

1.5 PRODUCT WARRANTIES

A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
   1. Manufacturer's Warranty: Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
   2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner.

B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.
   1. Manufacturer's Standard Form: Modified to include Project specific information and properly executed.
   2. Specified Form: When specified forms are included with the Specifications, prepare a written document using indicated form properly executed.
   3. See other Sections for specific content requirements and particular requirements for submitting special warranties.

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.

1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations.
3. Owner reserves the right to limit selection to products with warranties meeting requirements of the Contract Documents.
4. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.

B. Product Selection Procedures:
1. Sole Product: Where Specifications name a single manufacturer and product, provide the named product that complies with the requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
2. Limited List of Manufacturers or Products: Where Specifications include a list of names of both manufacturers and products, provide a product listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
3. Description of Product: Where Specifications include a description of a product, any product meeting those standards or description will be considered.
4. Or Equal: For products specified by name and accompanied by the term or equal, or approved equal, product shall possess the same performance qualities and characteristics to fulfill the utilitarian function without any decrease in quality, durability, or longevity. Products shall be approved by the Owner and Engineer.

PART 3 - EXECUTION (NOT USED)

END OF SECTION 01 60 00

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SECTION 01 77 00
CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Substantial Completion procedures.
B. Final completion procedures.
C. Project warranties.
D. Record Drawings.
E. Final cleaning.
F. Repair of the Work.

1.2 SUBSTANTIAL COMPLETION PROCEDURES

A. Submittals Prior to Substantial Completion: Complete the following a minimum of ten (10) days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
   1. Prepare and submit a list of items to be completed and corrected (Contractor's punch list).
   2. 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.
   3. Submit closeout submittals specified in other Division 01 Sections, including Project Record Documents, Operation and Maintenance manuals, and similar final record information.
   4. Submit operation and maintenance submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
   5. Submit items specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Owner. Label with manufacturer's name and model number.
   6. Submit testing, adjusting, and balancing records.
B. Procedures Prior to Substantial Completion: Complete the following a minimum of ten (10) days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
   1. Advise Owner of pending insurance changeover requirements.
   2. Advise Owner's personnel of changeover in security provisions and the need for personnel to still access the site with an ID badge.
   3. Complete startup and testing of systems and equipment.
   4. Perform preventive maintenance on equipment used prior to Substantial Completion.
   5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings.
   6. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
   7. Complete final cleaning requirements.
   8. Touch up paint and otherwise repair and restore marred exposed finishes to eliminate visual defects.
C. Final Punch List: Submit a written request for the final punch list to determine Substantial Completion a minimum of ten (10) days prior to date the Work will be completed and ready for final inspection and tests. On receipt of request, Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will prepare the

Certificate of Substantial Completion after inspection or will notify Contractor of items identified by Engineer, that must be completed or corrected before certificate will be issued.

1.3 FINAL COMPLETION PROCEDURES

A. Submittals Prior to Final Completion: Before final completion, complete the following:
   1. Submit a final Application for Payment.
   2. Certified List of Incomplete Items: Submit copy of Engineer's Substantial Completion punch list items to be completed or corrected. The punch list shall state that each item has been completed, the estimated date of completion, or is otherwise resolved for acceptance.

1.4 PROJECT WARRANTIES

A. Time of Submittal: Submit written warranties on request of Engineer 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.
B. Partial Occupancy: Submit properly executed warranties within fifteen (15) days of completion of designated portions of the Work that are completed and occupied or used by Owner during construction period by separate agreement with Contractor.
C. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.
D. 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.
E. Provide additional copies of each warranty to include in Operation and Maintenance manuals in a durable plastic cover.
F. Assemble warranty documents from subcontractors, suppliers, and manufacturers.

1.5 RECORD DRAWINGS

A. Record Prints: Maintain one (1) set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.
   1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.
      a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
      b. Accurately record information in an acceptable drawing technique.
      c. Record data concurrently with construction as soon as possible after obtaining it.
      d. Record and check the markup before enclosing concealed installations.
   2. Content: Types of items requiring marking include, but are not limited to, the following:
      a. Dimensional changes to Drawings.
      b. Revisions to details shown on Drawings.
      c. Revisions to routing of piping and conduits.
      d. Revisions to electrical circuitry.
      e. Actual equipment locations.
      f. Duct size and routing.
      g. Locations of concealed internal utilities.
      h. Changes made by Change Order or Construction Change Directive.

i. Details not on the original Contract Drawings.
j. Field records for variable and concealed conditions.

3. Mark record sets with erasable, red colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
4. Mark important additional information that was either shown schematically or omitted from original Drawings.
5. Store Record Documents separate from the documents used for construction.

B. Format: Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
1. Record Prints: Organize record prints into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
2. Format: Annotated PDF electronic file.
3. Record Digital Data Files: Organize digital data information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each digital data file.
4. Submit PDF electronic files of scanned record prints to the Owner and Engineer.
5. Identification:
a. Project name.
b. Date.
c. Designation "PROJECT RECORD DRAWINGS."
d. Name of Engineer.
e. Name of Contractor.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 FINAL CLEANING

A. General: Perform final cleaning prior to final project assessment.
B. Cleaning: Employ experienced workers for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:
a. 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.
b. Remove tools, construction equipment, machinery, and surplus material from Project site.
c. 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.
d. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
e. Sweep concrete floors broom clean.
f. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean according to manufacturer's recommendations if visible soil or stains remain.
g. Clean transparent materials, including mirrors and glass in doors and windows. Polish mirrors and glass, taking care not to scratch surfaces.

h. Remove labels that are not permanent.
i. Wipe surfaces of mechanical and electrical equipment and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
j. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grilles.
k. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency.
l. Leave Project clean and ready for occupancy.

C. Construction Waste Disposal: Comply with waste disposal requirements.

3.2 REPAIR OF THE WORK

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

B. 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 01 77 00

SECTION 22 05 00
COMMON WORK RESULTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Basic requirements applicable to Division 22 Specifications.
B. Firestopping.
C. Transition fittings.
D. Dielectric fittings.

1.2 REFERENCE STANDARDS

A.	ANSI -	American National Standards Institute
B.	ASHRAE -	American Society of Heating, Refrigerating and Air Conditioning Engineers
C.	ASME -	American Society of Mechanical Engineers
D.	ASPE -	American Society of Plumbing Engineers
E.	ASTM -	American Society for Testing and Materials
F.	AWWA -	American Water Works Association
G.	AWS -	American Welding Society
H.	EPA -	Environmental Protection Agency
I.	IEEE -	Institute of Electrical and Electronics Engineers
J.	MICA -	Midwest Insulation Contractors Association
K.	MSS -	Manufacturer's Standardization Society of the Valve & Fitting Industry, Inc.
L.	NBS -	National Bureau of Standards
M.	NEC -	National Electric Code
N.	NEMA -	National Electrical Manufacturers Association
O.	NFPA -	National Fire Protection Association
P.	UL -	Underwriters Laboratories Inc.
Q.	ASTM E814 -	Standard Test Method for Fire Tests of Through-Penetration Fire Stops
R.	ASTM E84 -	Standard Test Method for Surface Burning Characteristics of Building Materials
S.	UL1479 -	Fire Tests of Through Penetration Firestops
T.	UL723 -	Surface Burning Characteristics of Building Materials

1.3 DEFINITIONS

A. Piping: Includes all pipe, fittings, valves, hangers, supports, and accessories related to such piping.
B. Ductwork: Includes all ducts, fittings, transitions, dampers, hangers, supports, and accessories related to such ductwork.
C. Finished Spaces: Spaces other than mechanical and electrical rooms, furred spaces, pipe and duct chases, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
D. Exposed, Exterior Installation: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions such as rooftop locations.
E. Exposed, Interior Installations: Exposed to view indoors such as finished occupied spaces and mechanical equipment rooms.
F. Concealed, Exterior Installations: Concealed from view and physical contact by building occupants but subject to outdoor ambient temperatures such as unheated shelters.

G. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants such as above ceilings, in chases or shafts, or furred spaces.
H. Plumbing Work: All of the work in Division 22.
I. Contractor: Contractor or Subcontractor performing the required work of their respective Divisions.
J. Or Equal: Possess the same performance qualities and characteristics to fulfill the utilitarian function without any decrease in quality, durability, or longevity.
K. Owner: Consists of Owner, Owner's Representative, and Owner's personnel.
L. Provide: Contractor shall furnish and install work and/or equipment.

1.4 SUBMITTALS

A. See Section 01 33 00.
B. Engineer's review of Shop Drawings shall not relieve Contractor from the responsibility for any variation from the Contract Documents unless the Contractor has called the Engineer's attention in writing to each such variation at the time of submission and the Engineer has given written approval of each such variation by a specific written notation thereof incorporated in or accompanying the Shop Drawing review notes; nor shall any review by the Engineer relieve the Contractor from responsibility for having complied with the provisions of the contract, or from responsibility for errors or omissions in the Shop Drawings.
C. Clearly identify, with bold letters and a clouded symbol, any deviations from the Contract Documents.

1.5 SUBSTITUTIONS

A. See Section 01 25 00.
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.
C. Contractor shall provide all supporting data and assume the burden of proof that any substitute proposed as an equal as to appearance, construction, capacity, and performance.
D. Where substitute equipment is accepted and use of such equipment shall require redesign of any other part of the architectural, structural, mechanical, plumbing, or electrical work, the cost of all such redesign, drawings, detailing, and accompanying additional costs of any item of the Work shall be paid for by the Contractor. Redesign shall be subject to the approval of all authorities having jurisdiction over the work including the Engineer.
E. Provide piping, structural supports, insulation and any other additional materials and equipment required by the system due to equipment substitutions at no additional cost to the Owner.

1.6 COORDINATION

A. Coordinate all work with other Contractor's prior to installation. Any installed work that is not coordinated and that interferes with another Contractor's work shall be removed and relocated at the installing Contractor's expense. Coordinate with that of other trades to avoid interferences and maintain clearances for operation, repair, removal, and testing of mechanical equipment.
B. Arrange for pipe spaces, chases, and openings in building structure during progress of construction to allow for plumbing installations.

C. Verify that all devices are compatible for the surfaces and locations which they will be installed.
D. Coordinate installation of required supporting devices and other structural components as they are constructed.
E. Install systems, materials, and equipment to conform with approved submittal data, including Coordination Drawings, to the greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing the portions of the Work are shown only in diagrammatic form.

1.7 CUTTING & PATCHING

A. Establish sizes and locations of openings and lintels in new work and transmit this information to the Contractor whose work is involved at such time as to avoid cutting and patching.
B. Patching shall match adjacent surfaces.
C. Inspect and take note of existing conditions along with the Owner to avoid later disputes with regard to the condition of the existing surface before work commences.
D. Core drill or saw cut openings through existing concrete.
E. All cutting and patching that shall be necessary for the installation of the work of this Contract shall be provided by this Contractor under the direction and to the satisfaction of the Owner unless this work is specifically identified to be the work of the Contractors of other Divisions.
F. No cutting of structural work shall be done without the written consent of the Owner's Representative being previously obtained, and all such work shall be done in accordance with the Owner's direction and supervision.
G. The removal and replacement of lay-in ceiling systems, as required for work of this Section, shall be performed by the Plumbing Contractor unless specifically identified to be the work of the Contractors of other Divisions. Coordinate ceiling and light removal with the Electrical Contractor for any lights that require removal.
H. All patching required shall be done by this Contractor to match existing or new construction and adjacent areas. All existing items noted for removal on the Drawings shall have adjacent construction patched to match existing. All existing items noted for removal that would, after such removal, leave holes, or other defects in such construction to remain shall be patched by this Contractor to match adjacent construction that remains.

1.8 SCHEDULING & SEQUENCING

A. Cooperate with other trades in putting this installation in place at a time when space required is accessible and in such a manner that other work in this space may be installed as shown in the Contract Documents.
B. Schedule work and cooperate with the others to avoid delays, interferences, and unnecessary work, conforming to the construction schedule.
C. Install Work as required as part of the schedule, including installation of all Work that may be required after completion of Work under another Contract that this Contractor may or may not be participating in. It is the responsibility of this Contractor to ensure that preparations are made and ready to accept the installation of these items.
D. Do not interrupt or change existing services without prior written approval from the Owner. When interruption is required, coordinate the downtime with the Owner to minimize disruption to their activities. Unless specifically stated, all Work to occur during normal business hours.

1.9 EXAMINATION OF THE SITE

A. Examine the site and become familiar with the conditions that may affect the Work covered under this Division of the Specifications.

B. The Drawings indicate the general arrangement and location of piping and equipment. Should it be necessary to deviate from the arrangement or location indicated in order to meet architectural conditions or site conditions, or due to interference with other work, make such deviations as offsets, rises, and drops in piping that may be necessary, whether shown or not, without extra cost to the Owner. Extreme accuracy of data given herein and on the Drawings is not guaranteed. The Drawings and Specifications are for the assistance and guidance of this Section and exact locations, distances, and elevations shall be governed by actual site conditions.

C. Visit the site of work, take measurements, examine areas where work is to be performed and get such other information necessary for proper execution of the work. Ascertain and check conditions with the Drawings and Specifications, other trades, existing conditions, and by what means the Work is to be performed.

1.10 JURISDICTION OF WORK

A. The event of jurisdiction (as to whether the work is to be installed by another trade or subcontractor) shall not release the work from this Contract. In such occurrence, the original Contractor shall sublet the work to the trade or subcontractor having jurisdiction.

B. The trade or subcontractor having jurisdiction shall perform the work in conformance with these Drawings and Specifications.

1.11 OPERATION & MAINTENANCE MANUALS

A. Submit to comply with requirements outlined in Division 01.

B. Provide one (1) hard copy and one (1) electronic copy.

C. Submit an electronic copy to the Engineer for review prior to submitting to Owner.

D. Submit material in three-ring binders with an index at the beginning of each volume and tabs for each section. In addition to the data indicated in the Operation and Maintenance Submittal paragraph of each Section, include the following:

1. Copies of all approved Shop Drawings.
2. Records of test performed to certify compliance with system requirements.
3. Certificates of inspection by regulatory agencies.
4. Equipment manufacturer's warranties and date of warranty period.
5. Lubrication instructions, including list/frequency of lubrication.
6. Warranties and guarantees.
7. Final record drawings for piping systems.
8. Documentation that all penetrations in smoke and/or fire rated construction have been properly sealed and fire stopped.
9. Additional information as indicated in the technical specification sections.

E. Submit documentation for above items on Contractor's and/or manufacturer's standard forms, which have been customized for this Project.

F. Include checklists for all equipment and systems, indicting they have been installed and operating properly.

G. Upon completion of the work, furnish the Owner with Record Drawings. Include all changes installed under this Contract. Submit final copies to the Owner and Engineer.

1.12 GUARANTEES & WARRANTIES

A. See Section 01 10 00.

1.13 CERTIFICATES & INSPECTIONS

A. Contractor shall prepare, submit, and pay for all required State installation inspections except those provided by the Engineer in accordance with the code.

B. Contractor shall be registered with the appropriate agency for all work to be completed.

C. Include copies of all certifications and inspections in the Operation and Maintenance manual.

1.14 EXISTING WORK

A. Remove all related piping and equipment indicated by the Contract Documents to be demolished.
B. Materials and equipment removed, except that specifically specified or shown on the drawings to be salvaged, shall become the property of the Contractor and shall be removed from the job site.
C. Unless specifically identified, do not abandon items in place. Physically remove and dispose of all materials as part of this Project.

PART 2 - PRODUCTS

2.1 FIRESTOPPING

A. Manufacturers:
   1. 3M.
   2. HILTI.
B. One-part, intumescent elastomer, UL classified, non-corrosive to metal, and compatible with synthetic cable jackets.
C. Material shall expand up to ten (10) times when exposed to flame or heat.
D. Maximum flame spread and fuel contributed of twenty-five (25) and smoke development of fifty (50) when tested in accordance with ASTM E84.

2.2 TRANSITION FITTINGS

A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
   1. Underground Piping 1-1/2” & Smaller: Manufactured fitting or coupling.
   2. Underground Piping 2” & Larger: AWWA C219, metal sleeve type coupling.
B. Plastic to Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one (1) end with threaded brass insert and one (1) solvent cement joint end.
C. Plastic to Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one (1) end with threaded brass insert and one (1) solvent cement joint end.
D. Plastic to Metal Transition Unions: MSS SP107, CPVC four-part union. Include brass end, solvent cement joint end, rubber O-ring, and union nut.
E. Flexible Transition Couplings for Underground Non-Pressure Drainage Piping: ASTM C1173 with elastomeric sleeve ends same size as piping to be joined with a corrosion resistant metal band on each end.

2.3 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder joint, plain, or weld neck end connections that match piping system materials.
B. Insulating Material: Suitable for system fluid, pressure, and temperature.
C. Dielectric Flanges: Factory fabricated, companion flange assembly, for 150 PSIG minimum working pressure as required to suit system pressures.
D. Dielectric Flange Kits: Companion flange assembly for field assembly. Include flanges, full face or ring type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Separate companion flanges and steel bolts and nuts shall have 150 PSIG minimum working pressure where required to suit system pressures.

E. Dielectric Couplings: Galvanized steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300 PSIG minimum working pressure at 225°F.

F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain or threaded ends; and 300 PSIG minimum working pressure at 225°F.

PART 3 - EXECUTION

3.1 SEALING & FIRESTOPPING

A. Sealing and firestopping of sleeves/openings between piping and conduits and the sleeve, structural, or partition opening shall be the responsibility of the Contractor whose Work penetrates the opening.

B. Apply sealant to both sides of the penetration such that the annular space between the pipe sleeve or cored opening and the pipe or insulation is completely blocked.

C. The annular space between the duct (with or without insulation) and the non-rated wall or floor opening shall not be larger than 2”. Where existing openings have an annular space larger than 2”, the space shall be patched to match the existing construction to within 2” around the duct.

D. Contractor shall verify the location of all fire and smoke rated construction and their hourly ratings.

3.2 PROTECTION OF EQUIPMENT

A. Protect, handle, and store all products from damage. Care shall be exercised during construction to avoid damage or disfigurement. Equipment shall be protected from dust and moisture prior to and during construction.

B. Where required or directed, construct temporary protection for equipment and installations for protection from dust and debris caused by construction.

C. Should new or existing equipment become damaged, restore it to its original condition and finish before final acceptance.

D. Repair marred and damaged factory painted finishes with materials and procedures to match original factory finish.

END OF SECTION 22 05 00

SECTION 22 13 16
SANITARY WASTE & VENT PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Sanitary waste and vent pipe and fittings.

1.2 REFERENCE STANDARDS

A.	ASTM A888 -	Hubless Cast Iron Soil Piping & Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
B.	ASTM C1277 -	Shielded Couplings Joining Hubless Cast Iron Soil Piping and Fittings
C.	ASTM C564 -	Rubber Gaskets for Cast Iron Soil Pipe and Fittings
D.	ASTM F493 -	Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Fittings
E.	ASTM F477 -	Elastomeric Seals (Gaskets) for Joining Plastic Pipe
F.	ASTM F2618 -	Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Fittings for Chemical Waste Drainage
G.	CISPI 301 -	Hubless Cast Iron Soil Piping & Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
H.	CISPI 310 -	Coupling for Use in Connection with Hubless Cast Iron Soil Pipe & Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications

1.3 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
   1. Waste & Vent Piping: 10 feet of head of water.

1.4 SUBMITTALS

A. Product Data: For each type of the following:
   1. Pipe.
      a. 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.
   2. Fittings.
   3. Joining materials.

1.5 OPERATION & MAINTENANCE SUBMITTALS

A. As-Built Drawings: Plans, drawn to scale, on which the all piping, valves, and accessories are shown. Plan shall have complete layout including sizes, elevations, equipment locations, equipment tags, and clearances shown.

1.6 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
B. Comply with NSF/ANSI 14 for plastic piping components. Include marking with NSF-DWV for plastic drain, waste, and vent piping; NSF-sewer for plastic sewer piping.

PART 2 - PRODUCTS

2.1 HUBLESS, CAST IRON SOIL PIPE & FITTINGS

A. Pipe & Fittings: ASTM A888 or CISPI 301.
B. CISPI, Hubless Piping Couplings:
   1. Manufacturers:
      a. ANACO-Husky.
      b. Charlotte Pipe & Foundry Company.
      c. MIFAB, Inc.
      d. NewAge Casting.
      e. Tyler Pipe.
   2. Standards: ASTM C1277 and CISPI 310.
   3. Description: Stainless steel corrugated shield with stainless steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

2.2 CPVC PIPE & FITTINGS

A. Manufacturers:
   1. Charlotte Pipe & Foundry Company.
   2. Spears.
B. Pipe: ASTM F2618; Schedule 40; drain, waste, and vent.
C. Fittings: Socket type; ASTM F2618; drain, waste, and vent patterns and to fit Schedule 40 pipe.
D. Solvent Cement: ASTM F493.

PART 3 - EXECUTION

3.1 EXCAVATION & BACKFILL

A. Not required. Piping is located in the crawl space below the first floor. Coordinate with Owner for access.

3.2 INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on the Coordination Drawings.
B. Establish elevations of piping and check invert elevations required for connections.
C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
E. Install piping at indicated slopes.
F. Install piping free of sags and bends.
G. Install fittings for changes in direction and branch connections.
H. Install piping to all for expansion and contractor without stressing pipe, joints, or connected equipment.
I. Fittings:
   1. Make changes in direction for sanitary waste and vent piping using the appropriate branches, bends, and long sweep bends.

2. Use wyes and 1/8 bends for changes in direction more than 45 degrees. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
3. Cleanouts shall be made with wyes and 1/8 bends. Cleanouts at the end of sewers shall be made with (2) 1/8 bends or a long sweep 1/4 bend.

J. Install sanitary waste and vent piping at the following minimum slopes unless otherwise indicated:
1. Horizontal Drainage Piping: 1/8” pitch per foot downward in direction of flow.
2. Vent Piping: 1% down toward vertical fixture vent or toward vent stack.

K. Install cast iron soil piping according to CISPI's Cast Iron Soil Pipe and Fittings Handbook, Chapter IV.

3.3 PIPING APPLICATIONS

A. The following piping may be used on each respective piping system:

SYSTEM DESIGNATION	PVC PIPING	CPVC PIPING	CAST IRON PIPING
Crawl Space Sanitary & Vent Piping		X	X
Above Grade Sanitary & Vent Piping		X	X

3.4 JOINT CONSTRUCTION

A. Join hubless, cast iron soil piping according to CISPI 310 and CISPI's Cast Iron Soil Pipe and Fittings Handbook for hubless piping coupling joints.

B. Plastic, Non-Pressure Piping, Solvent Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
1. General: Comply with ASTM F402 for safe handling practice of cleaners, primers, and solvent cements.
2. CPVC Piping: Join according to ASTM F493.

3.5 FIELD QUALITY CONTROL

A. During installation, notify the authority having jurisdiction at least twenty-four (24) hours before the inspection must be made. Perform the tests specified below in the presence of the authority having jurisdiction.
1. Rough-In Inspection: Arrange for inspection of the piping before concealing or closing in after rough-in and before setting fixtures.
2. Final Inspection: Arrange for the final inspection by the authority having jurisdiction to observe the tests specified below and to ensure compliance.

B. Re-Inspection: If the authority having jurisdiction finds that the piping will not pass the tests or inspections, make the required corrections and arrange for a re-inspection.

C. Reports: Prepare inspection reports and have them signed by the authority having jurisdiction.

D. Test sanitary drainage and vent piping according to the procedures of the authority having jurisdiction or, in absence of published procedures, as follows:
1. Test for leaks and defects in the piping. If the testing is performed in segments, submit separate report for each test, complete with a diagram of the portion of piping tested.
2. Leave drainage and vent piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Rough-In Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of rough-in. Close openings in piping system and fill with

water to the point of overflow, but not less than ten (10) foot of head of water. From fifteen (15) minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug the vent stack openings on the roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1" WG. Use U-tube or manometer inserted in the trap of a water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout the period of the inspection. Inspect plumbing fixture connections for leaks.
5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

3.6 CLEANING & PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.
B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
C. Place plugs in the ends of uncompleted piping at the end of day and when the work stops.

END OF SECTION 22 13 16

SECTION 22 13 19
SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Cleanouts.
B. Floor drains.
C. Hub drains.
D. Trap seal gaskets.

1.2 REFERENCE STANDARDS

A. ASME A112.6.3 - Floor Drains
B. ASME A112.36.2M - Cleanouts

1.3 SUBMITTALS

A. Product Data: For each type of product.

1.4 OPERATION & MAINTENANCE SUBMITTALS

A. Operation & Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.
B. Record final location of cleanouts and drains.

1.5 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

1.6 COORDINATION

A. Coordinate size and location of floor penetrations to receive drains.

PART 2 - PRODUCTS

2.1 CLEANOUTS

A. Manufacturers:
   1. Jay R. Smith Manufacturing Company.
   2. Josam.
   3. Wade.
   4. Watts.
   5. Zurn.
B. Refer to the Cleanouts schedule on the Drawings.

2.2 FLOOR DRAINS

A. Manufacturers:
   1. Jay R. Smith Manufacturing Company.
   2. Josam.
   3. Wade.

4. Watts.
5. Zurn.

B. Refer to the Drains schedule on the Drawings.

2.3 HUB DRAINS

A. Description: Field fabricated drain including a P-trap, riser section, and increaser fitting.
B. Size: Same as connected piping with increaser fitting of size indicated.
C. Refer to the Drains schedule on the Drawings.

2.4 TRAP SEAL GASKETS

A. Manufacturers:
1. Josam.
2. ProVent Systems.
3. SureSeal.
4. Sioux Chief.

B. Description: Normally closed, inline, elastomeric device creating a seal to prevent evaporation of the trap seal that opens with fluid flow.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Install piping adjacent to equipment to allow service and maintenance.

3.2 CLEANOUTS

A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
1. Size same as drainage piping up to 6”. Use 6” for larger drainage piping unless a larger cleanout is indicated.

B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with the finished floor. Install cleanout fitting with the closure plug near the finished floor.
C. For cleanouts located in concealed piping or for piping below floors where indicated on the Drawings, install cleanout wall access covers, of types indicated, with frame and cover flush with the finished wall.

3.3 DRAINS

A. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with the finished floor, unless otherwise indicated.
1. Position floor drains for easy access and maintenance.
2. Install floor drain flashing collar or flange so no leakage occurs between the drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
3. Install individual traps for floor drains connected to the sanitary building drain, unless otherwise indicated.

B. Assemble hub drain fittings and install with top of hub above the floor as noted on the Drawings.
C. Identify the discharge device for each hub drain and locate the drain close to the device. Minimize piping to the drain and confirm adequate elevation exists for discharge to the hub drain.

3.4 TRAP SEAL GASKETS

A. Provide a trap seal gasket in each floor drain and hub drain to prevent a loss of the trap seal.

B. Fixture drains and drains that receive discharge under normal operating conditions do not require a trap seal gasket.

END OF SECTION 22 13 19

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SECTION 23 05 00
COMMON WORK RESULTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Basic requirements applicable to Division 23 Specifications.
B. Access doors.
C. Wall penetration sleeves.
D. Escutcheons.
E. Firestopping.

1.2 REFERENCE STANDARDS

A.	AABC -	Associated Air Balance Council
B.	ABMA -	American Boiler Manufacturers Association
C.	ADC -	Air Diffusion Council
D.	AGA -	American Gas Association
E.	AMCA -	Air Movement and Control Association
F.	ANSI -	American National Standards Institute
G.	AHRI -	Air-Conditioning, Heating, and Refrigeration Institute
H.	ASHRAE -	American Society of Heating, Refrigerating and Air Conditioning Engineers
I.	ASME -	American Society of Mechanical Engineers
J.	ASTM -	American Society for Testing and Materials
K.	AWWA -	American Water Works Association
L.	AWS -	American Welding Society
M.	CGA -	Compressed Gas Association
N.	EPA -	Environmental Protection Agency
O.	GAMA -	Gas Appliance Manufacturers Association
P.	IEEE -	Institute of Electrical and Electronics Engineers
Q.	ISA -	Instrument Society of America
R.	MCAA -	Mechanical Contractors Association of America
S.	MICA -	Midwest Insulation Contractors Association
T.	MSS -	Manufacturer's Standardization Society of the Valve & Fitting Industry, Inc.
U.	NBS -	National Bureau of Standards
V.	NEBB -	National Environmental Balancing Bureau
W.	NEC -	National Electric Code
X.	NEMA -	National Electrical Manufacturers Association
Y.	NFPA -	National Fire Protection Association
Z.	SMACNA -	Sheet Metal and Air Conditioning Contractors' National Association, Inc.
AA.	UL -	Underwriters Laboratories Inc.
BB.	ASTM E814 -	Standard Test Method for Fire Tests of Through-Penetration Fire Stops
CC.	ASTM E84 -	Standard Test Method for Surface Burning Characteristics of Building Materials
DD.	UL1479 -	Fire Tests of Through Penetration Firestops
EE.	UL723 -	Surface Burning Characteristics of Building Materials

1.3 DEFINITIONS

A. Piping: Includes all pipe, fittings, valves, hangers, supports, and accessories related to such piping.
B. Ductwork: Includes all ducts, fittings, transitions, dampers, hangers, supports, and accessories related to such ductwork.
C. Finished Spaces: Spaces other than mechanical and electrical rooms, furred spaces, pipe and duct chases, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
D. Exposed, Exterior Installation: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions such as rooftop locations.
E. Exposed, Interior Installations: Exposed to view indoors such as finished occupied spaces and mechanical equipment rooms.
F. Concealed, Exterior Installations: Concealed from view and physical contact by building occupants but subject to outdoor ambient temperatures such as unheated shelters.
G. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants such as above ceilings, in chases or shafts, or furred spaces.
H. Mechanical Work: All of the work in Division 23.
I. Contractor: Contractor or Subcontractor performing the required work of their respective Divisions.
J. Or Equal: Possess the same performance qualities and characteristics to fulfill the utilitarian function without any decrease in quality, durability, or longevity.
K. Owner: Consists of Owner, Owner's Representative, and Owner's personnel.
L. Provide: Contractor shall furnish and install work and/or equipment.

1.4 SUBMITTALS

A. See Section 01 33 00.
B. Engineer's review of Shop Drawings shall not relieve Contractor from the responsibility for any variation from the Contract Documents unless the Contractor has called the Engineer's attention in writing to each such variation at the time of submission and the Engineer has given written approval of each such variation by a specific written notation thereof incorporated in or accompanying the Shop Drawing review notes; nor shall any review by the Engineer relieve the Contractor from responsibility for having complied with the provisions of the contract, or from responsibility for errors or omissions in the Shop Drawings.
C. Clearly identify, with bold letters and a clouded symbol, any deviations from the Contract Documents.

1.5 SUBSTITUTIONS

A. See Section 01 25 00.
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.
C. Contractor shall provide all supporting data and assume the burden of proof that any substitute proposed as an equal as to appearance, construction, capacity, and performance.
D. Where substitute equipment is accepted and use of such equipment shall require redesign of any other part of the architectural, structural, mechanical, plumbing, or electrical work, the cost of all such redesign, drawings, detailing, and accompanying additional costs of any item of the Work shall be paid for by the Contractor. Redesign

shall be subject to the approval of all authorities having jurisdiction over the work including the Engineer.

E. Provide ductwork, piping, structural supports, insulation, controllers, motors, starters, electrical wiring and conduit, and any other additional materials and equipment required by the system due to equipment substitutions at no additional cost to the Owner.

1.6 COORDINATION

A. Coordinate all work with other Contractor's prior to installation. Any installed work that is not coordinated and that interferes with another Contractor's work shall be removed and relocated at the installing Contractor's expense. Coordinate with that of other trades to avoid interferences and maintain clearances for operation, repair, removal, and testing of mechanical equipment.

B. Cooperate with the Testing, Adjusting, and Balancing Contractor to ensure all systems are balanced as specified. Verify system completion to the Testing, Adjusting, and Balancing Contractor including system flushing, pressure testing, chemical treatment, filling and venting of hydronic systems, controls adjusted and calibrated, controls cycled through their sequence, etc.

C. Arrange for pipe spaces, chases, and openings in building structure during progress of construction to allow for HVAC installations.

D. Verify that all devices are compatible for the surfaces and locations which they will be installed.

E. Coordinate installation of required supporting devices and other structural components as they are constructed.

F. Coordinate requirements for access panels and doors for mechanical items requiring access that are concealed behind finished surfaces.

G. Install systems, materials, and equipment to conform with approved submittal data, including Coordination Drawings, to the greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing the portions of the Work are shown only in diagrammatic form.

1.7 CUTTING & PATCHING

A. Establish sizes and locations of openings and lintels in new work and transmit this information to the Contractor whose work is involved at such time as to avoid cutting and patching.

B. Patching shall match adjacent surfaces.

C. Inspect and take note of existing conditions along with the Owner to avoid later disputes with regard to the condition of the existing surface before work commences.

D. Core drill or saw cut openings through existing concrete.

E. All cutting and patching that shall be necessary for the installation of the work of this Contract shall be provided by this Contractor under the direction and to the satisfaction of the Owner unless this work is specifically identified to be the work of the Contractors of other Divisions.

F. No cutting of structural work shall be done without the written consent of the Owner's Representative being previously obtained, and all such work shall be done in accordance with the Owner's direction and supervision.

G. The removal and replacement of lay-in ceiling systems, as required for Work of this Section, shall be performed by the Mechanical Contractor unless specifically identified to be the work of the Contractors of other Divisions. Coordinate ceiling and light removal with the Electrical Contractor for any lights that require removal.

H. All patching required shall be done by this Contractor to match existing or new construction and adjacent areas. All existing items noted for removal on the Drawings shall have adjacent construction patched to match existing. All existing items noted for removal that would, after such removal, leave holes, or other defects in such construction

to remain shall be patched by this Contractor to match adjacent construction that remains.

1.8 SCHEDULING & SEQUENCING

A. Cooperate with other trades in putting this installation in place at a time when space required is accessible and in such a manner that other work in this space may be installed as shown in the Contract Documents.
B. Schedule work and cooperate with the others to avoid delays, interferences, and unnecessary work, conforming to the construction schedule.
C. Install Work as required as part of the schedule, including installation of all Work that may be required after completion of Work under another Contract that this Contractor may or may not be participating in. It is the responsibility of this Contractor to ensure that preparations are made and ready to accept the installation of these items.
D. Do not interrupt or change existing services without prior written approval from the Owner. When interruption is required, coordinate the downtime with the Owner to minimize disruption to their activities. Unless specifically stated, all Work to occur during normal business hours.

1.9 EXAMINATION OF THE SITE

A. Examine the site and become familiar with the conditions that may affect the work covered under this Division of the Specifications.
B. The Drawings indicate the general arrangement and location of piping, ducts, and equipment. Should it be necessary to deviate from the arrangement or location indicated in order to meet architectural conditions or site conditions, or due to interference with other work, make such deviations as offsets, rises, and drops in piping and ducts that may be necessary, whether shown or not, without extra cost to the Owner. Extreme accuracy of data given herein and on the Drawings is not guaranteed. The Drawings and Specifications are for the assistance and guidance of this Section and exact locations, distances, and elevations shall be governed by actual site conditions.
C. Visit the site of work, take measurements, examine areas where work is to be performed and get such other information necessary for proper execution of the work. Ascertain and check conditions with the Drawings and Specifications, other trades, existing conditions, and by what means the Work is to be performed.

1.10 JURISDICTION OF WORK

A. The event of jurisdiction (as to whether the work is to be installed by another trade or subcontractor) shall not release the work from this Contract. In such occurrence, the original Contractor shall sublet the work to the trade or subcontractor having jurisdiction.
B. The trade or subcontractor having jurisdiction shall perform the work in conformance with these Drawings and Specifications.

1.11 OPERATION & MAINTENANCE MANUALS

A. Submit to comply with requirements outlined in Division 01.
B. Provide one (1) hard copy and one (1) electronic copy.
C. Submit an electronic copy to the Engineer for review prior to submitting to Owner.
D. Submit material in three-ring binders with an index at the beginning of each volume and tabs for each section. In addition to the data indicated in the Operation and Maintenance Submittal paragraph of each Section, include the following:
   1. Copies of all approved Shop Drawings.
   2. Records of test performed to certify compliance with system requirements.
   3. Certificates of inspection by regulatory agencies.
   4. Valve charts and schedules.

5. Equipment manufacturer's warranties and date of warranty period.
6. Lubrication instructions, including list/frequency of lubrication.
7. Manufacturer's wiring diagrams for electrically powered equipment.
8. Temperature control record drawings and control sequences.
9. Parts lists for manufactured equipment.
10. Warranties and guarantees.
11. Final record drawings for ductwork and piping systems.
12. Equipment manufacturer's start-up and field service reports (boilers, pumps, variable frequency drives, etc.).
13. Piping system testing and cleaning documentation.
14. Documentation that all spare parts have been provided as listed in each specification section.
15. Documentation that all penetrations in smoke and/or fire rated construction have been properly sealed and fire stopped.
16. Final testing, adjusting, and balancing report.
17. Commissioning checklists and reports.
18. Additional information as indicated in the technical specification sections.

E. Refer to Temperature Controls for work required to verify and document operation of temperature control system. Documentation to be included in the Operation and Maintenance manuals.
F. Submit documentation for above items on Contractor's and/or manufacturer's standard forms, which have been customized for this Project.
G. Include checklists for all equipment and systems, indicting they have been installed and operating properly.
H. Upon completion of the work, furnish the Owner with Record Drawings. Include all changes installed under this Contract. Submit final copies to the Owner and Engineer.

1.12 GUARANTEES & WARRANTIES

A. See Section 01 10 00.

1.13 CERTIFICATES & INSPECTIONS

A. Contractor shall prepare, submit, and pay for all required State installation inspections except those provided by the Engineer in accordance with the code.
B. Contractor shall be registered with the appropriate agency for all work to be completed.
C. Include copies of all certifications and inspections in the Operation and Maintenance manual.

1.14 OWNER TRAINING

A. Instruct Owner personnel in the proper operation and maintenance of systems and equipment provided as part of this project.
B. Upon completion of all work and tests, furnish the necessary skilled, qualified personnel for operating the system for a total of eight (8) hours, in two (2) four (2) hour sessions, during times agreed to by the Owner.
C. Instruct the Owner fully in the operation, adjustment, and maintenance of equipment furnished. Demonstrate startup and shutdown procedures for all equipment.
D. A representative of the Temperature Control Contractor shall be present during these instruction periods.
E. Arrange for a manufacturer's representative to instruct Owner on the equipment installed.
F. Give at least forty-eight (48) hours notice to the Owner in advance of this period.
G. Maintain a record of operating instruction periods, documenting the date, time involved, people in attendance, and have the Owner attest in writing for each session held; only documented and signed records shall be used to show compliance to the specified instruction periods.

H. Use the Operation and Maintenance manual during this training.
I. All training to be completed during normal working hours.
J. Record the operating instruction sessions and provide the Owner with a copy of the recordings.

1.15 EXISTING WORK

A. Remove all HVAC related piping, ductwork, and equipment indicated by the Contract Documents to be demolished.
B. Materials and equipment removed, except that specifically specified or shown on the drawings to be salvaged, shall become the property of the Contractor and shall be removed from the job site.
C. Any equipment with power that is demolished shall have the power demolished back to the source panel.
D. Any pneumatic air tubing that is demolished shall have the air tubing demolished back to the main and capped.
E. Unless specifically identified, do not abandon items in place. Physically remove and dispose of all materials as part of this Project.

PART 2 - PRODUCTS

2.1 ACCESS PANELS & DOORS

A. Manufacturers:
   1. Acudor Products Inc.
   2. Babcock-Davis.
   3. Milcor.
B. Description: Face of door flush with frame, exposed flange, with continuous concealed hinge.
C. Size: As required to provide adjustment and/or service of concealed device. Minimum of 12” x 12”.
D. Door: 16-gauge steel.
E. Frame: 16-gauge one-piece steel frame, 1” wide flange.
F. Latch & Lock: Flush with door.
   1. Screwdriver operated.
   2. Key operated cylinder lock.
G. Rating: UL listed to conform to the fire rating of the surface it is installed in.

2.2 WALL PENETRATION SLEEVES

A. Galvanized Steel Pipe Sleeve: ASTM A53, Type E, Grade B, Schedule 40, anti-corrosion coated, with plain ends.

2.3 ESCUTCHEONS

A. Pipe:
   1. Type: One-piece or split-plate with concealed hinge and spring clip fasteners.
   2. Material: Brass or steel.
   3. Finish: Chrome plated.

2.4 FIRESTOPPING

A. Manufacturers:
   1. 3M.
   2. HILTI.

B. One-part, intumescent elastomer, UL classified, non-corrosive to metal, and compatible with synthetic cable jackets.
C. Material shall expand up to ten (10) times when exposed to flame or heat.
D. Maximum flame spread and fuel contributed of twenty-five (25) and smoke development of fifty (50) when tested in accordance with ASTM E84.

PART 3 - EXECUTION

3.1 ACCESS PANELS & DOORS

A. Provide access doors for access to equipment, dampers, valves, or other specialties installed behind wall or above ceiling surfaces.
B. Lay-in tee bar ceilings and snap-in removable metal pan ceilings shall be considered adequate for access.
C. Subcontract installation work to contractors specifically skilled in the construction of the surfaces involved.
D. Confer with the other contractors with respect to access panel locations and wherever practicable, group devices in such a manner so as to eliminate as many panels as possible.
E. Remove all markings and labels from access doors.
F. Provide screwdriver operated latches for all access doors except the following specific exclusions:

AREA SERVED	LATCH STYLE	FINISH
Public Areas	Key Operated	Prime Coated Steel
Public Toilet Rooms	Key Operated	Ceilings – Prime Coated Steel Walls – Stainless Steel
Hourly Rated Surfaces	As required by UL	Prime Coated Steel

3.2 WALL PENETRATION SLEEVES

A. Install sleeves for piping passing through penetrations in partitions, roofs, and walls.
B. Verify final equipment locations prior to roughing in sleeves.
C. Install sleeves for pipes passing through interior partitions:
   1. Cut sleeves to length for mounting flush with both surfaces.
   2. Install sleeves that are large enough to provide 1/4” annular clear space between sleeve and pipe or pipe insulation.
   3. Seal annular space between sleeve and piping or piping insulation; use sealants appropriate for size, depth, and location of joint.
D. Fire Resistance Rated Penetrations, Horizontal Assembly Penetrations, & Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire and smoke stop materials. Comply with requirements for sealing and firestopping materials.
E. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls.
F. Schedule of Sleeves: Use sleeves for the following piping penetrations:

APPLICATION	SLEEVE TYPE	PIPE PENETRATION SEAL
Existing Non-Rated Drywall Partitions	Not Required	No
Existing Masonry Walls & Partitions	Core Drill Hole & Grout Sleeve in Place	No

G. Existing concrete does not require pipe sleeves and shall be core drilled.

3.3 ESCUTCHEONS

A. Install escutcheons for exposed piping penetrations of walls, ceilings, and finished floors.
B. Install escutcheons with inside diameter to closely fit around pipe, tube, and insulation of piping and with outside diameter that completely covers opening.

3.4 SEALING & FIRESTOPPING

A. Sealing and firestopping of sleeves/openings between ductwork, piping, conduits, etc. and the sleeve, structural, or partition opening shall be the responsibility of the Contractor whose work penetrates the opening.
B. Apply sealant to both sides of the penetration such that the annular space between the pipe sleeve or cored opening and the pipe or insulation is completely blocked.
C. The annular space between the duct (with or without insulation) and the non-rated wall or floor opening shall not be larger than 2”. Where existing openings have an annular space larger than 2”, the space shall be patched to match the existing construction to within 2” around the duct.
D. Contractor shall verify the location of all fire and smoke rated construction and their hourly ratings.

3.5 PROTECTION OF EQUIPMENT

A. Protect, handle, and store all products from damage. Care shall be exercised during construction to avoid damage or disfigurement. Equipment shall be protected from dust and moisture prior to and during construction.
B. Where required or directed, construct temporary protection for equipment and installations for protection from dust and debris caused by construction.
C. Should new or existing equipment become damaged, restore it to its original condition and finish before final acceptance.
D. Repair marred and damaged factory painted finishes with materials and procedures to match original factory finish.

END OF SECTION 23 05 00

SECTION 23 05 13
COMMON MOTOR REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Single phase electrical motors.
B. Three phase electrical motors.
C. Motor starters.
D. Disconnect switches.

1.2 REFERENCE STANDARDS

A. IEEE 112 - Test Procedures for Polyphase Induction Motors & Generators
B. NEMA MG 1 - Motors & Generators
C. NFPA 70 - National Electrical Code

1.3 SUBMITTALS

A. Product Data: Provide project specific wiring diagrams with electrical characteristics and connection requirements.
B. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, relubrication provisions, and wiring instructions.
C. Include with the equipment which the motor drives the following motor information:
   1. Motor manufacturer.
   2. Horsepower.
   3. Voltage/phase.
   4. Hertz.
   5. RPM.
   6. Full load efficiency.

1.4 COORDINATION

A. Equipment selected is based on coordinated electrical voltage, phase, and horsepower. Changes to the coordinated conditions will require redesign and shall be paid by the Contractor.
B. Responsibilities of Mechanical Contractor:
   1. Verify voltage of motor with Electrical Contractor prior to ordering.
   2. Furnish the following equipment and give to Electrical Contractor for installation and wiring:
      a. Motor controllers.
      b. Disconnect switches.
   3. Provide engraved nameplate on outside cover of each motor controller and disconnect switch door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.
   4. Furnish all project specific wiring diagrams to the Electrical Contractor for all equipment and devices furnished by the Mechanical Contractor and indicated to be wired by the Electrical Contractor.
   5. Coordinate control wiring with the Temperature Controls Contractor.
C. Responsibilities of Electrical Contractor:
   1. Install all motor controllers and disconnect switches furnished by Mechanical Contractor in accordance with the manufacturer's instructions.

2. Furnish, install, and adjust the fuses required by equipment provided by the Mechanical Contractor.
3. Electrical Contractor will provide all power wiring and control wiring except temperature control wiring.
4. Mounting Height: 5’-0” to operating handle.
5. Maintain code required service clearances.

1.5 OPERATION & MAINTENANCE MATERIALS

A. Operation Data: Include instructions for safe operating procedures.
B. Maintenance Data: Documentation shall include manufacturer’s model number, manufacturer’s installation instructions, assembly drawings, bearing data including replacement sizes, lubrication instructions, adjustment procedures, inspection period, recommended cleaning methods and materials, testing, methods, shaft grounding brush replacement procedures, and calibration tolerances.
C. Motor Schedule: Provide an updated motor schedule which includes all connected motors installed.

1.6 QUALITY ASSURANCE

A. Products Requiring Electrical Connection:
1. Listed and classified by UL as suitable for the purpose specified and indicated.
2. Conform to applicable electrical code, NFPA 70, and local energy code.
3. Comply with code for all devices, materials, and equipment located in plenums.

1.7 DELIVERY, STORAGE, & HANDLING

A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weatherproof covering. Remove motors from equipment and store separately for extended outdoor storage.

PART 2 - PRODUCTS

2.1 MOTOR MANUFACTURERS

A. Manufacturers:
1. Baldor.
2. General Electric.
3. Marathon.

2.2 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.
B. All motors shall be selected and applied such that they are capable of powering the associated equipment at full design load/capacity without utilizing the service factor of the motor.
C. Type: Open drip proof (ODP) except where specifically noted otherwise.
D. Duty: Continuous duty at ambient temperature of 40°C and at altitude of 3300 feet above sea level.
E. Capacity & Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

F. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, and efficiency.
G. Wiring Terminations:
   1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
   2. Provide threaded conduit connection in end frame for fractional horsepower motors where a direct connection is made.

2.3 SINGLE PHASE MOTORS

A. Motors larger than 1/20 hp shall be one (1) of the following, to suit starting torque and requirements of specific motor application:
   1. Permanent split capacitor.
   2. Capacitor start, inductor run.
B. Bearings: Pre-lubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
C. Insulation: Class A.
D. Service Factor: 1.0.
E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal protection device shall automatically reset when motor temperature returns to normal range.

2.4 THREE PHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.
B. Efficiency: Premium efficient, as defined in NEMA MG 1.
C. Service Factor: 1.15.
D. Rotor: Random wound, squirrel cage.
E. Bearings:
   1. Re-greasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
   2. Rated for ABMA 9, L-10 life of 20,000 hours.
   3. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
F. Insulation & Temperature Rise: Class B.
G. Sound Power Levels: Conform to NEMA MG 1.
H. Motor Frames: NEMA standard T-frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.

2.5 ADDITIONAL REQUIREMENTS FOR THREE PHASE MOTORS

A. Motors Used with Variable Frequency Drives: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
   1. Windings: Copper magnet wire with moisture resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse width modulated inverters.
   2. Insulation: Class F.
   3. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
   4. Shaft: Grounded with shaft grounding rings.
      1) Description: Maintenance free shaft grounding ring to protect motors and attached equipment from damaging shaft electrical currents at all motors speeds.

2) Installation: Furnished and factory installed by equipment supplier.
3) Manufacturer: Aegis.

2.6 MOTOR STARTER MANUFACTURERS

A. Manufacturers:
1. Allen Bradley.
2. Cutler Hammer.
3. General Electric.
4. Square D.

2.7 GENERAL MOTOR STARTER REQUIREMENTS

A. Motor Controllers:
1. All motor controllers provided by same manufacturer unless integral part of equipment.

2.8 MANUAL STARTERS

A. NEMA ICS 2, AC general purpose Class A manually operated, full voltage controller with quick made and break toggle action and double break silver alloy contacts.
B. NEMA ICS, one-piece bimetallic or melting alloy type thermal overload units. Controller shall be inoperative unless thermal units are in position. Omit for motors with built-in thermal overload protection.
C. Provisions for resetting controller after thermal overload units trip controller.
D. Green pilot light to indicate when motor is operating.
E. Enclosure: NEMA ICS 6, general purpose flush mounted with stainless steel cover plate in finished areas and where indicated and Type 1 surface mounted in unfinished areas.
F. Pad locking attachment for Type 1 enclosures.

2.9 MAGNETIC STARTERS

A. NEMA ICS 2, AC general purpose Class A magnetic across-the-line for induction motor rated in horsepower.
B. Contacts: Double break silver alloy, replaceable from front of controller without removing power wiring or controller from enclosure, straight through wiring.
C. Coils: Molded construction removable from front of controller without removing controller from enclosure.
D. Overload Relay: NEMA solid state with user selectable settings, Class 10, 20, and 30; built-in memory to prevent hot motor restart.
1. Visible trip indicator.
2. Operating temperature: -20°C to +70°C.
3. Phase current loss protection.
4. Phase current unbalance protection (adjustable 20-50%).
E. Auxiliary Contacts: One (1) normally open isolated auxiliary contact and one (1) normally closed auxiliary contact.
F. Enclosure: NEMA 1 unless indicated otherwise on motor control schedule.
G. Coil Operating Voltage: 120V, 60 Hz.
H. Control Power Transformers: 120V, 60 Hz, secondary, 100VA fused minimum, in each motor starter. Provide fused primary and secondary, and bond unfused leg of secondary to enclosure.
I. Provide the following accessories where indicated on Drawings:
1. Pilot Lights: LED type, green-run.
2. Hand-Off-Auto Selector Switches: Rotary type.

2.10 DISCONNECT SWITCHES

A. Manufacturers:
   1. Allen Bradley.
   2. Cutler Hammer.
   3. Square D.
   4. General Electric.
B. Non-Fusible Switch Assemblies: NEMA KS 1; Type HD; quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle pad lockable in OFF position.
C. Fusible Switch Assemblies: Same as non-fused with fuse clips designed to accommodate Class R fuses.
D. Enclosures:
   1. Indoor: NEMA KS 1; Type 1; code gauge steel with rust inhibiting primer.
   2. Outdoor: NEMA KS 1; Type 3R; code gauge zinc coated steel with baked enamel finish or Type 4 when indicated on the drawings.
   3. Corrosive Areas: NEMA KS 1; Type 4X; 304 stainless steel with brushed finish.
   4. Hazardous Areas: NEMA KS 1; Type 7/9; copper free, aluminum alloy.

2.11 COMBINATION STARTER/DISCONNECT

A. Where a combination starter/disconnect is scheduled, combine the magnetic starter with a pad lockable disconnect switch in common enclosure.
B. Comply with the specification for both a magnetic starter and disconnect switch.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Verify voltage with Electrical Contractor prior to order.
B. Mount motors on a rigid base designed to accept a motor, using shims if required.
C. Verify the proper rotation of all motors before the motor is energized.
D. Align flexible coupled motors per the manufacturer’s recommendations.
E. Lubricate all motors requiring lubrication, recording material used and frequency.

3.2 MOTOR INSTALLATION

A. Install in accordance with the manufacturer's instructions.
B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
C. Check line voltage and phase and ensure agreement with nameplate.

END OF SECTION 23 05 13

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SECTION 23 05 14
VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Variable frequency drives (VFDs) for pump motors (alternate bid).

1.2 REFERENCE STANDARDS

A.	IEEE 519 -	Guide for Harmonic Content & Control
B.	UL 508 -	Standard for Industrial Control Equipment
C.	NEMA ICS 7.0 -	AC Adjustable Speed Drives
D.	NEC 430.120 -	Adjustable-Speed Drive Systems
E.	NFPA 70 -	National Electrical Code

1.3 SUBMITTALS

A. Product Data: Provide project specific wiring diagrams with electrical characteristics and connection requirements.
B. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, relubrication provisions, and wiring instructions.
C. Project Data: Physical, electrical, and performance characteristics of each variable frequency drive and associated components, including:
   1. Dimensions and weight.
   2. Input and output performance.
   3. Voltage, phase, current, and overcurrent characteristics.
   4. Short circuit current ratings.
   5. Installation instructions.
   6. Protective features.
   7. Wiring and block diagrams indicating specified options.
   8. Electrical noise attenuation equipment where required.
   9. Line side voltage notch wave form and line side current harmonics.
   10. Certified efficiency versus load and speed curves.
   11. Required operating environment.
   12. Mounting arrangements.
   13. Location of conduit entries.

1.4 OPERATION & MAINTENANCE SUBMITTALS

A. Include recommended maintenance procedures, maintenance schedules, recommended spare parts list, and vendor name for those parts.
B. Include test and start-up report.
C. Manufacturer's writing instruction for testing and adjusting overcurrent protective devices.

1.5 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
   1. Motor controllers.
   2. Torque, speed, and horsepower requirements of the load.
   3. Ratings and characteristics of supply circuit and required control sequence.
   4. Ambient and environmental conditions of installation location.

B. Equipment selected is based on coordinated electrical voltage, phase, and horsepower. Changes to the coordinated conditions will require redesign and shall be paid by the Contractor.

C. Responsibilities of Mechanical Contractor:
   1. Verify voltage of motor with Electrical Contractor prior to ordering.
   2. Furnish the variable frequency drive and give to Electrical Contractor for installation and wiring.
   3. Furnish all project specific wiring diagrams to the Electrical Contractor for all equipment and devices furnished by the Mechanical Contractor and indicated to be wired by the Electrical Contractor.
   4. Provide engraved nameplate on outside cover of each motor controller and disconnect switch door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.

D. Responsibilities of Electrical Contractor:
   1. Install all VFDs furnished by the Mechanical Contractor in accordance with manufacturer's instructions.
   2. Do not install VFDs until the building environmental is within the manufacturers required conditions.
   3. Install on strut support systems.
   4. Mounting Height: 5’-0” to operating handle.
   5. Furnish and install fuses in fusible disconnect switches.
   6. Provide all power wiring and control wiring except temperature control wiring.
      a. Control wiring shall be provided with an isolated, shielded cable.
      b. Provide dedicated conduit for control wiring.
      c. Provide dedicated conduit for power wiring.
   7. Provide separate ground wires for input power wiring to VFD and output power wiring to motor. Run both grounds wires to VFD ground lug. Do not use conduits as ground.
   8. Maintain code required service clearances.

1.6 QUALITY ASSURANCE

A. Performance: VFDs and all options shall be UL 508 listed as a complete assembly.

B. Minimum Short Circuit Rating: UL listed for interrupting rating of 100,000 RMS symmetrical amps at 600 VAC.

C. Electrical Components, Devices, & Accessories: Comply with IMC 602 and NFPA 70 for all devices, materials, and equipment located in plenums.

D. Source Limitations: Use same supplier/manufacturer for all VFDs.

1.7 DELIVERY, STORAGE, & HANDLING

A. Store VFDs indoors in a clean, dry space with uniform temperature to prevent condensation. Protect VFDs from exposure to dirt, fumes, water, corrosive substances, and physical damage.

B. Protect VFDs stored on site from weather and moisture by maintaining factory covers and suitable weatherproof covering.

1.8 START-UP & OWNER TRAINING

A. Provide the services of a factory trained and certified technician to approve the installation. Start-up, test, and adjust for proper operation.

B. Submit a completed manufacturer’s field report, including start-up and test log, signed by the factory trained technician.

C. Provide Owner training.

1.9 WARRANTY

A. Provide a factory warranty for a period of thirty-six (36) months from the date of shipment. The warranty shall include all parts, labor, travel time, and expenses.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. ABB.
B. Danfoss.
C. Eaton/Cutler Hammer.
D. Franklin.
E. Yasakawa.

2.2 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions:
   1. Ambient Temperature: 5°F to 104°F.
   2. Humidity: Less than 90% (non-condensing).
   3. Altitude: Not exceeding 3300 feet above sea level.

2.3 DESIGN & CONSTRUCTION

A. Description: Variable frequency drive consisting of a pulse width modulated (PWM) inverter listed and labeled as a complete unit and arranged to provided variable speed of a NEMA MG 1, Design B, three phase, alternating current induction motor by adjusting output voltage and frequency. Provide full wave bridge rectifier, DC line reactor capacitors and insulated gate bipolar transistors (IGBT) as the output switch device.
B. Filters for Electromagnetic & Radio Frequency Interferences: Comply with IEC 61800-3.
C. Line Reactors: Provide the impedance equivalent of 5% to reduce harmonic distortion to the power line in the form of a DC bus choke or an input AC line reactor in each phase, or a combination of both.
D. Design & Rating: Match electrical requirements including motor horsepower, voltage, phase, and frequency for fans and pumps for motor being driven. Select drive such that full load amps do not exceed continuous current rating of drive.
E. Unit Operating Requirements:
   1. Input AC Voltage Tolerance: ±5% for 200 to 240 volts and ±10% for 460 to 480 volts.
   2. Input Frequency Tolerance: ±5% of 60 hertz.
   3. Minimum Efficiency: 95% at full load and 85% at half load.
   4. Minimum Power Factor: 95%.
   5. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.
   6. Starting Torque: 100% rated torque.
   7. Speed Regulation: ±1%.
F. Enclosure:
   1. NEMA 1, fully enclosed, vertically configured with front accessible controls and components suitable for wall, freestanding, or strut mounting with all components fully factory assembled.
   2. Provide a hinged and lockable door with an internal partition to separate and isolate the drive and bypass sections so the drive and be serviced without live power in the drive section.
   3. Provide air inlet filters with accessible fans.

G. Keypad & Display:
   1. LCD display with backlit keypad mounted on front cover.
   2. Capable of displaying programming, fault diagnostics, and operating values in complete English words.
   3. Configurable in the hand, off, or auto mode.
   4. Manual speed adjustment via keypad with indication of speed command setting.

H. Serial Communications:
   1. Standard RS-485 port allowing VFD to be used with an external building automation system.
   2. Provide BACnet standard protocol without the use of gateways or multiplexers. Coordinate final communication protocol with the Temperature Control Contractor.
   3. Interface shall allow all parameter settings of VFD to be programmed.
   4. Provide the following control points:
      a. Fault condition.
      b. Speed signal.
      c. Frequency.
      d. VFD start/stop.
      e. Voltage.
      f. Bypass status (where bypass is provided).

I. Integral Protection Circuits: Provide an orderly shutdown under the following abnormal conditions:
   1. Undervoltage and overvoltage trips.
   2. Over temperature, overload, and overcurrent trips.
   3. Loss of phase.
   4. Short circuit.
   5. Motor overload.
   6. Ground fault.
   7. Keypad control panel, microprocessor fault, or serial communication.

J. Control Signal Interface:
   1. Two (2) setpoint controllers for closed lop control.
   2. Two (2) programmable analog inputs (0 to 10 VDC or 0/4 to 20 mA).
   3. Two (2) programmable analog outputs (0/4 to 20 mA).
   4. Six (6) programmable digital inputs for interfacing with the building automation system.
   5. Three (3) programmable, digital “Form C” relay outputs.

K. Control Limit Functions:
   1. Minimum and maximum speed limits.
   2. Maximum current or current limit.
   3. Undervoltage or overvoltage control.
   4. Minimum and maximum output frequency.
   5. Minimum and maximum torque limits.
   6. Adjustable acceleration and deceleration ramp speeds.

L. Restart:
   1. Automatic restart after controller fault or on return of power after an interruption and before shutting down for manual restart or fault correction. Number of restart attempts, trial time, and time between attempts shall be programmable.
   2. Capable of starting into a rotating load (forward or reverse) up to full speed and accelerate or decelerate to set point without tripping or component damage (flying start).

M. Disconnect Switch: NEMA KS-1, non-fusible switch with lockable handle.
   1. To disconnect all input power upstream of the VFD and bypass motor controller.
   2. Switch shall be configured such that with the switch closed, the VFD can be safely accessed for service and/or physically removed.

N. Manual Bypass Starter: Magnetic contactor arranged to safely open transfer motor between VFD controller outputs and bypass starter when motor is at zero (0) speed.

1. Provide one (1) main disconnect switch to disconnect power to both the drive and the bypass circuit.
2. Factory wired and tested bypass system consisting of two (2) or three (3) contactor bypass and motor controllers to operate the motor with line power when servicing the VFD.
3. Provide overload protection in the bypass circuit.
4. Provide service switches and fuses upstream of the VFD for the ability to replace or repair the VFD components when operating in bypass mode.
5. Unit shall be capable of stable operation (starting, stopping, and running) with motor completely disconnected from controller (no load).
6. Provide the bypass equipment in a common enclosure with the VFD or in a separate enclosure.
7. Provide manual bypass starter on equipment as indicated in the schedules.

O. Terminal Strip:
1. Isolated from wire to ground. Separate terminal strip for connection of external start-stop command. Maintain all external interlocks fully functional whenever the VFD is in hand, auto, or bypass mode.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Verify voltage with Electrical Contractor prior to order.
B. Install input power, output power, and control wiring in separate conduits for each variable frequency drive.
C. Select features of each VFD to coordinate with ratings and characteristics of supply circuit and motor required control sequence, and duty cycle of motor, drive, and load.
D. Coordinate the installation and connection of automatic controls and control devices with the Temperature Control Contractor.

3.2 START-UP & OWNER TRAINING

A. Provide start-up service of each variable frequency drive by a factory trained and certified service technician to approve the installation, start-up, test, and adjust for proper operation of the VFD.
B. Engage a factory authorized service representative to perform the following:
1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
2. Assist in field testing of equipment including pre-testing and adjusting of solid state controllers.
3. Report test results in writing.
4. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Submit a manufacturer's field report, including test and start-up report, signed by the factory authorized representative, in the operation and maintenance manual.
D. Provide one (1) hour of Owner training.
E. Demonstrate operation of variable frequency drive in automatic and bypass modes.
F. Once operational, the VFD shall be operated through its full range to determine resonant speeds and the VFD shall be programmed to skip those speeds.

END OF SECTION 23 05 14

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SECTION 23 05 19
METERS & GAUGES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Thermometers.
B. Pressure gauges.
C. Pressure/temperature test plugs.
D. Flow sensing devices.
E. Water meters.

1.2 REFERENCE STANDARDS

A. ASTM B40.100 - Pressure Gauges & Gauge Attachments
B. ASTM B40.200 - Thermometers, Direct Reading, & Remote Reading
C. AWWA C700 - Cold Water Meters - Displacement Type

1.3 SUBMITTALS

A. Product Data: Provide product data for each product that indicates materials of construction, dimensional data, system designation, scale, and range for each component.
B. Schedule: Provide a schedule indicating equipment scale range, figure intervals for each system served.

PART 2 - PRODUCTS

2.1 THERMOMETERS

A. Manufacturers:
   1. Ashcroft.
   2. H. O. Trerice Co.
   3. Marsh Bellofram.
   4. Milijoco Corporation.
   5. Weiss Instruments.
   6. Weksler Instruments.
B. Case: Cast aluminum, 9” scale.
C. Connector: 1-1/4” screw threads, adjustable angle stem, 180° in vertical plane, 360° in horizontal plane with positive locking device.
D. Stem: Brass, length to insert into middle of pipe.
E. Tube: Magnifying lens with blue or red organic liquid.
F. Tube Background: Non-reflective aluminum with black markings against a white background.
G. Window: Acrylic or glass.
H. Measurement: °F.
I. Accuracy: ±1% of scale division.
J. Scale:

SYSTEM DESIGNATION	SCALE RANGE [°F]	FIGURE INTERVALS [°F]	MINOR DIVISIONS [°F]
Hot Water	30-240	10	2

K. Thermowells:
   1. Description: Pressure tight, socket type fitting made for insertion into piping.
   2. Type & Diameter: Brass with threaded connections as required to hold thermometer stem.

2.2 PRESSURE GAUGES

A. Manufacturers:
   1. Ashcroft.
   2. H. O. Trerice Co.
   3. Marsh Bellofram.
   4. Milijoco Corporation.
   5. Weiss Instruments.
   6. Weksler Instruments.
B. Case: Cast aluminum with stainless steel ring, 4-1/2” diameter dial.
C. Connector: Brass, bottom-outlet type, 1/4” pipe threads.
D. Pressure Element Assembly: Bourdon tube.
E. Movement: Mechanical, with link to pressure element and connection to pointer.
F. Dial Face: Non-reflective aluminum with black markings against a white background.
G. Pointer: Black metal, front adjustable.
H. Window: Acrylic or glass.
I. Measurement: PSIG.
J. Accuracy: ±1% full scale.
K. Scale:

SYSTEM DESIGNATION	SCALE RANGE [PSIG]	FIGURE INTERVALS [PSIG]	MINOR DIVISIONS [PSIG]
Hot Water	0-160	20	2

L. Gauge Attachments:
   1. Snubbers: Brass, with 1/4” pipe threads, porous metal type with surge dampening device. Include extension for use on insulated piping.
   2. Valves: Brass ball valves for hydronic systems, 1/4” size.

2.3 PRESSURE/TEMPERATURE TEST PLUGS

A. Manufacturers:
   1. H. O. Trerice Co.
   2. Milijoco Corporation.
   3. Peterson Equipment Company.
   4. Sisco Manufacturing Company.
   5. Texas Fairfax Company.
B. Body: Brass with core inserts and gasketed and threaded cap.
C. Body Length:
   1. 1-1/2” for uninsulated piping.
   2. 3” for insulated piping.
D. Connection Size: 1/4” or 1/2” pipe thread.
E. Rating: 500 PSIG at 275°F.
F. Core Inserts: EPDM (Nordel) self-sealing rubber for receiving 1/8” pressure or temperature probe.

2.4 FLOW SENSING DEVICES

A. 2” & Smaller: Use balancing valves.

B. 2-1/2” & Larger: Pitot-type flow sensing devices.
   1. Manufacturers:
      a. Nexus Valve.
      b. Preso Meters.
   2. Sensor: Multi-port, insertion pitot-type measuring differential pressure.
      a. Probe: 316 stainless steel.
      b. Configuration: Diamond or elliptical shape length to span inside of pipe.
      c. Valves: 1/2” brass instrument connection valves with fitting for connection to a meter.
      d. Head: T-type or Y-type, brass.
      e. Insertion: Threaded weld fitting.
   3. Rating: 400 PSIG and 250°F.
   4. Accuracy: ±1%.
   5. Repeatability: ±0.1%.
   6. Turndown: 17:1.
   7. Accessories: Metal identification tag indicating design flow rate, line size, pressure characteristics, and identification number.

2.5 WATER METERS

A. Manufacturers:
   1. Badger Meter.
   2. Carlon Meter.
   3. Hersey.
B. Type:
   1. 2” & Smaller: AWWA C700 positive displacement industrial disc type.
C. Meter:
   1. Construction: Bronze body with magnetic drive register.
   2. Service: Cold water, 100°F.
   3. Maximum Operating Pressure: 150 PSIG.
   4. Accuracy: 1-1/2%.
   5. Repeatability: 0.5%.
   6. Sealed Register: Odometer style with multi-digit, non-reset totalizer with 10,000,000 gallon capacity; 360° sweep hand with 10 gallon range and 0.1 gallon increments.
D. Maximum Water Pressure Drop Sizing: 5 PSIG at maximum flow rate.
E. Transmitter:
   1. Construction: Corrosion resistant, glass filled plastic or cast bronze enclosure.
   2. Temperature rating: 250°F.
   3. Housing: NEMA 4 or 4X.
   4. Output Signal: Hermetically sealed reed switch (dry contacts).
   5. External Power Wiring: Not allowed.

PART 3 - EXECUTION

3.1 THERMOMETERS

A. Install thermometers in thermowells with socket extending to center of pipe with extension on insulated piping.
B. Fill thermowells with heat transfer medium.
C. Clean lens, adjust vertical and tilted positions to proper angle for best visibility, and calibrate.
D. Install thermometers in the following locations:
   1. Boilers, inlet and outlet.
   2. Where indicated.

3.2 PRESSURE GAUGES

A. Install pressure gauges located on pipe at the most readable position.
B. Clean lens, adjust faces of pressure gauges to proper angle for best visibility, and calibrate.
C. Install valve and snubber in piping for each pressure gauge for hydronic systems.
D. Provide 1/4” gauge piping of the same materials specified for the system.
E. Install pressure gauges in the following locations:
   1. Across pressure reducing valves.
   2. Across pump suction, discharge, and strainer/suction diffusers.
   3. At expansion tanks.
   4. Across water filters.
   5. Across boilers.
   6. Where indicated.

3.3 PRESSURE/TEMPERATURE TEST PLUGS

A. Locate and orient test plugs for ease of access.
B. Install test plugs at the following locations (additional test plug is not required when provided with another device):
   1. At inlet and outlet of each heat transfer device.
   2. Pumps suction and discharge.
   3. Where indicated.
C. Trim insulation around test plugs.

3.4 FLOW SENSING DEVICES

A. Install flow sensing devices in accessible positions in piping systems.
B. Install flow sensing devices, with at least minimum straight lengths of pipe, upstream and downstream, from element according to manufacturer's instructions.

3.5 WATER METERS

A. Provide shutoff valves upstream and downstream of the water meter.
B. Provide a full size bypass with a shutoff valve around the water meter.
C. Provide a water meter at the following locations:

SYSTEM DESIGNATION	FLOW RATE [GPM]	METER SIZE [INCHES]	COMBINED METER [YES/NO]	TRANSMITTER [YES/NO]
Hot Water Fill	8	3/4”	No	Yes

END OF SECTION 23 05 19

SECTION 23 05 23
VALVES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Hydronic system valves.
B. Gas system valves.

1.2 REFERENCE STANDARDS

A. ASME 31.1 - Power Piping
B. ASME 31.9 - Building Services Piping
C. NFPA 54 - National Fuel Gas Code

1.3 SUBMITTALS

A. Product Data: For each type of valve indicated.
   1. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances.
   2. Include rated capacities, weights, furnished specialties, and accessories.
B. Valve Schedule: Include list indicating valve and its application.

1.4 DELIVERY, STORAGE, & HANDLING

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, and weld ends.
   3. Set ball valves open to minimize exposure of functional surfaces.
B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.
D. Provide temporary protective coating on cast iron and steel valves.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from a single manufacturer.
B. Valve Pressure & Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
C. Valve Actuator Types:
   1. Handwheel: For valves other than quarter turn types.
   2. Lever Handle: For quarter turn valves 6” and smaller, except plug valves.
D. Valves & Extended Valve Stems in Insulated Piping:
   1. Include stem extensions.

2. Extended operating handle of non-thermal conductive material and protective sleeves that allow operation of valves without breaking the vapor seals or disturbing insulation.
3. Memory stops that are fully adjustable after insulation is applied.
4. Valves in insulated piping system shall have the body and flanges completely insulated. The practice of leaving heating valves and associated unions/flanges uninsulated is unacceptable.

E. Identification: Manufacturer's name and pressure rating shall be marked on the valve body.

2.2 HYDRONIC SYSTEMS

A. Shutoff Valves (Ball Valves – 2" & Smaller)
1. Manufacturers:
   a. Apollo.
   b. Hammond Valve.
   c. Milwaukee Valve.
   d. Nibco.
   e. Watts.
2. Description:
   a. Body Design: Two piece.
   b. Body Material: Bronze.
   c. Pipe Connections: Threaded or soldered.
   d. Seats: Reinforced PTFE.
   e. Stem: Stainless steel, blowout proof.
   f. Ball: Stainless steel, conventional or full port.
   g. Rating: 600 PSI WOG.

B. Shutoff Valves (Butterfly Valves – 2-1/2" & Larger):
1. Manufacturers:
   a. Apollo.
   b. Bray International, Inc.
   c. Hammond Valve.
   d. Milwaukee Valve.
   e. Nibco.
   f. Watts.
2. Description:
   a. Body Design: Lug type, suitable for bi-directional dead-end service at rated pressure without use of downstream flange.
   b. Body Material: Ductile iron.
   c. Seats & Seals: EPDM.
   d. Stem: Stainless steel.
   e. Disc: Aluminum bronze or stainless steel.
   f. Rating: 200 PSI WOG.

C. Balance Valves:
1. Manufacturers:
   a. Bell & Gossett.
   b. Griswold Controls.
   c. Hydronic Components, Inc.
   d. IMI Hydronic Engineering.
   e. Nexus.
   f. Nibco.
2. 2" & Smaller:
   a. Description:
      1) Body Design: Calibrated orifice or venturi type.
      2) Body Material: Brass.
      3) Pipe Connections: Threaded or soldered with or without unions.
      4) Seals: EDPM.

5) Stem: Stainless steel, blowout proof.
6) Ball (if required): Stainless steel.
7) Rating: 150 PSIG at 250°F.
8) Options:
a) Pressure/temperature ports with integral seals and protective caps.
b) Identification tag with model number and Cv rating.

3. 2-1/2” & Larger:
a. Description: Butterfly valve and flow sensing device.

D. Check Valves:
1. Manufacturers:
a. Apollo.
b. Hammond Valve.
c. Milwaukee Valve.
d. Mueller Company.
e. Nibco.
f. Watts.
2. Swing Check Valves:
a. General:
1) Rating: 150 PSI WOG.
2) Orientation: Horizontal or vertical with upward flow.
b. 2” & Smaller:
1) Body Material: Bronze.
2) Pipe Connections: Threaded or soldered.
3) Disc & Trim: Bronze.
4) Seat: PTFE.
c. 2-1/2” & Larger:
1) Body Design: Wafer type, non-slam operation.
2) Body Material: Cast iron.
3) Pipe Connections: Flanged.
4) Disc & Trim: Bronze.
5) Seat & Seals: Stainless steel or Viton.
3. Spring Loaded Check Valves:
a. General:
1) Rating: 125 PSI WOG.
b. 2” & Smaller:
1) Body Material: Bronze.
2) Pipe Connections: Threaded or soldered.
3) Disc & Trim: Bronze.
4) Spring: Stainless steel.
5) Seat: PTFE.
c. 2-1/2” & Larger:
1) Body Material: Cast iron or steel.
2) Type: Globe or wafer type.
3) Pipe Connections: Flanged.
4) Disc & Trim: Bronze.
5) Spring & Stem: Stainless steel.
6) Seat: EDPM.

E. Drain Valves:
1. Manufacturers:
a. Apollo.
b. Hammond Valve.
c. Milwaukee Valve.
d. Nibco.
e. Watts.

2. Description:
    a. 3/4” shutoff valve with hose adapter, cap, and chain.
    b. Strainer blowdown to be the same size as the strainer blowdown connection.

F. Gauge Valves:
1. Manufacturers:
    a. Apollo.
    b. Hammond Valve.
    c. Milwaukee Valve.
    d. Nibco.
    e. Watts.
2. Description:
    a. 1/4” shutoff valve.

2.3 NATURAL GAS SYSTEMS

A. Shutoff Valves:
1. Manufacturers:
    a. DeZurik.
    b. Homestead.
    c. Nibco.
    d. Rockwell.
    e. Walworth.
    f. Watts.
2. General:
    a. UL & AGA listed for use as a natural gas shutoff valve.
3. 2" & Smaller:
    a. Body Design: Two piece.
    b. Body Material: Bronze or brass.
    c. Pipe Connections: Threaded.
    d. Seats: Reinforced PTFE.
    e. Stem: Bronze or brass, blowout proof.
    f. Ball: Bronze or brass, conventional or full port.
    g. Rating: 600 PSI WOG.
4. 2-1/2" To 4":
    a. Body Material: Cast iron.
    b. Pipe Connections: Flanged.
    c. Bearings: Bronze.
    d. Plug: Electroless nickel plated cast iron.
    e. Seal: Hycar resilient plug.
    f. Stem Seal: Buna-N packing.
    g. Rating: 175 PSI WOG.
    h. Options:
        1) Lever handle.

B. Gas Pressure Regulators:
1. 2-1/2" & Larger:
    a. Body Material: Cast iron.
    b. Pipe Connections: Flanged.
    c. Spring: Aluminum.
    d. Diaphragm: Nitrile.
    e. Rating: 150 PSI WOG, ambient conditions of -20°F to 150°F.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
C. Examine threads on valve and mating pipe for form and cleanliness.
D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
B. Locate valves for easy access and provide separate support where necessary.
C. Install valves in position to allow full stem movement.
D. Install valve tags. Comply with requirements in Section 23 05 53 for valve tags and schedules.

3.3 HYDRONIC SYSTEM VALVES

A. Install valve stem between the vertical (upright) to horizontal position with the stem at or above the center of the pipe. Do not support weight of piping on the valve.
B. Butterfly valves shall have the bottom half of the disk opening in the direction of flow.
C. Butterfly valves installed at the location of flow sensing devices are to have a memory stop.
D. Install all stem extensions shipped loose from valve.
E. Install control valves as provided by the Temperature Control Contractor per the manufacturer's instructions.
F. Provide shutoff valves at the following locations:
    1. Downstream of balancing and control valves.
    2. Upstream of equipment.
    3. Division of mains or risers.
    4. Where indicated and detailed.
G. Provide balancing valves at the following locations:
    1. Downstream of equipment.
    2. Division of mains or risers.
    3. Discharge of each pump.
    4. Where indicated and detailed.
H. Provide drain valves at the following locations:
    1. At all low points for complete system drainage.
    2. Where indicated and detailed.
I. Provide gauge valves at all pressure gauges.
J. Provide swing check valves at the following locations:
    1. Where indicated and detailed.
K. Provide spring check valves at the following locations:
    1. At the discharge of each pump.
    2. Where indicated and detailed.

3.4 NATURAL GAS VALVES

A. When the gas pressure regulator is equipped with a vent connection, route vent to the exterior and terminate with a downturned elbow and weatherproof vent cap.
B. Provide shutoff valve and cap tight each tee or piping which will not be immediately extended.
C. Install a shutoff valve at each appliance.

END OF SECTION 23 05 23

SECTION 23 05 29
HANGERS & SUPPORTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Pipe, conduit, and equipment hangers and supports.
B. Thermal hanger shield inserts.
C. Concrete pads.
D. Corrosive atmosphere coatings.

1.2 REFERENCE STANDARDS

A.	ASME B31.1 -	Power Piping
B.	ASME B31.3 -	Process Piping
C.	ASME B31.9 -	Building Services Piping
D.	MSS SP-58 -	Pipe Hangers & Supports - Materials, Design, & Manufacturer
E.	MSS SP-69 -	Pipe Hangers & Supports - Selection & Application
F.	MSS SP-90 -	Guidelines for Terminology for Pipe Hangers & Supports

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and system fluid.

1.4 SUBMITTALS

A. Product Data: For each type of product.
B. Schedule: Submit a schedule with all hanger and support devices indicating shields, attachment methods, and type of device for each pipe size and type of service.

1.5 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1, Structural Welding Code - Steel.
B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
C. Conform to applicable codes for support of all piping.

PART 2 - PRODUCTS

2.1 HANGERS & SUPPORTS

A. Horizontal Piping Hangers & Supports:
   1. Adjustable Clevis Hangers (MSS Type 1): Carbon steel, adjustable clevis, with cross bolt and nut.
   2. Adjustable, Swivel Split or Solid Ring Hangers (MSS Type 6): For suspension of non-insulated, stationary pipes.

3. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated, stationary pipes.
4. Adjustable Band Hangers (MSS Type 9): For suspension of non-insulated, stationary pipes.
5. Adjustable, Swivel Ring Band Hangers (MSS Type 10): For suspension of non-insulated, stationary pipes.
6. Pipe Saddle Supports (MSS Type 36): For support of pipes with steel pipe base stanchion support and cast-iron floor flange or carbon steel plate.
7. Pipe Stanchion Saddles (MSS Type 37): For support of pipes with steel pipe base stanchion support and cast-iron floor flange or carbon steel plate, and with U-bolt to retain pipe.
8. Adjustable Pipe Saddle Supports (MSS Type 38): Floor stanchion type support with adjustable steel support with floor flange.

B. Trapeze Pipe Hangers
1. Description: MSS SP-69, Type 59, pipe support assembly made from structural carbon steel shapes with MSS SP-58 carbon steel hanger rods, nuts, saddles, and U-bolts.

C. Vertical Piping Clamps:
1. Extension Pipe or Riser Clamps (MSS Type 8): Carbon steel, bolts and nuts.

D. Building Attachments:
1. Center Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
2. C-Clamps (MSS Type 23): For structural shapes.
3. Top Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
4. Steel Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
5. Linked Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
6. Welded Steel Brackets (MSS Type 32 & 33): For support of pipes from below or for suspending from above by using clip and rod.
7. Side Beam Brackets (MSS Type 34): For sides of steel beams.

E. Saddles, Shields, & Inserts:
1. Pipe Covering Protection Saddles (MSS Type 39): Carbon steel, curved to match insulation thickness.
2. Protection Shields (MSS Type 40): Galvanized carbon steel not less than 18-gauge of length recommended by manufacturer to prevent crushing insulation, minimum length of 12”.
3. Thermal Hanger Shield Inserts: See below.

F. Miscellaneous Accessories:
1. Hanger Rods: Steel rods, continuously threaded, with adjusting and locking nuts.

2.2 THERMAL HANGER SHIELD INSERTS

A. Manufacturers:
1. Buckaroos, Inc.
2. National Pipe Hanger Corporation.
3. Pipe Shields, Inc.

B. Insulation Insert Material for Hot Piping: ASTM C552, Type II cellular glass with 100 PSIG or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125 PSIG minimum compressive strength.

C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

D. For Clevis or Band Hangers: Insert and shield shall cover lower 180° of pipe.

E. Insert Length: Extend 2” beyond sheet metal shield for piping operating below ambient air temperature.

2.3 CONCRETE PADS

A. Concrete: ASTM C150, Type 1, suitable for interior and exterior applications.
   1. Reinforcement:
      a. Rebar: ASTM A615, Grade 60.
      b. Welded Wire Mesh: ASTM A185, 6x6-W1.4 x W1.4.
   2. Design Mix: 3500 PSI, 28-day compressive strength; 3/4” mix aggregate; 2” to 4” slump.

B. Grout: ASTM C1107, factory mixed and packaged, dry, hydraulic cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
   1. Properties: Nonstaining, noncorrosive, and nongaseous.
   2. Design Mix: 5000 PSI, 28-day compressive strength.

2.4 CORROSIVE ATMOSPHERE COATINGS

A. Factory coat supports and anchors used in corrosive atmospheres with hot dip galvanizing after fabrication.
B. ASTM A123, 1.5 ounces/square foot of surface, each side.
C. Mechanical galvanize threaded products, ASTM B695 Class 150, 2.0 mil coating.
D. Field cuts and damaged finished to be field covered with zinc rich paint of comparable thickness to factory coating.

PART 3 - EXECUTION

3.1 HANGER & SUPPORT INSTALLATION

A. Provide all supports required for the installation of piping, conduit or equipment, whether or not it is specifically indicated or sized, including angles, channels, or beams to suspend or floor support equipment.
B. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure under all conditions of operation, and variations of installed and operating weight. Supports shall provide free expansion of the piping system.
C. Allow sufficient space between adjacent pipes and ducts for insulation, valve operation, and routine maintenance.
D. Arrange for grouping of parallel runs of horizontal piping, and support together on trapeze pipe hangers or multiple individual hangers.
   1. Pipes of Various Sizes: Support together and space trapeze for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories. Protect insulation at all hanger points.
F. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
G. Install lateral bracing with pipe hangers and supports to prevent swaying.
H. Install building attachments to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, and at changes in direction of piping.
I. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
J. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

K. Support riser piping independently of connected horizontal piping. Support vertical piping at every floor with clamps secured to the piping and resting on the building structure or secured to the building structure below each floor.

L. Provide hangers with 12” of each horizontal elbow, valve, strainer, or similarly piping specialty item.

M. Insulated Piping:
   1. Saddles:
      a. Fill interior voids with insulation that matches adjoining insulation.
   2. Shields:
      a. Install protective shields on piping. Shields shall span an arc of 180°.
   3. Thermal Hanger Shield Inserts:
      a. Install with insulation same thickness as piping insulation.
      b. Thermal hanger shield inserts may be used in lieu of saddles or individual pipe shields.

3.2 HANGER & SUPPORT SCHEDULE

A. Comply with MSS SP-69 for pipe hanger selections and applications.

B. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field applied finish.

C. Use carbon steel pipe hangers and supports and attachments for general service applications.

D. Use copper plated or nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use corrosive atmosphere coatings for hangers and attachments for corrosive applications.

F. Provide pipe supports based on the following:

SYSTEM DESIGNATION	CLEVIS HANGER	ROLLER SUPPORT	RING/BAND HANGERS	TRAPEZE
Hot Water	Up to 5”	6” & Up	Up to 2”	All sizes
Make-Up Water	All sizes	-	Up to 2”	All sizes
Conduit	All sizes	-	All sizes	All sizes

G. Provide pipe protection at supports based on the following:

SYSTEM DESIGNATION	PROTECTION SHIELD	THERMAL HANGER SHIELD INSERT	PIPE SADDLE
Hot Water	Up to 2”	2-1/2” & Up	2-1/2” & Up
Make-Up Water	Up to 2”	2-1/2” & Up	2-1/2” & Up

H. Pipe hangers shall be spaced in accordance with the following schedule:

PIPE SIZE	HANGER SPACING & ROD SIZE			
	STEEL PIPING	COPPER PIPING	PVC PIPING	HANGER ROD SIZE
1/2"	7'	5'	4’	1/4”
3/4"	7'	5'	4'	1/4”
1"	7'	6'	5'	1/4”
1-1/4”	9'	8'	5'	3/8”
1-1/2"	9'	8'	5'	3/8”
2"	10'	8'	6'	3/8”
2-1/2'	11'	9'	6'	3/8”
3"	12'	10'	7'	3/8”
4"	14'	12'	7'	1/2”

3.3 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
B. Trim excess length of continuous threaded hanger and support rods.

3.4 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting.
B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing repair paint to comply with ASTM A780.

3.5 CONCRETE PADS

A. Provide concrete housekeeping pads nominal 4” thick unless noted otherwise, extended 6” beyond equipment footprint in all directions. Coordinate concrete pad size with the boiler requirements for the condensate drain and piping to the neutralization basin.
B. Bond pads to concrete slabs with hooked dowel rods.
C. Reinforcement:
   1. Pads: Welded wire mesh with minimum 1” cover.
D. Provide equipment templates, anchor bolt locations, and accessories for mounting and anchoring equipment.
E. Bold equipment with flanges to pad.

3.6 CORROSIVE ATMOSPHERE COATINGS

A. Corrosive atmospheres include the following locations:
   1. Exterior locations.

END OF SECTION 23 05 29

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SECTION 23 05 48
VIBRATION CONTROLS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Isolation pads & mounts.
B. Spring isolators.
C. Vibration isolation equipment bases.
D. Flexible pipe connections.

1.2 REFERENCE STANDARDS

A. ASHRAE Applications Handbook - Chapter 48 Noise & Vibration Control

1.3 SUBMITTALS

A. Product Data: For each type of product.
   1. Include rated load, rated deflection, and overload capacity for each vibration isolation device. Include load deflection curve for each vibration isolation device.
   2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device type required.
   3. Include isolator type, materials of construction, isolator free and operating heights, and isolation efficiency based on the lowest operating speed of the equipment supported.
B. Shop Drawings:
   1. Detail Fabrication & Assembly: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

1.4 COORDINATION

A. Coordinate layout and installation of vibration controls with other construction trades.
B. Coordinate size and location of concrete bases. Cast anchor bolt inserts into base.
C. Coordinate installation equipment supports.

1.5 QUALITY ASSURANCE

A. Source: Obtain vibration control products from a single manufacturer.

PART 2 - PRODUCTS

2.1 GENERAL

A. All rotating and reciprocating mechanical equipment shall be mounted on vibration control products to prevent the transmission of vibration and mechanically transmitted sound to the building structure.
B. Use materials that will retain their isolation characteristics for the life of the equipment served. Use industrial grade neoprene for elastomeric materials.
C. Treat all isolators to resist corrosion. For isolation devices used in exterior applications or in high humidity locations, hot dip galvanize steel parts or use stainless steel parts.
D. Color code or otherwise mark vibration isolation devices to indicate capacity range.

E. For equipment with variable speed capability, select vibration isolation devices based on the lowest speed.
F. Consider weight distribution to provide uniform isolator deflection.

2.2 MANUFACTURERS

A. Kinetics Noise Control, Inc.
B. Mason Industries, Inc.
C. The VMC Group.
D. Vibration Mounting & Controls.

2.3 ISOLATION PADS & MOUNTS

A. Type 1 – Elastomeric Isolation Pads
   1. Description: Elastomeric isolation pads.
   2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
   3. Size: Factory or field cut to match requirements of supported equipment.
   4. Pad Material: Oil and water resistant with elastomeric properties.
   5. Surface Pattern: Waffle pattern.
   6. Infused nonwoven cotton or synthetic fibers.
   7. Load bearing metal plates adhered to pads when multiple layers are required.
   8. Stiffness: 40 durometer.
B. Type 2 – Elastomeric Isolation Mounts
   1. Description: Elastomeric isolation mounts.
   2. Mounting Plates:
      a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
      b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
   3. Elastomeric Material: Double deflection, molded, oil resistant rubber, neoprene, or other elastomeric material.
   4. Deflection: Minimum of 0.35”.

2.4 SPRING ISOLATORS

A. General:
   1. Outside Spring Diameter: Not less than 80% of the compressed height of the spring at rated load.
   2. Minimum Additional Travel: 50% of the required deflection at rated load.
   3. Lateral Stiffness: More than 80% of rated vertical stiffness.
   4. Overload Capacity: Support 200% of rated load, fully compressed, without deformation or failure.
B. Type 3 – Open Spring Isolators
   1. Description: Freestanding, laterally stable, open spring isolators.
   2. Baseplates: Factory drilled steel plate for bolting to structure with a ribbed elastomeric isolator pad attached to the underside.
   3. Top Plate & Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
C. Type 4 – Restrained Spring Isolators
   1. Description: Freestanding, laterally stable, open spring isolators with vertical limit stop restraint.
   2. Housing: Steel housing with vertical limit stops to prevent spring extension due to weight being removed.
      a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside.

b. Top plate with threaded mounting holes and ribbed elastomeric pad.
c. Internal leveling bolt that acts as blocking during installation.

3. Restraint: Limit stop as required for equipment.

D. Type 5 – Spring Hangers
1. Description: Combination coil spring and elastomeric insert hanger with spring.
2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30° of angular hanger rod misalignment without binding or reducing isolation efficiency.
3. Elastomeric Element: Molded, oil resistant rubber or neoprene. Steel washer reinforced cup to support spring and bushing projecting through bottom of frame.
4. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
5. Hanger Rod Cap: Self-centering to ensure concentricity between hanger rod and support spring coil.

E. Type 6 – Pre-Compressed Spring Hangers
1. Description: Combination coil spring and elastomeric insert hanger with pre-compressed spring.
2. Similar to Type 5 except pre-compressed to the rated deflection to keep the piping or equipment at a fixed elevation during installation.
3. Design hanger with a release mechanism to free the spring after installation is completed and hanger is subjected to full load.

2.5 VIBRATION ISOLATION EQUIPMENT BASES

A. Type A – Direct Isolation, No Base Required.

B. Type B – Structural Steel Bases
1. Description: Factory fabricated, welded, structural steel bases and rails.
2. Design Requirements: Lowest possible mounting height with not less than 1” clearance above the floor or housekeeping pad. Include equipment anchor bolts and auxiliary motor slide bases or rails.
3. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36. Bases shall have shape to accommodate supported equipment.
a. Perimeter steel members shall have a minimum depth of 1/10 of the longest dimension of the base but not less than 4”.
b. Base depth need not exceed 12” unless required for mass or rigidity.
4. Support Brackets: Factory welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

C. Type C – Concrete Inertia Bases
1. Description: Factory fabricated, welded, structural steel bases and rails ready for placement of cast-in-place concrete.
2. Design Requirements: Lowest possible mounting height with not less than 1” clearance above the floor or housekeeping pad. Include equipment anchor bolts and auxiliary motor slide bases or rails.
a. Include supports on inertia base for suction and discharge elbows for pumps.
3. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36. Bases shall have shape to accommodate supported equipment.
a. Perimeter steel members shall have a minimum depth of 1/10 of the longest dimension of the base but not less than 4”.
b. Base depth need not exceed 12” unless required for mass or rigidity.
c. Provide 1/2” rebar 6” on center running in two (2) layers perpendicular to one another.
d. Bases may be “T” or “L” shaped based on equipment configuration.
4. Support Brackets: Factory welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

5. Fabrication: Fabricate steel templates to hold equipment anchor bolt sleeves and anchors in place during placement of concrete. Obtain anchor bolt templates from supported equipment manufacturer.

2.6 FLEXIBLE PIPE CONNECTIONS

A. Manufacturers:
   1. Hyspan.
   2. Mason.
   3. Metraflex.
   4. Proco.
   5. Twin City Hose.

B. Rubber, Spherical, Flexible Connections:
   1. Body: Fiber reinforced rubber body.
   2. Cover: EPDM.
   3. Tube: EPDM.
   4. End Connections: Drilled to align with Class 150 steel flanges. Solid steel rings within the raised face rubber flanged ends.
   5. Performance: Capable of misalignment.
   6. Spheres: Twin spheres with external ring between spheres.
   7. Rating: 150 PSIG at 250°F.

PART 3 - EXECUTION

3.1 DESIGN REQUIREMENTS

A. Select vibration isolation control devices as indicated below

Equipment Isolation Schedule														
			Equipment Location											
						Floor Span								
			Slab on Grade			Up to 20 Feet			20 to 30 Feet			30 to 40 Feet		
Equipment Type	HP & Other	RPM	Base Type	Isolator Type	Min. Defl., [In]	Base Type	Isolator Type	Min. Defl., [In]	Base Type	Isolator Type	Min. Defl., [In]	Base Type	Isolator Type	Min. Defl., [In]
Pumps														
End Suction	≤40	All	A	-	-	C	3	0.75	C	3	1.50	C	3	1.50
Boilers	All	All	A	1	0.25	A	1	0.25	A	1	0.25	A	1	0.25

3.2 EXAMINATION

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

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

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

3.3 VIBRATION CONTROL DEVICES

A. Install vibration control devices in accordance with the manufacturer's instructions.

B. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork.

C. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.
D. Adjust isolators after piping systems have been filled and equipment is at operating weight.
E. Do not allow installation practices to short circuit any isolation device. Inspect vibration control devices after final installation.

3.4 FLEXIBLE PIPE CONNECTIONS

A. Flexible piping connections are required for piping connected to coils that are connected to an assembly where the entire assembly is mounted on vibration supports.
B. Provide flexible piping connections at the following locations:
   1. Base mounted pumps.
C. Provide flexible piping connections on the equipment side of shutoff valves.
D. Provide the following flexible piping connections:

SYSTEM DESIGNATION	SPHERICAL RUBBER	STAINLESS STEEL	BRONZE
Hot Water	X		

END OF SECTION 23 05 48

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SECTION 23 05 53
IDENTIFICATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Equipment labels.
B. Pipe labels.
C. Valve tags.

1.2 REFERENCE STANDARDS

A. ASME 13.1 - Scheme for the Identification of Piping Systems

1.3 SUBMITTALS

A. Product Data: For each type of product provide manufacturers catalog literature.
B. Identify letter size and color coding for mechanical identification.
C. Label Schedules:
   1. Submit a schedule of proposed equipment to be labeled with the proposed content for each label.
   2. Submit the valve schedule including numbering schedule and scheme.

1.4 OPERATION & MAINTENANCE SUBMITTALS

A. Record Drawings: Provide actual locations of tagged valves.
B. Valve Tag Schedule: For each piping system, including valve tag number, actual location, function, size, and manufacturers name and model number.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Manufacturers:
   1. Brady Corporation.
   2. Marketing Services Incorporated.
   3. Seton Identification Products.
B. Material & Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16” thick, with pre-drilled holes for attachment hardware with beveled edges.
   1. Colors: White letters on black background.
   2. Maximum Temperature: Able to withstand temperatures up to 160°F.
   3. Letter Size: 3/4” tall.
   4. Fasteners: Stainless steel self-tapping screws.
   5. Adhesive: Contact type permanent adhesive, compatible with label and substrate.
C. Label Content: Equipment tag on the Drawings.

2.2 PIPE LABELS

A. Manufacturers:
   1. Brady Corporation.
   2. Marketing Services Incorporated.
   3. Seton Identification Products.

B. General Requirements for Manufactured Pipe Labels: Pre-printed, color coded, with lettering indicating service, and showing flow direction.
C. Pre-Tensioned Snap-On Pipe Labels: Pre-coiled, semi-rigid vinyl formed to cover circumference of pipe and to attach to pipe without fasteners or adhesive.
D. Self-Adhesive Pipe Labels: Factory fabricated vinyl, 0.13mm thick, pre-formed to fit around pipe or pipe covering with permanent adhesive backing. Secure with 2” wide tape with arrows indicating flow direction.
E. Label Contents:
   1. Identification: Full system name on the Drawings.
   2. Flow Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
   3. Coloring & Text Size: According to ASME A13.1.

2.3 VALVE TAGS

A. Manufacturers:
   1. Brady Corporation.
   2. Marketing Services Incorporated.
   3. Seton Identification Products.
B. Description: Stamped with 1/2” numbers and 1/4” letters with piping system abbreviation.
C. Tag Material: Brass, 0.032” minimum thickness, and having pre-drilled or stamped holes for attachment hardware.
D. Fasteners: Brass wire link chain with S-hook around valve stem.
E. Label Contents: Number & system abbreviation.
F. Valve Schedule: For each piping system, on 8-1/2”x11” bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal operating position (open, closed, or modulating). Mark valves for emergency shutoff and similar special uses.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.
B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
C. Coordinate installation of identifying devices with locations of access panels and doors.
D. Install identifying devices before installing acoustical ceilings and similar concealment.

3.2 EQUIPMENT LABEL INSTALLATION

A. Locate equipment labels where accessible and visible.
B. Coordinate final equipment label convention with Owner prior to ordering labels.
C. Install or permanently fasten labels on major mechanical equipment including:
   1. Boilers.
   2. Pumps.
   3. Variable frequency drives.
   4. Motor controllers and disconnects.
   5. Control panels.

3.3 PIPE LABEL INSTALLATION

A. Locate pipe labels along axis of piping, where piping is exposed or above accessible ceilings in finished spaces; mechanical rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
   1. Near each valve and control device.
   2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
   4. At access doors, manholes, and similar access points that permit view of concealed piping.
   5. Near major equipment items and other points of origination and termination.
   6. Identify piping not less than once every 20'-0", including risers, and not less than once in each room.
   7. On piping above removable acoustical ceilings.

B. Flow directional arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions. The arrow shall always point away from the pipe legend and in the direction of flow. If flow can be in both directions, use a double headed arrow. Place flow direction arrows at each piping identification location.

C. Provide pipe labels on parallel, adjacent piping aligned with each other.

D. For natural gas piping, include working pressure.

3.4 VALVE TAG INSTALLATION

A. Provide a valve chart located in Mechanical 1103 under glass.

END OF SECTION 23 05 53

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SECTION 23 05 93
TESTING, ADJUSTING, & BALANCING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Balancing hydronic systems.
B. Testing, adjusting, and balancing (TAB) equipment.

1.2 REFERENCE STANDARDS

A.	AABC -	National Standards for Total System Balance
B.	AMCA -	Field Performance Measurement of Fan Systems
C.	ASHRAE Applications -	Testing, Adjusting, & Balancing
D.	ASHRAE -	Practices for Measurement, Testing, Adjusting, & Balancing of Building HVAC&R Systems
E.	NEBB -	Procedural Standards for Testing, Adjusting, & Balancing on Environmental Systems
F.	SMACNA -	HVAC Systems; Testing, Adjusting, & Balancing
G.	TABB -	TAB Procedural Guide

1.3 SUBMITTALS

A. Final Report: Submit final testing, adjusting, and balancing (TAB) report prior to project completion and in advance of occupancy.
B. Code Compliance: Comply with SPS 364.0313.

1.4 OPERATION & MAINTENANCE SUBMITTALS

A. Final Report: Certified TAB reports on standard AABC or NEBB forms with modifications made based on submittal comments.

1.5 QUALITY ASSURANCE

A. TAB Agency: Perform work in accordance with AABC or NEBB procedural standards.
B. Instrumentation Type, Quantity, Accuracy, & Calibration: As described in AABC or NEBB.
C. Calibration: Calibrate instruments at least every six (6) months or more frequently if required by instrument manufacturer.
   1. Keep an updated record of instrument calibration that indicates date of calibration and name of party performing instrument calibration.
D. Certification of TAB Reports: Certify TAB field data reports including the following:
   1. Review of field data reports to validate accuracy of data and to prepare certified TAB reports.

1.6 QUALIFICATIONS

A. Agency: Independent firm specializing in the adjustment and balancing of systems specified in this Section with a minimum of three (3) years of experience.
B. Qualifications: Certified by AABC, NEBB, or TABB in the specific area of work performed.
   1. Certification: Maintain for the entire duration of the Project. If certification of firm or any staff performing the work is terminated or expires during the duration of the Project, contact the Engineer immediately.
   2. Supervision: Perform work under supervision of an AABC Certified Test & Balance Engineer or NEBB Certified Testing, Balancing, & Adjusting supervision.

3. Submittal: Submit certifications upon request.

1.7 PRE-TAB CONFERENCE

A. Description: Meet with the Owner at the Project site in addition to all other Project Contractors prior to TAB work commencing. Discuss approval of the TAB process to develop a mutual understanding of the details.
B. Participants: TAB team members, Mechanical Contractor, Temperature Control Contractor, equipment manufacturer's authorized service representatives, and other support personal as deemed appropriate.
C. Notice: Provide a minimum of seven (7) days advance notice of the scheduled meeting time and location.
D. Minimum Agenda Items:
   1. TAB plan, strategies, and procedures.
   2. Contract Documents examination and review of changes.
   3. Submittal distribution requirements.
   4. Coordination and cooperation of trades and subcontractors.
   5. Work schedule.
   6. Project site specific access requirements.
   7. Procedures for documentation and communication flow.

1.8 COORDINATION

A. The TAB Contractor shall provide the Mechanical Contractor a detailed schedule of testing, adjusting, and balancing tasks for incorporation into the project schedule.
B. Coordinate the schedule with all other trades.
C. Provide seven (7) days advance notice to all trades prior to beginning work. Include scheduled test dates, times, systems to be tested, and locations of work.
D. Perform TAB after leakage and pressure test on hydronic distribution systems have been satisfactorily completed.
E. Coordinate the efforts of factory authorized service representatives for system and equipment, Temperature Controls Contractor, and Mechanical Contractor to operate HVAC systems and equipment to support and assist TAB activities.

PART 2 - PRODUCTS

2.1 INSTRUMENTATION

A. Provide all required instrumentation to obtain proper measurements during testing, adjusting, and balancing operations. Make instruments available to the Engineer or Owner for spot checks during testing.
B. 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.
C. Calibration and maintenance of all instruments used for measurements shall be accurate with calibration histories for each instrument, available for examination upon request, in accordance with the requirements of NEBB, AABC, or TABB Standards.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.
B. Examine installed systems for balancing devices, such as test ports, gauge valves, thermometer wells, flow control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.
C. Examine the approved submittals for HVAC systems and equipment.
D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.
E. Examine equipment performance data including pump curves.
    1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
F. Examine system and equipment installations and verify that testing, cleaning, and adjusting specified in individual Sections have been performed.
G. Examine test reports specified in individual system and equipment Sections.
H. Examine HVAC equipment and verify that bearings are greased and equipment with functioning controls is ready for operation.
I. Examine strainers. Verify that startup screens have been replaced by permanent screens with indicated perforations.
J. Examine control valves for proper installation for their intended function of throttling, diverting, or mixing fluid flows.
K. Examine system pumps to ensure absence of entrained air in the suction piping.
L. Examine operating safety interlocks and controls on HVAC equipment.
M. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes strategies and step by step instructions.
B. Review applicable Construction Bulletins, Change Orders, and approved Shop Drawings of equipment to observe system modifications from the original Contract Documents.
C. Perform system readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
    1. Airside:
        a. Duct systems are complete.
        b. System is free from any dirt and debris.
        c. Fans are operating, free of vibration, and rotating in correct direction.
        d. Equipment is lubricated.
        e. Thermal overload protection is in place for electrical equipment.
        f. Temperature control systems are installed, completed, and operating.
    2. Hydronics:
        a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
        b. Piping is complete.
        c. Strainers are pulled and cleaned.
        d. Control valves are functioning per the sequence of operation.
        e. Shutoff and balance valves have been verified to be 100% open.
        f. Systems are flushed, filled, and air purged.

g. Water treatment is complete.
h. Pumps are started and proper rotation is verified.
i. Pump gauge connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
j. Variable frequency drive start-up is complete and safeties are verified.
k. Suitable access to balancing devices and equipment is provided.
l. Temperature control systems are installed, completed, and operating.

3. Report defects and deficiencies which prevent system balance.
4. Beginning of work means acceptance of existing conditions.

3.3 GENERAL PROCEDURES FOR TESTING, ADJUSTING, & BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC National Standards for Total System Balance or NEBB Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems and this Section.
B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
   1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
   2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish identical to those removed to restore to the original condition.
C. Mark equipment and balancing devices, including damper control positions, valve position indicators, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings and allowing settings to be restored. Set and lock memory stops.
D. In areas containing ceilings, remove ceiling tile to accomplish balancing work. Replace tile when work is completed and provide new tile for any damage from this procedure.
E. Contact the Temperature Control Contractor for assistance in operation and adjustment of controls during TAB procedures. Cycle controls and verify proper operating and setpoints.
F. Leave system in proper working order, closing access doors, and electrical boxes, and restoring temperature controls to normal operating settings.
G. Locate disconnect switches, electrical interlocks, and motor starters.
H. Verify that motor starters are equipped with properly sized thermal protection.

3.4 PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports for pumps and heat exchangers. Obtain approved submittals and manufacturer recommended testing procedures. Cross check the summation of required heat exchanger flow rates with pump design flow rate.
B. Check liquid level in expansion tank.
C. Check pressure reducing valve pressure gauge for adequate pressure for the highest vent.
D. Set calibrated balancing valves to calibrated setting.
E. Effect system balance with automatic control valves fully open to heat transfer elements.
F. Effect adjustment of water distribution systems by means of balancing valves. Do not use shutoff valves for balancing.
G. Use installed flow meters or other metered fittings and pressure gauges to determine flow rates for system balance.
H. Measure flow at all equipment and adjust to provide the design quantities. System components that have Cv rating with accurately cataloged flow pressure drop relationship may be used as a flow indicating device.
I. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.

J. Measure water flow at pumps and adjust for design flow rate. Take final measurements of pump voltage, amperage, speed, pump head, system pressures, and temperatures.
K. System Diversity: Where available pump capacity is less than the total flow requirements or individual system parts, simulate full flow in part of the system by temporary restriction of flow to other parts of the system.
L. Pumps with VFDs: Use the VFD to provide system balancing in lieu of closing the combination valve.
M. Differential Pressure Control Setpoint: For hydronic systems with variable speed pumping, determine the minimum required system differential pressure setpoint needed to ensure that all terminal devices are operating at the design water flows with the most demanding terminals device control valve wide open. Provide the differential control setting setpoint to the Temperature Control Contractor and record the setpoint.

3.5 TOLERANCES

A. Set HVAC system airflow rates and water flow rates within the following tolerances:
   1. Hydronic Systems:
      a. Heating Water Flow Rate: ±10%.

3.6 DEFICIENCES

A. Provide written notification, within twenty-four (24) hours, to the Mechanical Contractor and Engineer of any component and/or system deficiencies.
B. The Mechanical Contractor shall correct any installation deficiencies found by the TAB Contractor that were specified and/or shown on the Contract Documents. All corrective work shall be done at no cost to the Owner.
C. Retest mechanical systems, equipment, and devices once corrective work is complete as specified.

3.7 SPS 364.0313 REQUIREMENTS

A. Water system balancing shall be accomplished per Paragraph SPS 364.0313 requirements.

3.8 ADDITIONAL TESTS

A. Within ninety (90) days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
B. Seasonal Periods: If initial TAB procedures were not performed during near peak summer and winter conditions, perform additional TAB during near peak summer and winter conditions.
C. If any items requiring TAB are inaccessible or inoperable at time of testing, TAB Contractor shall return to the site and test such systems when they become accessible or operable and submit the associated data at that time, as an amendment to the primary report.

3.9 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
   1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
   2. Include a list of instruments used for procedures, along with types, serial numbers, and dates of calibration. Include NIST calibration.
   3. Certify validity and accuracy of field data.

B. Final Report Contents: In addition to certified field report data, include the following:
   1. Pump curves.
   2. Other information relative to equipment performance; do not include Shop Drawings or Product Data.

C. General Report Data: In addition to form titles and entries, include the following data:
   1. Title page.
   2. Name and address of the TAB Contractor.
   3. Project name.
   4. Project location.
   5. Engineer's name and address.
   6. Mechanical Contractor's name and address.
   7. Report date.
   8. Signature of TAB supervisor who certifies the report.
   9. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
   10. Notes to explain why final data in the body of reports vary from indicated values.
   11. Test conditions for pump performance forms including the following:
      a. Pump speed settings.
      b. Settings for differential pressure controller.
      c. Other system operating conditions that affect performance.

D. Resubmittals: Any resubmittal report shall have a summary page in the report that describes all the changes made from the previous submittal.

E. Pump Test Reports:
   1. Unit Data:
      a. Unit identification.
      b. Location.
      c. Service.
      d. Make and size.
      e. Model number and serial number.
      f. Water flow rate in GPM.
      g. Water pressure differential in FT HD.
      h. Required net positive suction head in FT HD.
      i. Pump RPM.
      j. Impeller diameter in inches.
      k. Motor make and frame size.
      l. Motor horsepower and RPM.
      m. Voltage at each connection.
      n. Amperage for each phase.
      o. Full load amperage and service factor.
   2. Test Data (Indicated & Actual Values):
      a. Static head in FT HD.
      b. Pump shutoff pressure in FT HD.
      c. Full open flow rate in GPM.
      d. Full open pressure in FT HD.
      e. Final discharge pressure in FT HD.
      f. Final suction pressure in FT HD.
      g. Final total pressure in FT HD.
      h. Final water flow rate in GPM.

F. Boiler Report:
   1. Unit Data:
      a. Unit identification.
      b. Location.
      c. Make and size.
      d. Model number and serial number.
      e. Voltage at each connection.

2. Test Data (Indicated & Actual Values):
   a. Boiler pressure drop in FT HD.
   b. Final water flow rate in GPM.
   c. Entering water temperature in °F.
   d. Leaving water temperature in °F.

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SECTION 23 07 00
INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Duct insulation.
B. Pipe insulation.
C. Equipment insulation.
D. Insulation protective jackets.

1.2 REFERENCE STANDARDS

A.	ASTM B209 -	Aluminum and Aluminum Alley Sheet & Plate
B.	ASTM C165 -	Compressive Properties of Thermal Insulation
C.	ASTM C177 -	Steady State Heat Flux Measurements and Thermal Transmission Properties by Means of Guarded Hot Plate Apparatus
D.	ASTM C195 -	Mineral Fiber Thermal Insulating Cement
E.	ASTM C209 -	Cellulosic Fiber Insulating Board
F.	ASTM C272 -	Water Absorption of Core Materials for Structural Sandwich Construction
G.	ASTM C302 -	Density of Preformed Pipe Insulation
H.	ASTM C335 -	Steady State Heat Transfer Properties of Horizontal Pipe Insulation
I.	ASTM C355 -	Test Methods for Test for Water Vapor Transmission of Thick Materials
J.	ASTM C411 -	Hot Surface Performance of High Temperature Thermal Insulation
K.	ASTM C449 -	Mineral Fiber Thermal Insulating and Finishing Cement
L.	ASTM C518 -	Steady State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
M.	ASTM C547 -	Mineral Fiber Preformed Pipe Insulation
N.	ASTM C553 -	Mineral Fiber Block and Board Thermal Insulation
O.	ASTM C612 -	Mineral Fiber Block and Board Thermal Insulation
P.	ASTM C921 -	Properties of Jacketing Materials for Thermal Insulation
Q.	ASTM C1104 -	Determining the Water Vapor Sorption of Unfaced Mineral Fiber Insulation
R.	ASTM E96 -	Water Vapor Transmission of Materials
S.	UL 723/ASTM E84 -	Surface Burning Characteristics of Building Materials
T.	NFPA 90A -	Installation of Air Conditioning and Ventilating Systems
U.	MICA -	National Commercial & Industrial Insulation Standards, Sixth Edition
V.	ASHRAE 90.1 -	Energy Standard for Buildings

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.
   1. Include thermal conductivity, water vapor permeance, thickness, and jackets (both factory and field applied if any).
B. Schedule: For all systems indicating insulation material, thicknesses, adhesives, fastening methods.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program. Within the past five (5) years, the Contractor shall be able to document at least three (3) projects of at least 50% of the size and similar scope.
B. Surface Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E84. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings.
   1. Flame Spread Index: Maximum of twenty-five (25).
   2. Fuel Contributed & Smoke Developed Index: Maximum of fifty (50).
C. Installation:
   1. Insulation thickness shall comply with ASHRAE 90.1 requirements.
   2. Install all insulation in accordance with the latest edition of MICA Standard and manufacturer's insulation instructions.
   3. Maintain ambient temperatures and conditions required by manufacturers of adhesive, mastic, and insulation cements.

1.5 DELIVERY, STORAGE, & HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.
B. Protection: Protect insulation from damage. Repair or replace any damaged insulation, including insulation that has be exposed to water.

1.6 SCHEDULING

A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.
B. Complete installation and concealment of materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 DUCT INSULATION

A. Manufacturers:
   1. Johns Manville.
   2. Knauf Insulation.
   3. Owens Corning.
B. TYPE SR – Semi-Rigid Glass Fiber Insulation: Glass fibers bonded with a thermosetting resin. Semi-rigid board material with factory applied ASJ or FSK jacket.
   1. Standard: ASTM C1393, Type II or Type IIIA Category 2.
   2. Density: 3 PCF.
   3. Thermal Conductivity: 0.24 BTU-in/h x SF x °F at 75°F.
   4. Temperature: Maximum of 450°F.

2.2 PIPE INSULATION

A. Manufacturers:
   1. Johns Manville.
   2. Knauf Insulation.
   3. Owens Corning.

B. Type R – Glass Fiber, Preformed Pipe Insulation: Glass fibers bonded with a thermosetting resin.
   1. Standard: ASTM C547, Type I, Grade A, with factory applied ASJ-SSL.
   2. Density: 3 PCF.
   3. Thermal Conductivity: 0.28 BTU-in/h x SF x °F at 75°F.
   4. Maximum Temperature: 850°F.
   5. Fittings: Pre-cut inserts similar to adjacent material and thickness with PVC jacket.
C. TYPE SR – Semi-Rigid Glass Fiber Insulation: Glass fibers bonded with a thermosetting resin. Semi-rigid board material with factory applied ASJ jacket.
   1. Standard: ASTM C1393, Type II or Type IIIA Category 2.
   2. Density: 3 PCF.
   3. Thermal Conductivity: 0.24 BTU-in/h x SF x °F at 75°F.
   4. Temperature: Maximum of 450°F.

2.3 EQUIPMENT INSULATION

A. Manufacturers:
   1. Johns Manville.
   2. Knauf Insulation.
   3. Owens Corning.
B. TYPE SR – Semi-Rigid Glass Fiber Insulation: Glass fibers bonded with a thermosetting resin. Semi-rigid board material with factory applied ASJ or FSK jacket.
   1. Standard: ASTM C1393, Type II or Type IIIA Category 2.
   2. Density: 3 PCF.
   3. Thermal Conductivity: 0.24 BTU-in/h x SF x °F at 75°F.
   4. Temperature: Maximum of 450°F.

2.4 ADHESIVES, MASTICS, SEALANTS, COATINGS, & TAPES

A. Provide in accordance with the insulation manufacturer's specifications and requirements.
B. Materials shall be compatible with insulation surfaces, materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated. Materials shall be suitable for use at operating temperatures of systems which they are applied.
C. Adhesive used to bond fiberglass insulation: Must comply with ASTM C916, Type II.
   1. Manufacturers:
      a. Foster 85-60.
      b. Childers CP-127.
      c. Duro Dyne SSG.
D. Vapor Barrier Mastic: Maximum Water Vapor Permeability: ASTM E96, .03 perm at 45 mils dry (cold service pipe, equipment, and duct insulation).
   1. Manufacturers:
      a. Foster 30-65.
      b. Childers CP-34.
      c. Vimasco 749.
E. Weather Barrier Breather Mastic: Water Based Breather Mastic (warm/hot service piping and equipment).
   1. Manufacturers:
      a. Foster 46-50.
      b. Childers CP-10/11.
      c. Vimasco WC-5.

F. Lagging Adhesive: Water based (use with canvas cloth jackets).
   1. Manufacturers:
      a. Foster 30-36.
      b. Childers CP-50 AMV1.
      c. Vimasco 713.
G. Insulation Joint Sealant (used with cellular glass).
   1. Manufacturers:
      a. Foster 95-50.
      b. Childers CP-76.
      c. Pittsburgh Corning CW.
H. Tapes:
   1. ASJ or FSK vapor retarder tape matching factory or field applied jackets

2.5 INSULATION PROTECTIVE JACKETS

A. Canvas: Plain weave, glass fiber fabric, a minimum of 8 oz./sq. yd.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
B. Verify that systems to be insulated have been tested and are free of defects prior to installing insulation.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application. Proceed with installation only after unsatisfactory conditions have been corrected

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install all materials in accordance to the manufacturer's instructions.
B. Keep insulated surfaces and insulation materials dry during application and finishing.
C. Install insulation in full length sections with the least number of joints practical.
D. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the installation.
E. Cut insulation in a manner to avoid compressing insulation more than 75% of its nominal thickness.
F. Do not insulate over nameplates or ASME stamps. Bevel and seal insulation around such, unless omitting insulation would cause condensation problems. If such is the case, appropriate tagging shall be provided to identify the presence of these items.
G. Provide removable/reusable insulation covers on equipment as required to provide ready access to components requiring periodic maintenance or repair.
H. Provide continuity of insulation and vapor barrier through penetrations (wall, floor, and roof) unless code prohibits. Seal penetrations and jacketing to flashing with sealant. For exterior applications, extend jacketing at least 2" past respective penetration flashing.
I. Provide continuity of insulation and vapor barrier through hangers and supports with hangers and supports on the exterior of the insulation. Provide high density inserts at hangers and supports to prevent compression of insulation.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor barrier mastic. Extend insulation on anchor legs from point of attachment of supported item to point of attachment to structure.
K. Install insulation with tight longitudinal seams and end joints with longitudinal seams at top and bottom of horizontal runs. Bond seams and joints with adhesive recommended by insulation material manufacturer.
L. Install multiple layers of insulation with longitudinal and end seams staggered.
M. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4” beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
O. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement. Repair all damaged insulation during the construction process with mastic and tape.
P. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of system as specified in insulation system schedules.

3.4 JACKET INSTALLATION

A. ASJ & FSK Jackets: Draw jacket material smooth and tight and install lap or joint strips with 3” wide tape with same material as jacket. Seal openings, punctures, and breaks in vapor retarder jackets and exposed insulation with vapor barrier mastic.
B. Canvas Jackets: Install directly over bare insulation or insulation with factory applied jackets without wrinkles. Draw jacket smooth and tight to surface with 2” overlap at seams and joints. Embed canvas jacket between two (2) coats of lagging adhesive.

3.5 DUCT INSULATION INSTALLATION

A. Secure insulation to ductwork with adhesive and insulation pins. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for coverage of duct surfaces. Cover pins with tapes of same material as jacket.
B. Butt all joints as close as possible to adjoining insulation or equipment surface. Cover with 3” wide tape of same material as jacket maintain integrity of the vapor barrier.
C. Point insulation around all access doors, damper operators, and other locations requiring access to allow operation without damage to the insulation or jacket.
D. Provide 4” overlap of external insulation over ends of acoustically lined ductwork.
E. Insulate duct supports secured directly to the ductwork by encapsulating.
F. For duct penetrations through fire rated assemblies, terminate insulation at damper sleeve and externally insulate sleeve to match adjacent insulation. Seal all fire rated penetrations with firestopping per Section 23 05 00.

3.6 DUCT INSULATION SCHEDULE

A. Insulate the ductwork based on the following:

APPLICATION	INSULATION TYPE	FACTORY APPLIED JACKET TYPE	PROTECTIVE JACKET TYPE	INSULATION THICKNESS [IN]
Combustion Air Duct for Boilers, Exposed	SR	ASJ	Canvas (Alternate Bid)	2”

B. For duct accessories, without internal lining or insulation, insulate with the same material and thickness as specified for the duct system the device serves.
C. Duct insulation is not required in the following locations:
   1. Factory insulated access panels and doors.

3.7 PIPE INSULATION INSTALLATION

A. Provide inserts, shields, and saddles to prevent crushing insulation per Section 23 05 29.
B. Install insulation with butt joints and longitudinal seams closed tightly. Provide 2” lap on jacket seams and 2” tape on butt joints. Additionally, secure with staples along seams and butt joints.
C. Seal off all raw ends of insulation and butt joints with mastic or insulating cement. Coat staples, seams, and fittings with vapor retarding mastic on systems requiring a vapor barrier.
D. Where riser clamps are required to be attached directly to piping requiring vapor regarding jacket, extend insulation and vapor retarding jacket around riser clamp.
E. Fully insulate piping up to heat exchanger connection.
F. Insulation Installation on Fittings, Valves, & Specialties:
   1. Install pre-formed sections of same material as straight segments of pipe insulation. Secure according to manufacturer's instructions.
   2. Insulation shall be the same thickness as the adjacent pipe insulation.
   3. Insulate pipe elbows and fittings using pre-formed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation with a fitted PVC cover. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
   4. Insulate valves and strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe.
      a. For valves, insulate up to and including the bonnets, valve stuffing box studs, bolts, and nuts.
      b. For strainers, insulate so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover.
G. Insulate instrument connections for thermometers, pressure gauges, pressure/temperature test plugs, flow meters, sensors, switches, and transmitters on insulated pipes. Point insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
H. Fiberglass Insulation:
   1. Position longitudinal lap downward.
   2. Tape joints between fitting cover and adjoining pipe insulation with pressure sensitive vapor barrier tape. Provide a 2” overlap on tape joint and with overlap facing down.

3.8 PIPE INSULATION SCHEDULE

A. Insulate the piping based on the following:

APPLICATION	INSULATION TYPE	FACTORY APPLIED JACKET TYPE	PROTECTIVE JACKET TYPE	INSULATION THICKNESS [IN]
Hot Water, Concealed & Exposed	R or SR	ASJ	-	(1)
Make-Up Water, Concealed & Exposed	R or SR	ASJ	-	(2)

B. Provide piping insulation thickness based on the following:

APPLICATION SCHEDULE REFERENCE	SYSTEM REFERENCE	3/4” & SMALLER	1” TO 1-1/4”	1-1/2” TO 3”	4” TO 6”	8” & LARGER
(1)	Hot Water	1-1/2”	1-1/2”	2”	2”	2”
(2)	Make-Up Water	1/2”	1/2”	1”	1”	1”

3.9 EQUIPMENT INSULATION INSTALLATION

A. Secure insulation with adhesive and anchor pins. Apply adhesives according to manufacturer's recommended coverage rates per unit area.

B. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Cut, bevel, and miter insulation to fit curved sides and domed heads of tanks and vessels.

C. Fiberglass Insulation:

1. Secure with pins to equipment.

3.10 EQUIPMENT INSULATION SCHEDULE

A. Insulate the equipment based on the following:

APPLICATION	INSULATION TYPE	FACTORY SUPPLIED JACKET TYPE	PROTECTIVE JACKET TYPE	INSULATION THICKNESS [IN]
Hot Water Air Separators	SR	ASJ	Canvas (Alternate Bid)	2”
Hot Water Expansion Tanks	SR	ASJ	Canvas (Alternate Bid)	2”
Hot Water Water Filter	SR	ASJ	Canvas (Alternate Bid)	2”

END OF SECTION 23 07 00

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SECTION 23 08 00
COMMISSIONING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Commissioning requirements of mechanical systems.

1.2 SCOPE OF WORK

A. Commissioning work of Division 23 shall include, but not to be limited to:
   1. Start-up and testing of equipment.
   2. Providing qualified personnel for participation in commissioning tests, including seasonal tests required after initial testing.
   3. Providing required documentation for inclusion in the Operation and Maintenance manuals and separate Commissioning Report.
   4. Reporting any system deficiencies found during the commissioning process.
   5. Periodic commissioning meetings held at the job site paralleled with the construction coordination meeting.

1.3 SUBMITTALS

A. Submit draft copies of commissioning report for review prior to final acceptance of Project.
B. Provide final copies of the report for inclusion in the Operation and Maintenance manuals.

1.4 SEQUENCING & SCHEDULING

A. Mechanical Contractor shall coordinate commissioning work and monitor the construction progress to ensure systems are completed and commissioned by date of substantial completion.

1.5 DEFINITIONS

A. “Physical Inspection Process” includes the on-site inspection and review of related system components for conformance to the Specifications.
B. “Functional Performance Testing Process” includes the documented testing of system parameters, under actual or simulated operating conditions. Final performance commissioning of systems will begin only after the appropriate Contractor certifies that systems are 100% complete and ready for functional testing. The Contractor shall be required to schedule, coordinate and perform device tests, calibration and functional performance test procedures as defined by the Commissioning Agent. Noted deficiencies will be documented for future resolution.
C. “Deficiencies and Resolutions List” includes a list of noted deficiencies discovered as a result of the commissioning process. This list also includes the current disposition of issues, and the date of final resolution. Deficiencies are defined as those issues where products, execution or performance does not satisfy the project specifications and/or the design intent.
D. “Final Commissioning Report” includes the overall final commissioning document, which details the actual commissioning procedures performed, inspection and testing results, and the final version of the deficiencies and resolutions list indicating that all issues discovered through the commissioning process have been verified as resolved.

1.6 OVERVIEW OF THE COMMISSIONING PROCESS

A. Upon confirmation of system readiness, perform functional performance tests and oversee the process and shall provide the format and documentation for these tests.
B. Deficiencies noted during these tests shall be documented on the Deficiencies and Resolutions list. Deficiencies shall be noted as either resolved or pending resolution.
C. The construction phase commissioning process shall be complete when all noted deficiencies have been corrected, proved to be in compliance with the Specifications or otherwise resolved to the satisfaction of the Owner.

1.7 MECHANICAL CONTRACTORS RESPONSIBILITIES

A. Meet and communicate with the Owner's Representative, Contractors, Equipment Representatives, and Design Professionals as necessary, to facilitate the commissioning process.
B. Review commissioning related specifications, submittals, and Contract Documents. Communicate noted deficiencies and concerns to the Owner.
C. Perform site inspections and verify contractor readiness for the functional testing process. Document deficiencies for future resolution.
D. Witness contractor performed functional testing process. Document deficiencies for future resolution.
E. Provide Owner with a Final Commissioning Report.

1.8 EQUIPMENT MANUFACTURER'S START-UP FORMS

A. Contractors shall provide completed copies of all installation and start-up checklists as provided by the equipment manufacturers.

1.9 COMMISSIONING FORMS

A. Provide commissioning forms used for documentation of commissioning work.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 DESCRIPTION OF WORK

A. Work includes the pre-functional testing and completion of formal commissioning procedures on selected equipment and systems.

3.2 COMMISSIONING REQUIREMENTS

A. Commissioning shall include the following components and systems:
   1. 100% of Boilers.
   2. 100% of Pumps.
   3. 100% of Piping systems.
   4. 100% of Variable frequency drives.
   5. 100% of HVAC control system.
B. The equipment start-up reports, testing, etc. shall be included in the Final Commissioning Report.
C. Operating tests and checks shall be performed to verify that all components, equipment, systems, and controls operate in accordance with the Contract Documents under all operating modes, with all interlocks and during both normal and emergency conditions.

D. Heating equipment shall be tested during winter design conditions. Contractor shall be responsible for initial and alternate peak season tests of the systems as required to demonstrate proper performance.

E. Initial commissioning work shall be completed as soon as contract work is installed and operational, regardless of season. Provide follow-up testing and documentation for commissioning of equipment during alternate peak season as required to demonstrate proper performance.

F. Contractors may be required to demonstrate compliance with all specified operational criteria during the functional performance testing phase of the commissioning process.

G. During the functional performance testing phase, once issues have been identified and reported as Contractor related deficiencies on the Deficiencies and Resolutions List, the Contractor shall be required to correct these issues.

END OF SECTION 23 08 00

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SECTION 23 09 14
INSTRUMENTATION & CONTROL DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Instrumentation & Control Devices.

1.2 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

1.3 SUBMITTALS

A. Include the following information:
1. Manufacturer's data sheets indicating model number, pressure/temperature ratings, capacity, 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.
2. Schematic flow diagrams of systems showing pumps, coils, valves, and other control devices. Each control device provided under this Section shall be uniquely labeled. Duplicate labeling may be used within similar mechanical systems. 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 details contact states and relay references.
3. Details of construction, layout, and location of each temperature control panel within the building, including instruments location in panel and labeling. Drawings shall show the 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).
4. 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.
5. A complete description of each control sequence for equipment.

1.4 OPERATION & MAINTENANCE SUBMITTALS

A. Submit Record Drawings which accurately record actual location of control components including panels, thermostats, wiring, and sensors. Incorporate changes required during installation and start-up.

B. Where communication and/or power wiring is specified to be provided under this Section, point to point routing of communication trunks and power wiring between DDC controllers, DDC communication devices, control panels, and Ethernet switches shall be documented in the control Record Drawings.

1.5 QUALITY ASSURANCE

A. Installing Contractor must be a manufacturer's branch office or an authorized representative of a Direct Digital Control (DDC) equipment manufacturer that provides engineering and commissioning of DDC equipment.
B. Submit written confirmation of such authorization from the manufacturer. Indicate in letter of authorization that installing Contractor has successfully completed all necessary training required for engineering, installation, and commissioning of equipment and systems and that such authorization has been in effect for a period of not less than three (3) years.
C. DDC equipment may or may not be required to be installed by this Contractor as part of the Project, but the intent is to ensure that the installing Contractor has the capabilities to engineer, install, and commission the field devices supplied under this Section for temperature control.

1.6 DELIVERY, STORAGE, & HANDLING

A. Provide factory shipping cartons for each piece of equipment and control device. Contractor is responsible for storage of equipment and materials inside and protected from the weather.

1.7 DEMOLITION

A. Where existing control devices, piping, or wiring are discontinued from use, remove and turn over to the Owner. If the Owner does not want them, remove from premises. Remove any previously abandoned control devices in a similar manner.

1.8 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 shall meet the requirements of Division 26.

PART 2 - PRODUCTS

2.1 CONTROL VALVES

A. Provide all control valves as shown on the Drawings and as required to perform the 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.
C. For electric modulating actuation, use fully proportional actuators with 0-10 VDC inputs and zero and span adjustments. For two-position electric actuation use 24 VAC for DDC controlled actuators. 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, feedback reference, and integrated end switch. All power required for electric actuation shall be provided by this Contractor.

D. Provide spring-return for applications involving fire, freeze protection, moisture protection, or as specified normally open/closed operation. Valves shall move to their fail positions on loss of electrical power.
E. Provide operators with linkages and brackets for mounting on device served.
F. Provide the following control valves:

VALVE SERVING	TYPE	SIGNAL	SPRING RETURN	FAIL POSITION
Boiler Isolation	Butterfly	24 VAC	Yes	Open (to Boiler)
Minimum Flow Bypass	Ball or Butterfly	0-10 VDC	Yes	Open

G. Hydronic 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. Consult with Engineer 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. Butterfly Valves: Iron body, stainless steel shaft, bronze bearings, and resilient seat. Disc to be aluminum bronze or stainless steel. Valve assembly to be bubble tight, suitable for use on water systems at 150 PSIG and 240°F. The Temperature 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.
3. Characterized Ball Valves: 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 at 212° F. Minimum size for ball valves shall be 0.4 Cv.

2.2 WATER FLOW MEASUREMENT

A. General: Provide flow meters complete with integral electronics module.
B. Type: Insertion style flow meter installed through a 1” full port ball valve to enable insertion and removal of the meter without system shutdown. Hand insertable up to 400 PSI.
C. Certification: NIST traceable wet calibration for each flow meter.
D. Accuracy: ±1% of reading over a 10:1 turndown (from 2 to 20 ft/s).
E. Rangeability: 0.25 ft/s to 20 ft/s (80:1 turndown ratio).
F. Maximum Operating Pressure: 400 PSI.
G. Maximum Operating Temperature: 200°F.
H. Pressure Drop: Less than 1 PSI at 17 feet per second flow velocity.
I. BAS Integration: Minimum of one (1) analog output, 0-10 VDC or 4-20 mA, for liquid flow rate and a scalable dry contact output for totalization unless the flow meter is connected to a BTU measurement system that will provide this output or be directly integrated to the BAS. Provide integral frequency output for diagnostic purposes and for connection to local display. All outputs shall be linear with flow rate.
J. BTU Measurement System:
1. Equipment: Flow sensor, two (2) temperature sensors, a BTU meter, thermowells, and all required mechanical installation hardware. The meter shall be supplied by 24 VAC or 24 VDC to provide power to the BTU meter electronics, flow meter, and temperature sensors.
2. Display: Front panel mounted display for liquid flow rate, BTU total, supply temperature, and return temperature.
3. BACnet MSTP RS-485 Communication Interface: Provide information corresponding to total thermal energy transfer, supply temperature, return temperature, and liquid flow rate. For meters that do not have integral BACnet communications, provide a separate gateway device that will provide a BACnet

MSTP communication interface. All programming of the gateway device shall be provided by this Contractor. Temperature sensors shall be calibrated and matched for the specific temperature range for each application.

2.3 GAS FLOW MEASUREMENT (ALTERNATE BID)

A. General: Provide flow meters complete with integral electronics module.
B. Type: Insertion style flow meters shall be installed through a 1” full port ball valve.
C. Certification: NIST traceable wet calibration for each flow meter.
D. Accuracy: ±1% of reading from 500 to 7,000 SFPM.
E. Rangeability:15 to 35,000 SFPM.
F. Maximum Operating Pressure: 60 PSIG.
G. Maximum Operating Temperature: 250°F.
H. Pressure Drop: Less than 1/2 IN WG.
I. BAS Integration: Analog output, 4-20 mA, for connection to the BAS for flow rate and a scalable dry contact output for totalization. The flow meter shall also include integral frequency output for diagnostic purposes and for connection to local display. All outputs shall be linear with flow rate.
J. BTU Measurement System:
   1. Equipment: Flow sensor, a BTU meter with local display, and all required mechanical installation hardware. The meter shall be supplied by 24 VAC or 24 VDC to provide power to the BTU meter electronics and flow meter.
   2. Display: Front panel mounted display for gas flow rate and BTU total.
   3. BACnet MSTP RS-485 Communication Interface: Provide information corresponding to total thermal energy transfer and gas flow rate. For meters that do not have integral BACnet communications, provide a separate gateway device that will provide a BACnet MSTP communication interface. All programming of the gateway device shall be provided by this Contractor.

2.4 ELECTRIC/ELECTRONIC THERMOSTATS

A. Immersion Type Thermostat Sensors:
   1. Rod and tube type with linear output. Units shall be factory calibrated.

2.5 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. 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 and control Record 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 120 VAC power feeds provide a resettable circuit breaker. Provide label within the panel indicating circuit number of 120 VAC serving panel.

2.6 TEMPERATURE SENSORS

A. Thermistor temperature sensor manufacturers:
   1. PreCon.
   2. BAPI.
   3. 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 32°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.

E. RTD:

1.	Accuracy	Minimum ± 0.65°F
2.	Range	Minimum – 40 - 220°F

F. Thermistor:

1.	Accuracy	Minimum ± 0.36°F
2.	Range	Minimum – 30 - 230°F
3.	Heat Dissipation Constant	Minimum 2.7 mW/°C

G. Temperature Transmitter:

	Accuracy	Minimum ± 0.1°F or +0.2% of span
1.	Output	4 – 20 mA

H. 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.

I. 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.

J. In piping systems use temperature sensors with separable wells designed to be used with temperature element.

2.7 PRESSURE TRANSDUCERS (LIQUID)

A. Provide a transmitter that utilizes capacitive or thin film strain gauge sensing. Provide for an analog gauge piped in parallel with the transducer. For differential pressure applications provide with bypass valve manifold assembly with valved venting capability.

1.	Accuracy (including non-linearity and hysteresis)	± 0.5% FS
2.	Compensated Temperature Range	32°-150° F
3.	Temperature Effect (over compensated range)	0.03%/°F;
4.	Output	4-20 MA
5.	Load Impedance (smallest maximum acceptable)	600 Ω Minimum
6.	Operating Temperature	0°-175° F
7.	Hysteresis	0.75% of span

2.8 CURRENT STATUS SWITCHES

A. Provide a current sensor with adjustable threshold and digital output with LED display. Threshold adjustment shall 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.

2.9 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.

PART 3 - EXECUTION

3.1 INSTALLATION

A. 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.

B. All cables to the electronic input/output devices, sensors, relays, and interlocking wiring (all of which shall be supplied and installed under this Section) interfaced with the Direct Digital Control System shall be extended into a control panel for termination. This Contractor shall provide a technician to inspect and validate all tubing, wiring, and field devices associated with the DDC interface to ensure that each device is operating per the control sequences as specified in Section 23 09 93.

C. Label all control devices with permanent printed labels that correspond to control Record 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.

D. 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.

E. 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 conduit as scheduled below and hereafter referred to generically as conduit.

F. All raceways, enclosures, fittings, and associated supports shall be provided and installed according to the requirements set forth in Division 16, 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, and hangers 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 18 AWG for inputs. All low voltage wiring to be stranded. See the Owners DDC cabling standard below.

J. Provide communication trunk wiring to integrated devices (i.e. VFD's, Flow Meters, Boilers) that are specified to be connected to the building automation system.

K. Communication trunk wiring shall be routed to the DDC panel designated for that equipment as shown on the Drawings or the closest DDC panel if not designated. If communication trunks require daisy chained style wiring, provide two (2) communication cables to the DDC panel so that the communication trunk is not dead ended.

L. All wiring in control panels shall be terminated on a terminal strip. Wire nuts are not acceptable. A maximum of two (2) wires shall be terminated under any one (1) terminal.

M. All electrical wiring are to be permanently tagged or labeled within 1" of the terminal strip with a numbering system to correspond with the Record Drawings. Provide all color coding and labeling per the Marathon County standards.

N. After completion of installation, test and adjust control equipment. Submit data showing set points and final adjustments of controls.

3.2 CONDUIT INSTALLATION SCHEDULE

A. The following conduit schedule shall apply to wire in conduit where conduit is specified for wiring. Conduit and tubing referenced below shall meet specifications in Division 26 and as defined below:
   1. Exposed Dry Interior Locations: Rigid metal conduit (RMC) or electrical metallic tubing (EMT).

3.3 CONTROL VALVES

A. All temperature control valves furnished by the Temperature Control Contractor are to be installed by the Mechanical Contractor under the coordinating control and supervision of the Temperature Control Contractor in locations shown on the Drawings or where required to provide the specified sequence of control.
B. Hydronic valves and actuators shall be mounted in the upright vertical position. If upright vertical mounting is not possible due to lack of space, obtain approval from the Engineer of record on the project for alternate mounting that meet the manufacturer's recommended installation.

3.4 CONTROL SYSTEM INSTRUMENTATION

A. Install thermometers at each point of temperature transmission (sensors) and control, unless the Drawings indicate a thermometer is to be installed by the piping installer.

3.5 LIQUID FLOW MEASUREMENT

A. Install where indicated on the Drawings for flow sensing in hydronic piping systems. Do not install close to elbows, valves, or other piping specialties, which might affect the reading of the sensor; follow manufacturer's instructions.
B. Where flow meters are located more than 5'-0" above the floor or where they cannot be read due to equipment location, provide remote mounting of the flow meter display and programming controls. Location of remote mounted display shall be so that the flow measurement display shall be mounted 5'-0" above the finished floor.

3.6 GAS FLOW MEASUREMENT (ALTERNATE BID)

A. Install where indicated on the Drawings for flow sensing in gas piping systems. Do not install close to elbows, valves, or other piping specialties, which might affect the reading of the sensor; follow manufacturer's instructions.
B. Where flow meters are located more than 5'-0" above the floor or where they cannot be read due to equipment location, provide remote mounting of the flow meter display and programming controls. Location of remote mounted display shall be so that the flow measurement display shall be mounted 5'-0" above the finished floor.

3.7 PRESSURE TRANSDUCERS

A. Install differential pressure transducers for filter monitoring at the water filters and the system differential pressure unit unless otherwise specified.
B. All devices mounted on equipment shall be mounted in a location that is at a maximum of 5'-0" above the floor. For liquid applications, provide shutoff valves at piping takeoff points.

3.8 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. A cabinet may accommodate more than one (1) system in same equipment room.

B. Provide control Record Drawings of all systems served by each local panel inside of panel cover. Provide a protective cover or envelope for drawings.

3.9 CURRENT STATUS SWITCHES

A. Provide for each pump specified or shown on DDC Point Chart. Set threshold adjustment to indicate belt or coupling loss. Re-adjust 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.

3.10 OWNER DDC CABLING SPECIFICATIONS

A. All DDC cabling shall match the Owners standard as follows:

INPUT/OUTPUT TYPE	COLOR	NO. OF CONDUCTORS	CONDUCTOR AWG	SHIELDED
Analog Input	Yellow	3 Stranded	18	Yes
Analog Output	Brown	3 Stranded	18	Yes
Digital Input	Orange	2 Stranded	18	Yes
Digital Output	Purple	2 Stranded	18	Yes
Field Bus/BACnet	Blue	3 Stranded	22	Yes
SA Bus Interface	White	CAT 3/ 3 pair	24	No
24V Power	Grey	2 Stranded	18	No

B. All cabling shall be plenum rated.

3.11 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 (2) hours.

END OF SECTION 23 09 14

SECTION 23 09 23
DIRECT DIGITAL CONTROL SYSTEM

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Direct Digital Control (DDC) panels, main communication trunk, software programming, and other equipment and accessories necessary to constitute a complete Direct Digital Control (DDC) system.

1.2 REFERENCE STANDARDS

A. FCC Part 15, Subpart J, Class A - Digital Electronic Equipment to Radio Communication Interference

1.3 SUBMITTALS

A. Details of construction, layout, and location of each temperature control panel within the building, including instrument location in the panel and labeling. Indicate which piece of mechanical equipment is associated with each controller and what area within the building is being served by that equipment.

B. Product Data:
   1. Submit manufacturer's specifications for each control device furnished, including installation instructions and start-up instructions. General catalog sheets showing a series of the same device is not acceptable unless the specific model is clearly marked.
   2. Submit annotated software program documentation for system sequences, along with descriptive narratives of the sequence of operation of the entire system involved.
   3. 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.

1.4 OPERATION & MAINTENANCE SUBMITTALS

A. Per Section 23 09 14 Operation and Maintenance submittal requirements.

1.5 QUALITY ASSURANCE

A. The existing Marathon County head end is Johnson Controls and all controls work must be fully integrated into the existing system. The following manufacturers listed below are acceptable provided they provide full BACnet capabilities and integration into the existing system:
   1. Automated Logic.
   2. Honeywell.
   3. Johnson Controls.
   4. Trane.
   5. Siemens.

B. Installer:
   1. 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 the installing Contractor is an authorized representative

of the control equipment manufacturer, submit written confirmation of such authorization.

2. 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 (3) 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.
3. Installation of the equipment shall be done by qualified mechanics and/or electricians as a direct employee or be directly subcontracted and under the supervision of the manufacturer or Authorized Representative. The Contractor providing and installing the equipment under this Section shall be the same Contractor providing and installing equipment under Section 23 09 14.

C. Response Time:
1. During warrantee period, four (4) hours or less, twenty-four (24) hours/day, seven (7) days/week.

D. Electrical Standards:
1. Provide electrical products, which have been tested, listed and labeled by Underwriters Laboratories (UL) and comply with NEMA standards.

1.6 DELIVERY, STORAGE, & HANDLING

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.

1.7 DEMOLITION WORK

A. Facilitate demolition work required for the controls for the existing hot water system.
B. Maintain the existing system controls as required based on the phasing of the Project.

PART 2 - PRODUCTS

2.1 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 the 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.

2.2 LOCAL CONTROL PANELS

A. Per Section 23 09 14.
B. Provide control panels for controllers and associated function modules. All controls to be in control panels provided under this Section.
C. All wiring for controllers shall be managed in a neat and workmanlike manner.
D. Permanently label all controls; tag all control wiring, and document both on control Record Drawings.
E. Match all wiring standards of the Owner per Section 23 09 14.

2.3 DIRECT DIGITAL CONTROLS

A. System shall be capable of integrating multiple building functions, including equipment supervision and control, alarm management, energy management, and trend data collection.
B. DDC system to consist of Supervisory Controllers, Programmable Controllers, stand-alone Application Specific Controllers (ASCs), Operators Terminals, Operator Workstations, DDC system servers, and other 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, ASCs, 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.

2.4 NETWORKING/COMMUNICATIONS

A. The design of the DDC shall be networked and connected to the existing control system. 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 (2) 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.
C. The supervisory controller shall directly oversee a local network such that communications may be executed directly to and between programmable controllers and ASCs. 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 ASCs 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 ASCs when it would be impractical to locate multiple sensors.
G. Network design shall include the following provisions:
    1. Data transfer rates for alarm reporting and quick point status from multiple programmable controllers and ASCs. The minimum baud rate shall be 9600 baud.
    2. Support of any combination of programmable controllers and ASCs. A minimum of 32 programmable controllers and ASCs shall be supported on a single local network. The buss shall be addressable for up to 32 ASCs.
    3. Detection of single or multiple failures of ASCs or the network media.
    4. Error detection, correction, and retransmission to guarantee data integrity.
    5. Use commonly available, multiple sourced, networking components.
    6. Use of an industry standard communication transport, such as, ARCNET, Ethernet, and IEEE RS-485 communications interface.
H. Provide a temporary Ethernet network for communications between supervisory controllers and operator workstation until the building IT network is available for use by the DDC system. The temporary Ethernet network and all other communications required for the DDC system shall be installed as required for specified operation of mechanical equipment so check out and commissioning of the equipment can occur in a timely manner.

2.5 BACNET REQUIREMENTS

A. BACnet of highest level network communications shall be capable of BACnet/IP over Ethernet and field level communications shall utilize BACnet MSTP.

B. All controllers shall provide a Protocol Implementation Conformance Statement (PICS) and BACnet Interoperability Building Blocks (BIBBs) 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.

D. Standard Object Types Supported
   1. Analog input.
   2. Analog output.
   3. Analog value.
   4. Binary input.
   5. Binary output.
   6. Binary value.
   7. Calendar.
   8. Device.
   9. Event enrollment.
   10. Group.
   11. Multistate input.
   12. Multistate output.
   13. Multistate value.
   14. Notification class.
   15. Schedule.

E. Character Sets supported
   1. ANSI X3.4.
   2. ISO 10646 Universal Character Set-2.

F. BACnet object name and description shall match the existing naming conventions used by Marathon County for their existing Building Automation System. Coordinate with the Owner's control personnel to establish the naming conventions prior to programming of any controllers provided under this Section.

G. 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.

H. Coordinate BACnet device instance numbering with the Owner 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 Owner's BACnet device instance numbering scheme

2.6 SUPERVISORY CONTROLLERS

A. Supervisory controllers shall be microprocessor based, multi-tasking, multi-user, and digital control processors.

B. 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.

C. Each supervisory controller shall have sufficient memory to support its own operating system and databases including:
   1. Control processes.
   2. Energy management application.
   3. Alarm management.
   4. Trend data.
   5. Maintenance support applications.
   6. Operator I/O.
   7. Dial-up communications.
   8. Manual override monitoring.

D. The system shall be modular in nature and shall permit easy expansion through the addition of field controllers, sensors, and actuators.

E. Supervisory controllers shall provide at least two (2) 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.

F. 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.

G. 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.

H. 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.

I. 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 seventy-two (72) hours.

J. Upon restoration of normal power, the supervisory controller shall automatically resume full operation without manual intervention.

K. Should supervisory controller memory be lost for any reason, the supervisory controller shall have the capability of reloading it's 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.

2.7 SYSTEM SOFTWARE FEATURES

A. All necessary software to form a complete operating system, as described in this Section, 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 (1) 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:
   1. Time of day scheduling.
   2. Calendar based scheduling.
   3. Holiday scheduling.
   4. Optimal start.
   5. Optimal stop.

6. Demand limiting.
7. Load rolling.
8. 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.

F. Supervisory controllers shall be able to execute configured processes defined by the Owner to automatically perform calculations and control routines.

G. It shall be possible to use any of the following in a configured process:
1. Any system-measured point data or status.
2. Any calculated data.
3. Any results from other processes.
4. Boolean logic operators (and, or).

H. Configured processes may be triggered based on any combination of the following:
1. Time of day
2. Calendar date
3. Other processes
4. Events (e.g., point alarms)

I. A single process shall be able to incorporate measured or calculated data from any and all other ASCs and shall be able to issue commands to points in any and all other programmable controllers and ASCs on the local network.

J. 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 ASCs on the network.

K. All alarm or point change reports shall include the English language description of each point and the time and date of the occurrence.

L. The Owner 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 (3) priority levels shall be provided. Users shall have the ability to manually inhibit alarm reporting for each point.

M. The Owner 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.

N. Alarms reports and messages shall be directed to an operator device.

O. In addition to the point's descriptor and the time and date, the Owner shall be able to print, display or store a sixty (60) character alarm message to more fully describe the alarm condition or direct operator response.

P. Each supervisory controller shall be capable of storing a library of at least one hundred (100) messages. Each message may be assignable to any number of points in the panel.

Q. A data collection utility shall be provided to automatically sample, store, and display system data.

R. 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 one (1) minute to twenty-four (24) hours, in one (1) minute or one (1) hour intervals, shall be provided. Each supervisory controller shall have a dedicated buffer for trend data and shall be capable of storing sixteen (16) trend logs. Each trend log shall have up to four points trended at forty-eight (48) data samples each. Data shall be stored at the supervisory controller and uploaded to the DDC system server when archiving is desired.

S. Supervisory controllers shall automatically accumulate and store runtime hours for binary input and output points.

T. 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.
U. The totalization routine shall have a sampling resolution of one (1) minute.
V. The Owner shall have the ability to define a warning limit. Unique, user specified messages shall be generated when the limit is reached.
W. The information available from pulse totalization shall include, but not be limited to, the following:
    1. Peak demand, with date and time stamp.
    2. 24-hour demand log.
    3. Accumulated KWH for day.
    4. Sunday through Saturday KWH usage.
    5. KWH annual history for past periods.
X. Supervisory controllers shall have the ability to count events, such as the number of times a pump system is cycled on and off.
Y. The event totalization feature shall be able to provide calculations, storage accumulations, and store the records associated with a minimum of 9,999,999 events before reset.

2.8 PROGRAMMABLE CONTROLLERS

A. Programmable controllers shall be provided with a software program that shall allow the Owner to design flexible software algorithms for the control sequences as described in Section 23 09 93.
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:
    1. Display temperatures.
    2. Display status.
    3. Display setpoints.
    4. Display control parameters.
    5. Override binary output control.
    6. Override analog output control.
    7. Override analog setpoints.
    8. Modification of gain and offset constants.
E. All system setpoints, 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.

2.9 APPLICATION SPECIFIC CONTROLLERS – HVAC APPLICATIONS

A. Each supervisory controller shall be able to extend its monitoring and control through the use of stand-alone application specific controllers (ASCs).
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:
    1. Control processes.
    2. Energy management applications.

3. 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. ASCs 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:
   1. Display temperatures.
   2. Display status.
   3. Display setpoints.
   4. Display control parameters.
   5. Override binary output control.
   6. Override analog output control.
   7. Override analog setpoints.
   8. Modification of gain and offset constants.

F. 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.

G. All application specific controllers shall be fully programmable. Question and answer or template programming is 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 and temperature setpoint setback).

2.10 OPERATOR INTERFACE REQUIREMENTS

A. Command Entry/Menu Selection Process:
   1. Operator interface software shall minimize operator training through the use of English language prompting and English language point identification.

B. Text Based Displays:
   1. 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:
   1. The operator interface shall provide graphic based displays of the hot water system. The point data associated with each system shall dynamically update at a minimum of every thirty (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. Points provided in the graphic shall have the override and adjust capability specified under operator commands.
   2. 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:
      a. Level 1 = Data access and display.

b. Level 2 = Level 1 + operator overrides and commands.
c. Level 3 = Level 2 + database generation and modification.

4. A minimum of four (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 one (1) to sixty (60) minutes to prevent operators from inadvertently leaving devices online.

E. Operator Commands:

1. The operator interface shall allow the operator to perform commands including, but not limited to, the following:
   a. Startup or shutdown selected equipment.
   b. Adjust setpoints.
   c. Override analog and binary outputs.
   d. Add/modify/delete time programming.
   e. Enable/disable process execution.
   f. Lock/unlock alarm reporting for each point.
   g. Enable/disable totalization for each point.
   h. Enable/disable trending.
   i. Enter temporary override schedules.
   j. Define holiday schedules.
   k. Change time/date.
   l. Enter/modify analog alarm limits.
   m. Enable/disable analog alarm limits.
   n. Enable/disable demand limiting.
   o. Enable/disable duty cycle.

F. Logs & Summaries:

1. Reports shall be generated manually, and directed to the displays. As a minimum, the system shall allow the Owner to easily obtain the following general listing of all points in the system that shall include, but not be limited to:
   a. Points currently in alarm.
   b. Off-line points.
   c. Points currently in override status.
   d. Points in weekly schedules.
   e. Holiday programming.
2. Summaries shall be provided for specific points, for a logical point group, for a Owner 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 & 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:
   a. Add/delete/modify application specific controllers.
   b. Add/delete/modify points of any type, and all associated point parameters, and tuning constants.
   c. Add/delete/modify alarm reporting definition for each point.
   d. Add/delete/modify energy management applications.
   e. Add/delete/modify time and calendar based programming.
   f. Add/delete/modify totalization for every point.

g. Add/delete/modify historical data trending for every point.
h. Add/delete/modify configured control processes.
i. Add/delete/modify dial-up telecommunication definition.
j. Add/delete/modify all operator passwords.
k. Add/delete/modify alarm messages.

H. Programming Description:
1. Definition of operator device characteristics, ASCs, individual points, and shall be performed through fill in the blank templates.

I. Network Wide Strategy Development:
1. 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 ASCs to allow the development of network wide control strategies.

J. System Definition/Control Sequence Documentation:
1. 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:
1. Backup copies of all programmable controller, ASC and supervisory controller databases shall be stored in at least one (1) personal computer or laptop. The Owner shall have the ability to manually execute upload and downloading of a programmable controller, ASC, and supervisory controller database.

2.11 OPERATOR WORK STATION & DDC SYSTEM SERVER

A. Connect to the existing Marathon County DDC System Server software shall be provided for command entry, information management, network alarm management, database management, and archiving functions. The functions of the operator workstation and DDC system server may reside on a single personal computer.

B. Provide a separate DDC System Server PC if required to perform the specified requirements. All functions specified under the entire Operator Interface section of this specification must be met.

C. All real time control functions shall be resident in the stand-alone supervisory controllers to facilitate greater fault tolerance and reliability.

D. Provide software, including but not limited to, functions such as:
1. Grouping point data by systems or types.
2. Displaying trends in textual and graphical format.
3. Application software for programming all DDC controllers specified herein.
4. Graphis definition and development.
5. Managing archive data and programs.

E. This Contractor shall provide all labor and software upgrades required so that the manufacturer's current software revision is provided at substantial completion. If the manufacturer will be upgrading within three (3) months after substantial completion, the contractor must notify the Owner that this will occur before substantial completion and provide a quote for upgrading to the current revision.

2.12 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 their 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

3.1 GENERAL

A. All electronic work required as an integral part of the Direct Digital Control system work is the responsibility of this Section unless specifically indicated otherwise.
B. This Contractor shall provide all labor, materials, engineering, software, permits, tools, checkout, and certificates required to install a complete Direct Digital Control system as herein specified.
C. Any and all points added with this Project shall be grouped for display purposes into the system such that all points associated with a new or existing DDC system can appear together on the flat panel 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 (1) system. An English descriptor and an alpha/numeric identifier shall identify each system.
D. This Direct Digital Control system 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.

3.2 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 with the wiring installation as specified in the installation section of Section 23 09 14. All material shall be UL approved.
B. Install system and materials in accordance with manufacturer's instructions, rough-in drawings, and details on drawings.
C. Line voltage wiring to power the DDC Controllers, not provided by the Division 26 Contractor, to be by this Contractor.
D. Mount control panels adjacent to associated equipment on vibration free walls or free-standing angle iron supports. One (1) cabinet may accommodate multiple systems in the same equipment room. Provide engraved plastic nameplates for instruments and controls inside cabinet and on cabinet face.
E. Provide control Record Drawings of all systems served by each local panel inside of panel cover. Provide a protective cover or envelope for drawings.
F. Cable tray routing of the communication trunks is acceptable.
G. Where a new system is required to be extended to an existing agency Building Automation Network (BAN) (typically connected via the Owner’s 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.
H. Provide all necessary routers and or repeaters to accomplish connection to the BAN via the panel mounted port provided.
I. Provide two (2) 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.
J. All tubing, cable, and individual wiring is to be permanently tagged, with numbers corresponding with control Record Drawings, spares are to be labelled as "Spare".
K. 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.

3.3 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 (2) hours.

B. Provide two (2) follow-up visits for troubleshooting and instruction, with one (1) visit six (6) months after substantial completion and the other at the end of the warranty period. Length of each visit to be not less than two (2) hours or the time necessary to provide required information and complete troubleshooting and inspection activity for all controls installed. Coordinate the visit with the Owner and provide an inspection report of any deficiencies found.

END OF SECTION 23 09 23

SECTION 23 09 93
SEQUENCE OF OPERATIONS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Sequence of operations for the following systems:
   1. Hot Water Heating System.
   2. Emergency Shutdown Switch for Gas Fired Appliances.
   3. Miscellaneous Monitoring & Control Points.
   4. DDC Point Chart.

1.2 SYSTEM DESCRIPTION

A. This Section defines the manner and method by which controls function. Requirements of each type of control system are specified. The equipment, devices, and system components required for the control sequences are specified in other Sections.

1.3 SUBMITTALS

A. See Section 23 09 14.

1.4 OPERATIONAL & MAINTENANCE SUBMITTALS

A. See Section 23 09 14.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS FOR SEQUENCE OF OPERATIONS

A. Provide access doors for access to equipment, valves, or other specialties installed behind walls or above ceiling surfaces.
B. Setpoints:
   1. All setpoints indicated in the control specification are to be adjustable. The setpoints shall be readily available to be modified in the building automation system (BAS) software system summary (either textual or graphic based) and under the same software level as hardware points. 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 Temperature Control Contractor shall work with the Testing, Adjusting, and Balancing Contractor to provide the final system setpoint adjustments and control loop tuning after the system is in operation and building is in use.
C. Anti-Cycling:
   1. 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 2°F 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. Cooling

differentials shall be set for below setpoint and heating differentials shall be set above setpoint and will be used to turn the process off. 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 fifteen (15) minutes (adjustable) and off timers of five (5) minutes (adjustable). Safeties shall override runtime timers.

D. Dead-Bands:
   1. Provide dead-bands for all DDC control loops to prevent constant hunting of output signals to controlled devices. Dead-bands shall be set to provide adequate control around setpoint.

E. Alarms:
   1. Provide all alarmed points with adjustable time delays to prevent nuisance tripping under normal operation and on equipment start-up. Provide alarms on all points as indicated on the DDC Point Chart.

F. Equipment Start/Stop Failure States:
   1. All start/stop points for equipment shall utilize normally open contacts unless called out specifically in the individual control sequences.

G. Variable Frequency Drive (VFD) Motor Run Status:
   1. When furnished by the unit manufacturer, use the VFD programmable relay dry contact output 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.

H. VFD Bypass & Safety Interlocks:
   1. 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.

I. VFD Minimum Speed:
   1. The VFD start-up technician shall work with the Temperature Control Contractor to 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.

J. Lead/Lag Sequencing:
   1. 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.
   2. Provide lead/lag sequencing for all equipment with 100% standby.
   3. Make provisions to allow independent operation of pumps so that upon failure of one (1) pump or its associated VFD, the other pump is fully operational.

K. Current Switch Setup:
   1. When current switches are used for proving 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 control contractor after the balancing work is complete.

L. Thermostats & Sensors:
   1. All devices and equipment 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 Drawings.

M. Safeties & Fire Alarm Shutdowns:
   1. Provide hard wiring in conduit for all safeties and fire alarm shutdowns to motor starters or VFDs with DDC system annunciation thru auxiliary contacts on safety relays. Description of required safeties and fire alarm shutdown sequences are specified separately for each system.

N. Control Panels:
   1. All components required for control of systems shall be installed in temperature control panels located where shown on the Drawings. Provide a service shutdown switch on the front face of panel to allow maintenance personnel to shut-down the system in an orderly manner without initiating false alarms.

O. VFD Interlocks:
   1. For motors controlled by VFDs which have a local disconnect switch at the motor downstream of the VFD, interlock the VFD operation with the local disconnect switch located near the fan motor. Turn off the VFD whenever the local motor disconnect switch is turned off. Provide limit switch or auxiliary switch at local motor disconnect.

3.2 HOT WATER HEATING SYSTEM

A. General:
   1. The hot water system consists of sealed combustion boilers with modulating burners to serve the terminal units and air handling units within the building.
   2. The boilers shall operate in a variable primary flow configuration.

B. The System Consists of the Following:
   1. Two (2) condensing hot water boilers with modulating burners.
   2. Two (2) distribution pumps with variable frequency drives.
   3. One (1) flow meter with temperature sensors.
   4. Boiler management system provided by the boiler manufacturer.

C. Furnish the following automatic control valves and actuators for the main building system:
   1. Boiler Isolation Control Valve: Two-way, two-position, normally open control valve for isolating each boiler.
   2. Minimum Flow Bypass: Two-way, modulating, normally open control valve for maintaining system minimum flow.

D. Hot Water Supply Temperature:
   1. Enable the system if there is a demand for heating.
   2. Once enabled, the boiler management system shall maintain the hot water supply temperature serving the system at 180°F by sequencing the boilers and modulating the burners to satisfy the building heating system.
   3. Provide operational and alarm status at the BAS from the boiler panels.
   4. Install and wire sensors and components shipped loose furnished by the boiler manufacturer including power wiring from control transformer.
   5. Whenever a respective boiler burner is turned off by the boiler management system, close its respective isolation control valve.
   6. Whenever a respective boiler burner is turned on by the boiler management system, open its respective isolation control valve prior to energizing the burner.
   7. Prevent boilers from operating if water flow and water level are not proven.

E. Distribution Pump Operation:
   1. Start/Stop:
      a. Open the isolation control valve for the lead boiler.
      b. The lead pump shall operate continuously whenever there is a demand for building heating.
      c. Prior to enabling the lag boiler, open the isolation control valve for the boiler.
      d. The lag pump shall operate upon failure of the lead pump.
      e. Provide a current sensor for each pump that shall energize the other pump if flow has been insufficient for at least thirty (30) seconds.
   2. Lead/Lag Selection:
      a. Manual selector switch at the temperature control panel.
      b. Automatically by the BAS to equalize run time.

3. Distribution Pump Speed Control:
   a. Provide one (1) differential pressure sensor located in the third floor Mechanical Room.
   b. Provide the same control signal to the distribution pump online. Reduce the speed of the pumps if the differential pressure signal is maintaining setpoint. Increase the pump speed if the branch differential pressure signal is below setpoint.

F. Hot Water Supply Reset:
   1. Monitor and reset hot water supply temperature from the boiler management system based on outside air temperature per the following schedule:

OUTSIDE AIR [°F]	HOT WATER SUPPLY TEMPERATURE [°F]
0	180
60	140

   2. Maintain reset schedule by modulating the boiler burners and operating them in sequence.

G. Flow Meter:
   1. Provide a hot water flow meter to monitor system the flow rate. Provide integral temperature sensors for calculating the hot water system production.

H. Minimum Flow Rate:
   1. The minimum flow rate of twenty-five (25) GPM per boiler shall be met by a minimum flow bypass located in the third floor Mechanical Room.
   2. Verify final GPM with the boiler manufacturer.

3.3 EMERGENCY SHUTDOWN SWITCHES FOR GAS FIRED APPLIANCES

A. General:
   1. Provide a wall mounted, manual emergency push button shutdown switch for the boilers in Mechanical 1103.

B. Location:
   1. Inside the entry door to Mechanical 1103.

C. The wall mounted shutdown switch shall turn off the following equipment:
   1. Boilers: B-1 and B-2.

3.4 MISCELLANEOUS MONITORING

A. Integration of Equipment & Systems: From the BAS, monitor and adjust the equipment and systems identified in Section 23 09 94 via integration. Coordinate with the Owner on the points required.

B. Water Filters: For each unit, monitor the differential pressure to determine when the water filters need replacement.

C. Make-up Water Systems:
   1. Monitor the make-up water system water meter usage (gallons) for the hot water system.
   2. Provide wiring to the BAS from reed switches (dry contacts) located in the water meter transmitters.

3.5 DDC POINT CHART

A. Furnish, as a minimum, all point indicated on the DDC Point Chart and as necessary for proper system operation.

END OF SECTION 23 09 93

DDC POINT CHART	INPUTS											OUTPUTS								SYSTEM FEATURES								
	ANALOG							DIGITAL				ANALOG			DIGITAL					ALARMS			MISCELLANEOUS					
MARATHON COUNTY LAKE VIEW PROFESSIONAL PLAZA (LVPP) FACILITY BOILER CONVERSION	TEMPERATURE	RELATIVE HUMIDITY	PRESSURE	CARBON DIOXIDE	FLOW	SETPOINT ADJUST	OTHER	STATUS	ALARM	OVERRIDE	OTHER	SPEED	ELECTRIC MODULATING	OTHER	ENABLE/DISABLE	START/STOP	OPEN/CLOSE	ON/OFF	OTHER	HIGH ANALOG	LOW ANALOG	OFF NORMAL	RUNTIME	POINT HISTORY	SYSTEM GRAPHIC	KW / KWH	INTEGRATION AT BAS	OTHER	NOTES
HOT WATER SYSTEM																									X		X		Integrate at BAS
Enable Hot Water Boilers						X		X	X		X		X		X	X						X	X	X	X		X		Flow Switch Status
Each Boiler Inlet/Outlet Temperatures	X					X														X	X			X	X				HWS-T & HWR-T
System Inlet and Outlet Temperatures	X																			X	X			X	X				HWS-T & HWR-T
Distribution Pumps								X	X			X	X			X						X	X	X	X				
Branch Piping Differential Pressure Sensors			X																	X	X			X	X				
Water Filter Pressure Differential									X											X				X	X				
Make-Up Water Meter Usage							X																	X	X				Water Totalization
Minimum Flow Bypass Control Valve													X											X	X				
Boiler Isolation Control Valves																	X							X	X				One (1) per Boiler
Hot Water Flow Meter					X															X	X			X	X				
System Fill Pressures (Pump Suction Pressure)			X																	X	X			X	X				
MISCELLANEOUS MONITORING																													
All VFDs								X	X			X											X	X	X		X		
Gas Flow Meter					X																			X	X		X		Alternate Bid

END OF SECTION 23 09 94

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SECTION 23 11 23
NATURAL GAS PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Pipes & fittings.

1.2 REFERENCE STANDARDS

A.	ANSI B16.3 -	Malleable Iron Threaded Fittings
B.	ASTM A53 -	Pipe, Steel, Black & Hot Dipped, Zinc Coated Welded & Seamless
C.	ASTM A234 -	Pipe Fittings of Wrought Carbon Steel & Alloy Steel for Moderate & Elevated Temperatures
D.	NFPA 54 -	National Fuel Gas Code

1.3 SUBMITTALS

A. Product Data: For each type of the following:
   1. Pipe:
      a. 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.
   2. Fittings.
   3. Joining materials.

B. Welding certificates.

1.4 OPERATION & MAINTENANCE SUBMITTALS

A. Reports: Submit pipe testing and inspection reports.

B. As-Built Drawings: Plans, drawn to scale, on which the all piping, fittings, and specialties are shown. Plans shall have complete layout including sizes, elevations, equipment locations, equipment tags, and clearances shown.

1.5 QUALITY ASSURANCE

A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
   1. Comply with ASME B31.9 for materials, products, and installation.
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

1.6 DELIVERY, STORAGE, & HANDLING

A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural gas piping according to requirements of authorities having jurisdiction.

B. Deliver pipes and tubes with factory applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

C. Store and handle pipes and tubes having factory applied protective coatings to avoid damaging coating and protect from direct sunlight.

D. Cover pipe to eliminate rust and corrosion while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade.

1.7 EXISTING PROJECT CONDITIONS

A. Interruption of Existing Natural Gas Service: Do not interrupt natural gas service to facilities occupied by Owner unless permitted under the following conditions and then only after arranging to provide purging and startup of natural gas supply according to requirements indicated:
   1. Notify Owner no fewer than two (2) days in advance of proposed interruption of natural gas service.

PART 2 - PRODUCTS

2.1 PIPE & FITTINGS

A. Steel Pipe: ASTM A53, black steel, Schedule 40, Type E or S, Grade B, standard weight.
   1. Threaded Fittings: ASME B16.3, Class 150, malleable iron, standard weight.
   2. Welded Fittings: ASTM A 234, forged steel, butt welded, seamless.
   3. Unions: ASME B16.39, Class 150, malleable iron with brass to iron seat, ground joint, and threaded ends.
   4. Flanges: ASME B16.5, minimum Class 150.
      a. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral wound metal gaskets.
      b. Bolts & Nuts: ASME B18.2.1, carbon steel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine rough-in for natural gas piping system to verify actual locations of piping connections before equipment installation.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PIPING INSTALLATION

A. Comply with NFPA 54 for installation and purging of natural gas piping.
B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
D. Conceal pipe installations in walls, pipe spaces, utility spaces, and above ceilings unless indicated to be exposed to view or in equipment rooms and service areas.
E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
G. Locate valves for easy access.
H. Install natural gas piping at uniform grade of 1” per 60’-0” in the direction of flow.
I. Install piping free of sags and bends.
J. Install fittings for changes in direction and branch connections.

K. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
L. Use only long radius elbows having a centerline radius of 1.5 pipe diameters.
M. Comply with requirements in Sections specifying gas fired appliances and equipment for rough-in requirements. Verify final equipment locations for rough-in.
N. Drips & Sediment Traps: Install drips at points where condensate may collect, including service meter outlets. Locate where accessible to permit cleaning and emptying.
   1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of three (3) pipe diameters, but not less than 4" long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap. Locate as close as practical to inlet of each appliance.
   2. Provide at bottom of each vertical run and at each appliance.
O. The following piping may be used based on the following:

SIZE/PRESSURE DESIGNATION	THREADED STEEL	WELDED STEEL
2" or Less or Less Than 5 PSIG	X	X
2-1/2" & Above or 5 PSIG & Above		X

3.3 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
C. Threaded Joints:
   1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
   2. Cut threads full and clean using sharp dies.
   3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
   4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
   5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
D. Welded Joints:
   1. Construct joints according to AWS D10.12, using qualified processes and welding operators.
   2. Bevel plain ends of steel pipe.
   3. Patch factory applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.
E. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural gas service. Install gasket concentrically positioned.

3.4 CONNECTIONS

A. Connect to existing gas piping located in the Laundry Building.
B. Install natural gas piping electrically continuous and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
C. 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.
D. Install piping adjacent to appliances to allow service and maintenance of appliances.
E. Connect piping to appliances using manual gas shutoff valves and unions. Install valve near each gas fired appliance and equipment. Provide a union or flange at each piping specialty or piece of equipment which may require removal for maintenance, repair, or replacement. Install union between valve and appliances or equipment.

3.5 PIPING SYSTEM LEAK TESTS

A. Verify that the piping system best tested in fully connected to all components and that all equipment is properly installed, wired, and ready for operation.
B. Test, inspect, and purge natural gas according to NFPA 54 and authorities having jurisdiction.
C. Perform the following tests on gas piping:

SYSTEM	TEST PRESSURE	MEDIUM	DURATION
Natural Gas	100 PSIG	Air	24 Hour

D. Gradually increase the pressure to not more than 1/2 the test pressure. Increase the pressure insteps of approximately 1/10 the test pressure until the required pressure is reached. Examine all joints with a soap bubble solution or equivalent method. After completion of test, slowly release the pressure in a safe manner.
E. Natural gas piping will be considered defective if it does not pass tests and inspections.
F. Prepare test and inspection reports.

3.6 PAINTING (ALTERNATE BID)

A. Paint all interior, exposed, new gas piping with two (2) coats of rust resistant paint, yellow in color.

END OF SECTION 23 11 23

SECTION 23 21 13
HYDRONIC PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Hydronic piping & fittings.

1.2 REFERENCE STANDARDS

A.	ASME -	Boiler and Pressure Vessel Codes, SEC 9 - Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators
B.	ASME B16.3 -	Malleable Iron Threaded Fittings Class 150 and 300
C.	ASME B16.18 -	Cast Copper Alloy Solder Joint Pressure Fittings
D.	ASME B16.22 -	Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
E.	ASME B16.29-	Wrought Copper Solder Drainage Fittings
F.	ASME B31.9 -	Building Services Piping
G.	ASTM A53 -	Pipe, Steel, Black and Hot Dipped, Zinc Coated Welded and Seamless
H.	ASTM A234 -	Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
I.	ASTM B32 -	Solder Metal
J.	ASTM B88 -	Seamless Copper Water Tube
K.	AWS A5.8 -	Brazing Filler Metal
L.	AWS D1.1 -	Structural Welding Code

1.3 SUBMITTALS

A. Product Data: For each type of the following:
   1. Pipe:
      a. 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.
   2. Fittings.
   3. Joining materials.

B. Welding certificates.

1.4 OPERATION & MAINTENANCE SUBMITTALS

A. As-Built Drawings: Plans, drawn to scale, on which the all piping, fittings, and specialties are shown. Plans shall have complete layout including sizes, elevations, equipment locations, equipment tags, and clearances shown.

B. Reports: Submit pipe testing and inspection reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Installers of Pressure Sealed Joints: Installers shall be certified by pressure seal joint manufacturer as having been trained and qualified to join piping with pressure seal pipe couplings and fittings.

B. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Comply with ASME B31.9 for materials, products, and installation.
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

1.6 DELIVERY, STORAGE, & HANDLING

A. Deliver pipes and tubes with factory applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
B. Store and handle pipes and tubes having factory applied protective coatings to avoid damaging coating, and protect from direct sunlight.
C. Cover pipe to eliminate rust and corrosion while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:

SYSTEM DESIGNATION	PRESSURE [PSIG]	TEMPERATURE [°F]
Hot Water	100	200
Make-Up Water	100	100

2.2 COPPER TUBE & FITTINGS

A. Copper Tubing: ASTM B88, Type L, hard drawn.
   1. Fittings:
      a. Wrought Copper: ASME B16.22, socket solder type joint.
      b. Mechanically Formed Tee Option: For forming T-branch takeoffs up to one-half the diameter of the main.
   2. Joints:
      a. Solder Filler Metals: ASTM B32, lead-free alloys. Include water flushable flux according to ASTM B813.
      b. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.
      c. Unions: Bronze, three-piece, threaded, with soldered joints.

2.3 STEEL PIPE & FITTINGS

A. Steel Pipe: ASTM A53, black steel with plain ends; welded and seamless, Grade B, Type E or S, schedule 40.
   1. Fittings:
      a. 2” & Smaller:
         1) Cast Iron Threaded Fittings: ASTM A126/ASME B16.4, Class 125, standard weight.
      b. 2-1/2” & Larger:
         1) Fittings: ASTM A234, wall thickness to match adjoining pipe, seamless, black steel, welded fittings.
         2) Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2. Pipe Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   a. ASME B16.21, nonmetallic, flat, asbestos free, 1/8” maximum thickness.
      1) Full Face Type: For flat face, Class 125, cast iron and cast bronze flanges.
      2) Narrow Face Type: For raised face, Class 250, cast iron and steel flanges.
      3) Wrought Cast & Forged Steel Flanges & Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets.
      4) Facings: Weld neck, raised face, ASTM A181 Grade 1.
3. Flange Bolts & Nuts: ASME B18.2.1, carbon steel.

2.4 PRESSURE SEAL PRESS FITTINGS & COUPLINGS

A. Manufacturers:
   1. Nibco.
   2. Viega.
B. Copper:
   1. Housing: Copper.
   2. O-Rings & Pipe Stops: EPDM.
   3. Tools: Manufacturer's special tools.
   4. Rating: 200 PSIG working pressure at 250°F.

2.5 MECHANICAL GROOVED JOINT FITTINGS & COUPLINGS

A. Manufacturers:
   1. Anvil Corporation.
   2. Grinnell Corporation.
   3. Victaulic Company.
B. Steel:
   1. Joint Fittings:
      a. ASTM A536, ductile iron.
      b. ASTM A47, Grade 32510 malleable iron.
      c. ASTM A53, Type F, E, or S, Grade B fabricated steel.
   2. Couplings: Ductile or malleable iron housing and EPDM gasket of central cavity pressure responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
   3. Strap on tees are not allowed.

2.6 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder joint, plain, or weld neck end connections that match piping system materials.
B. Insulating Material: Suitable for system fluid, pressure, and temperature.
C. Dielectric Flanges: Factory fabricated, companion flange assembly, for 150 PSIG minimum working pressure as required to suit system pressures.
D. Dielectric Flange Kits: Companion flange assembly for field assembly. Include flanges, full face or ring type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
   1. Separate companion flanges and steel bolts and nuts shall have 150 PSIG minimum working pressure where required to suit system pressures.
E. Dielectric Couplings: Galvanized steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 150 PSIG minimum working pressure at 225°F.
F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain or threaded ends; and 150 PSIG minimum working pressure at 225°F.

PART 3 - EXECUTION

3.1 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
E. Install piping to permit valve servicing.
F. Install piping at indicated slopes. Install piping at a uniform grade 1” per 40’-0” upward in direction of flow.
G. Install piping free of sags and bends.
H. Install fittings for changes in direction and branch connections.
I. Install piping to allow application of insulation.
J. Install groups of pipes parallel to each other at common elevations where practical, spaced to permit applying insulation and servicing of valves.
K. Select system components with pressure rating equal to or greater than system operating pressure.
L. Install drains, consisting of a 3/4” drain valve, at low points in piping system mains and elsewhere as required for complete system drainage.
M. 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 an accessible location.
N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
O. Use long radius elbows having a centerline radius of 1.5 pipe diameters.
P. Thread-o-lets and weld-o-lets may be used for branch takeoffs up to one-half (1/2) the diameter of the main.
Q. Install all valves, control valves, and piping specialties, including items furnished by others, as specified or detailed. Make connections to all equipment installed by others where that equipment requires the piping services indicated in this Section.

3.2 PIPING APPLICATIONS

A. The following piping may be used on each respective piping system:

SYSTEM DESIGNATION	BLACK STEEL PIPING	COPPER PIPING	PVC
Hot Water	X	X	
Make-Up Water		X	

B. Safety Valve Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed according to piping manufacturer's instructions.
C. Chemical Treatment Piping: Same materials and joining methods as for piping system specified.

3.3 PRESSURE SEAL PRESS FITTINGS & COUPLINGS

A. Install according to the manufacturer’s instructions.
B. The following services may use pressure seal press fitting pipe connections for copper piping within the building:

SYSTEM DESIGNATION	YES	NO
Hot Water	X	
Make-Up Water	X	

C. Pressure fittings are not allowed in inaccessible locations.
D. Copper tubing shall be cut square with a wheeled tubing cutter or approved copper tubing cutting tool.

3.4 MECHANICAL GROOVED JOINT FITTINGS & COUPLINGS

A. Install according to the manufacturer's instructions.
B. The following services may use grooved pipe connections for steel piping within the building:

SYSTEM DESIGNATION	YES	NO
Hot Water	X	
Make-Up Water		X

C. Grooved fittings are not allowed in inaccessible locations.
D. Either cut grooved or roll grooved products are acceptable provided the system temperature and pressure ratings are met.
E. Use pipe factory grooved in accordance with the coupling manufacturer's specifications or pipe field grooved in accordance with the same specification using specifically designed tools available for the application.
F. Lubricate pipe and coupling gasket, align pipe, and secure joint in accordance with the coupling manufacturer's specifications.
G. Credit for the inherent flexibility of mechanical grooved pipe connections may be allowed upon specific applications when used for expansion joints. Requests shall be made in writing and shall include service, location, line size, proposed application, and supplying calculations for the intended surface.
H. The use of mechanical grooved piping connections does not eliminate vibration isolation at the equipment.

3.5 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
C. 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.
D. Install unions in piping, 2" and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
E. Install flanges in piping, 2-1/2" and larger, at final connections of equipment and elsewhere as indicated.
F. Furnish and install and flanges, caps, bypasses, drains, and valves required to facilitate flushing and draining all piping.
G. Soldered Joints: Apply ASTM B813, water flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B828 or the Copper Tube Handbook, using lead-free solder alloy complying with ASTM B32.
H. Brazed Joints: Construct joints according to AWS's Brazing Handbook, Pipe and Tube Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
I. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

J. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators.

K. All piping 2-1/2” and larger and non-accessible piping of all sizes shall be welded.

L. Fusion weld in accordance with ASME Codes, ANSI B31, and state codes where applicable.

M. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

N. Mechanically Formed, Copper-Tube-Outlet Joints: Use manufacturer recommended tool and procedure, and brazed joints. Mechanically formed tees may be used for branch takeoffs up to one-half (1/2) the diameter of the main. 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 (3) times the thickness of the tube wall. Use an adjustable collaring device. Notch and dimple the branch tube. Remove all debris created by the forming process from inside of the piping. Braze the joint, applying heat properly so that pipe and tee do not distort.

O. Pressure Sealed Joints: Use manufacturer recommended tool and procedure. Leave insertion marks on pipe after assembly.

3.6 DIELECTRIC FITTINGS

A. Provide two (2) new dielectric fittings of the size and location as follows:
   1. Second Floor: 3”.
   2. Third Floor: 3”.

B. Coordinate the exact location with the Owner.

3.7 FIELD QUALITY CONTROL

A. Verify that the piping system being tested is fully connected to all component as and that all equipment is properly installed, wired, and ready for operation. If required for the additional pressure load under test, provide temporary restraints and expansion joints or isolation them during the test. Provide all piping, fittings, flanges, and equipment to perform the testing.

B. If leaks are found, repair the area with new materials and repeat the test.

C. Conduct the pressure test with test medium of water. The minimum test time is indicated in the table below. All tests shall be witnessed by the Owner. If leaks are found, repair the area with new materials and repeat the test.

D. Flush and use clean water and remove all air from the piping being tested by means of air vents. Measure and record the test pressure at the high point in the system.

E. Prepare hydronic piping according to ASME B31.9 and as follows:
   1. Leave joints, including welds, uninsulated and exposed for examination during test.
   2. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
   3. Install safety valve to protect against damage by expanding liquid or other source of overpressure during test.

F. Perform the following tests on hydronic piping:

SYSTEM DESIGNATION	TEST PRESSURE	MEDIUM	DURATION
Hot Water	100 PSIG	Water	8 Hour

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use air vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90% of specified minimum yield strength.
5. After hydrostatic test pressure has been applied for at least ten (10) minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare test and inspection reports.

G. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set make-up pressure reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, to specified values.
7. Verify lubrication of motors and bearings.

END OF SECTION 23 21 13

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SECTION 23 21 16
HYDRONIC PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Air vents.
B. Pressure reducing valves.
C. Safety relief valves.
D. Automatic balancing valves.
E. Expansion tanks.
F. Air separators.
G. Suction diffusers.
H. Combination valves.
I. Strainers.
J. Water filters.

1.2 REFERENCE STANDARDS

A. ASME - Boilers & Pressure Vessels Code Section VIII, Division 1
B. ASME B31.9 - Building Services Piping

1.3 SUBMITTALS

A. Product Data: For each type of product:
   1. Include construction details and material descriptions for hydronic piping specialties.
   2. Include rated capacities, operating characteristics, pressure drop where appropriate, identification as referenced on the Drawings, sizes, model numbers, and furnished specialties and accessories.

1.4 OPERATION & MAINTENANCE SUBMITTALS

A. Operation & Maintenance Data: Include installation instructions, assembly views, and replacement parts list.
B. As-Built Drawings: Plans, drawn to scale, on which the all specialties are shown.
C. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Filters: One (1) set of filters.

1.5 QUALITY ASSURANCE

A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
B. Safety Valves & Pressure Vessels: Shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 AIR VENTS

A. Manufacturers:
   1. Bell & Gossett.
   2. Hydronic Components Inc.
   3. Taco Comfort Solutions, Inc.
   4. Nexus Valve, Inc.

B. Manual Key Type Air Vents:
   1. Body: Bronze.
   2. Internal Parts: Nonferrous.
   3. Operator: Screwdriver or thumbscrew.
   4. Rating: 250°F at 150 PSIG.

C. Manual Ball Valve Air Vents:
   1. 1/4” ball valve.

D. Automatic Air Vents:
   1. Body: Bronze or cast iron.
   2. Internal Parts: Nonferrous.
   3. Operator: Noncorrosive metal float.
   4. Rating: 150 PSIG at 250°F.

2.2 PRESSURE REDUCING VALVES

A. Manufacturers:
   1. Bell & Gossett.
   2. Watts.

B. Body: Bronze or brass.

C. Disc: Glass and carbon filled PTFE.

D. Seat: Stainless steel.

E. Stem Seals & Diaphragm: Buna-N.

F. Check Valve: Low inlet pressure.

G. Inlet Strainer: Stainless steel, removable without system shutdown.

H. Valve Seat & Stem: Noncorrosive.

I. Rating: 160°F at 125 PSIG.

J. Valve Size, Capacity, & Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

2.3 SAFETY RELIEF VALVES

A. Manufacturers:
   1. Bell & Gossett.
   2. Kunkle.
   3. Watts.

B. Body: Cast iron, bronze, or brass.

C. Seat: Brass.

D. Stem, Screw, & Springs: Stainless steel.

E. Diaphragm: EPDM.

F. Wetted, Internal Work Parts: Brass and rubber.

G. Valve Size, Capacity, & Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set.

2.4 AUTOMATIC BALANCING VALVES

A. Manufacturers:
   1. Griswold Controls.
   2. Hydronic Components Inc.
   3. IMI Hydronic Engineering.
   4. Nexus Valve, Inc.
B. 2” & Smaller:
   1. Body: Brass.
   2. Flow Cartridge & Springs: Stainless steel, tamper proof, and removeable.
   3. Combination Assemblies: Include ball valve, y-strainer, integral unions, and dual pressure/temperature ports.
C. Identification Tag: Metal tag with valve number, model number, spring range, and flow rate.
D. Accuracy: Maintain constant flow within ±5%, regardless of system pressure fluctuations.
E. Rating: 250°F at 175 PSIG.

2.5 EXPANSION TANKS

A. Manufacturers:
   1. Amtrol.
   2. Armstrong.
   3. Bell & Gossett.
   4. Taco Comfort Solutions, Inc.
   5. Wessels.
B. Tank:
   1. Welded steel, designed and constructed according to ASME Boiler and Pressure Vessel Code Section VIII, Division 1.
   2. Drain connection, system connection, and air valve charge connection.
   3. Vertical units to have integral base ring.
C. Bladder: Replaceable heavy duty butyl rubber.
D. Rating: 125 PSIG at 240° F.

2.6 AIR SEPARATORS

A. Manufacturers:
   1. Armstrong.
   2. Bell & Gossett.
   3. Taco Comfort Solutions, Inc.
   4. Wessels.
B. Tangential Air Separators:
   1. Welded steel, designed and constructed according to ASME Boiler and Pressure Vessel Code Section VIII, Division 1.
   2. Air Collector Tube & Strainer: Perforated stainless steel, constructed to direct released air into expansion tank.
   3. Tangential Inlet & Outlet Connections: Flanged.
   4. Blowdown Connection & Top Connection: Threaded.
   5. Rating: 125 PSIG at 350°F.

2.7 SUCTION DIFFUSERS

A. Manufacturers:
   1. Armstrong.
   2. Bell & Gossett.
   3. Taco Comfort Solutions, Inc.
B. Construction: Angle pattern.

1. Body: Cast iron.
2. Straightening Vanes & Orifice Cylinder: Steel.
3. Start-Up Strainer: Bronze.
4. Permanent Strainer: Steel.
5. Connections: Flanged.

C. Accessories:
1. Adjustable support foot.
2. Strainer blowdown connection in bottom.
3. Pressure gauge tapping.
4. Bolted flange for strainer removal.

D. Rating: 175 PSIG at 250°F.

2.8 COMBINATION VALVES

A. Manufacturers:
1. Armstrong.
2. Bell & Gossett.
3. Taco Comfort Solutions, Inc.

B. Construction: Straight or angle pattern, globe valve with a spring loaded check valve.
1. Body: Cast iron.
2. Disc: Brass with EPDM seat.
3. Stem & Spring: Stainless steel.
4. Connections: Flanged.

C. Accessories:
1. Pressure gauge tappings.
2. Calibrated adjustment with memory stop.

D. Rating: 175 PSIG at 250°F.

2.9 STRAINERS

A. Manufacturers:
1. Armstrong.
2. Keckley.
3. Metraflex.
4. Mueller.
5. Spirax Sarco.

B. Body:
1. Y-Type: Cast iron with bolted cover and bottom drain connection.

C. Strainer Screen:
1. Construction: Stainless steel.
2. Perforations:
a. Up to 2”: 20 mesh.
b. 2-1/2” to 4”: 1/16”.

D. Connections:
1. Up to 2”: Threaded.
2. 2-1/2” & Larger: Flanged.

E. Rating: 125 PSIG.

2.10 WATER FILTERS

A. Manufacturers:
1. Pall Corporation.
2. Parker Filtration.
3. Rosedale Products.
4. Wessels.

B. Housing:
   1. Carbon steel with gasketed clamped cover.
   2. ASME code stamp.
   3. Floor mounting support.
   4. Rating: 150 PSIG at 250°F.
C. Connections:
   1. Inline inlet and outlet.
   2. Up to 2”: Threaded.
   3. 2-1/2” & Larger: Flanged.
D. Accessories:
   1. Provide gauge connections on inlet and outlet connections.
   2. Provide air vent and drain connections.
E. Filters:
   1. Filtration Efficiency: 98% removal to 5 microns.
   2. Clean Pressure Loss: 2 PSIG.
   3. Media Material: Polypropylene.
   4. Cartridge Seal: Internal rod and stainless steel nut.
      Maximum Differential Pressure: 75 PSIG.

PART 3 - EXECUTION

3.1 AIR VENTS

A. Install manual air vents at high points in piping, at heat transfer coils, and elsewhere as required for system air venting.
B. Install automatic air vents at high points of system piping in mechanical equipment rooms only.
C. Manual Key Type Vents:
   1. Install at all high points where air may collect. Use a soft copper, Type L, pigtail so the vent can be positioned for venting and collecting any water that might escape.
D. Manual Ball Valve Vents:
   1. Where indicated.
E. Automatic Air Vents:
   1. Install on top of air separators.
   2. Provide a shutoff valve installed upstream of the vent.
   3. Use a soft copper, Type L, from vent discharge to floor drain.

3.2 PRESSURE REDUCING VALVES

A. Install pressure reducing valves at make-up water connection to regulate system fill pressure.
B. Provide shutoff valve and strainer upstream of each device.
C. Install pressure gauges at inlet and outlet of each valve.
D. Adjust fill pressure to that indicated on the Drawings.

3.3 SAFETY RELIEF VALVES

A. Install safety relief valves at hot water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.
B. Install valves in vertical position with discharge piped to the floor.
C. Cut discharge pipe at 45° angle from the floor.

3.4 AUTOMATIC BALANCING VALVES

A. Install so that integral strainer can be removed.
B. Where a shutoff valve or pressure/temperature plugs are integral to the automatic balancing valve, a separate valve or plug is not required.

3.5 EXPANSION TANKS

A. Install vertical expansion tanks on a concrete pad.
B. Vent and purge air from hydronic system, and ensure that tank is properly charged with air as scheduled. Recharge as necessary.
C. In the piping between the tank and the shutoff valve, install a pressure gauge and a drain valve. Remove handle or lock open shutoff valve after charging.

3.6 AIR SEPARATORS

A. Air separator shall be the same size as the piping which it is installed.
B. Install air separator at pump suction.
C. Install bottom blowdown piping with a shutoff valve.
D. Support air separator independent of piping with hangers supporting at adjacent piping.
E. Open the drain valve and blowdown the strainer after system cleaning and again after thirty (30) days of operation.

3.7 SUCTION DIFFUSERS

A. Install at each pump suction connection for end suction pumps.
B. Provide sufficient space for removal of the strainer.
C. Install a drain valve in the blowdown connection.
D. Install an adjustable foot support below the suction diffuser so the weight of the suction piping does not rest on the pump suction connection.
E. Install a pressure gauge across the pump suction, pump discharge, and suction diffuser. Provide gauge piping and gauge valves so that a single gauge can be used to read all the pressures.
F. Open the drain valve and blowdown the strainer after system cleaning and again after thirty (30) days of operation.
G. Remove the start-up strainers after the system has been flushed and cleaned.

3.8 COMBINATION VALVES

A. Install at the discharge of each pump.

3.9 STRAINERS

A. Install strainers on inlet side of each boiler, pressure reducing valve, and where indicated.
B. Allow sufficient space for screens to be removed. Rotate screen retainers so that blowdown can remove accumulated dirt from strainer body.
C. Install a nipple and shutoff valve for blowdown in the tapped screen retainer. Match the size of strainer blowdown connection.

3.10 WATER FILTERS

A. Install water filter in a bypass configuration around the system distribution pump(s).
B. Allow sufficient clearance at the top of the unit for filter removal and replacement.
C. Anchor filter support stand to housekeeping pad.

D. Install a pressure gauge with gauge valves piped so the pressure differential across the filter can be read.
E. Install filters after the piping system has been cleaned and flushed.
F. Provide an automatic balancing valve and shutoff valve upstream of the filter and a shutoff valve downstream of the filter.
G. Provide drain and vent piping connections.

END OF SECTION 23 21 16

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SECTION 23 21 23
HYDRONIC PUMPS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. End suction centrifugal pumps.

1.2 REFERENCE STANDARDS

A. UL 778 - Motor Operated Water Pumps
B. NFPA 70 - National Electric Code

1.3 SUBMITTALS

A. Product Data: For each type of pump.
   1. Include certified performance curves and rated capacities with net positive suction head requirements, operating characteristics, furnished specialties, final impeller dimensions, equipment dimensions, materials of construction, manufacturer's installation requirements, and accessories for each type of product.
   2. Indicate operating point on pump curve.
B. Shop Drawings: For each pump.
   1. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
   2. Include diagrams for power, signal, and control wiring.

1.4 OPERATION & MAINTENANCE SUBMITTALS

A. Operation & Maintenance Data: Include installation instructions, assembly views, lubrication instruction, and replacement parts list.
B. Alignment Certificate: Certify that base mounted pumps have been aligned.
C. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Mechanical Seals: One (1) mechanical seal(s) for each pump.

1.5 DELIVERY, STORAGE, & HANDLING

A. Store pumps in a dry location.
B. Retain protective covers for flanges during storage and installation.
C. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

PART 2 - PRODUCTS

2.1 END SUCTION CENTRIFUGAL PUMPS

A. Manufacturers:
   1. Armstrong.
   2. Bell & Gossett.
   3. Grundfos.
   4. Taco Comfort Solutions, Inc.
   5. Wilo.

B. Type: Separately coupled, end suction, designed for base mounting, with pump and motor shafts horizontal.
C. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gauge tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and flanged suction and discharge connections. Provide integral mount on volute to support the casing.
D. Impeller: Cast bronze or stainless steel. Statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw.
E. Pump Shaft: Alloy steel with replaceable copper, bronze, or stainless steel shaft sleeve.
F. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless steel spring, and a Buna-N bellows and gasket. Maximum continuous operating temperature of 225°F.
G. Pump Bearings: Grease lubricated ball bearings in cast iron housing with grease fittings.
H. Shaft Coupling: Molded rubber insert and interlocking spider capable of absorbing vibration. Couplings shall be EDPM drop-out type to allow disassembly and removal without removing pump shaft or motor.
I. Serviceability: True back pull-out capable of servicing without disturbing piping connections.
J. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.
K. Mounting Frame: Welded steel frame and cross members to mount pump casing, coupling guard, and motor.
L. Nameplate: Metal, permanently attached, with manufacturer's name, model number size, serial number, capacity in GPM, and head in feet at design conditions.
M. Wiring Terminations: Provide terminal lugs to match branch circuits conductor quantities, sizes, and materials indicated. Enclosed terminal lugs in terminal box sized to NFPA 70.
N. Rating: 225°F at 175 PSIG.
O. Pump Motors:
    1. Single speed and rigidly mounted to pump casing. Non-overloading at any point on the pump curve.
    2. Designed to operate at 1750 RPM unless noted otherwise.
    3. Secured to mounting frame, with adjustable alignment.
    4. Per Section 23 05 13.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment foundations and anchor bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
B. Examine rough-in for piping systems to verify actual locations of piping connections before pump installation.
C. Examine foundations for suitable conditions where pumps are to be installed.
D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 END SUCTION PUMP INSTALLATION

A. Comply with the Hydraulic Institute and manufacturer's instructions.
B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.
C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.
D. Equipment Mounting:
    1. Install base mounted pumps on cast-in-place concrete equipment bases.

2. Comply with requirements for vibration isolation devices.

E. Manufacturer shall not trim the pump impeller. Pump impeller size is provided as a reference for testing, adjusting, and balancing work. Manufacturer shall work with the Testing, Adjusting, and Balancing Contractor and the Temperature Control Contractor to current limit the variable frequency drive to meet the capacity requirements after system balancing is completed as directed by the Engineer at no additional cost.

F. Provide air vent and drain valve on horizontal pumps.

3.3 ALIGNMENT

A. Perform alignment service for flexible coupled pumps in accordance with the pump and coupling manufacturer's instructions.

B. Comply with requirements in Hydronics Institute standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.

C. Level and bolt down prior to grouting.

D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with non-shrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts. Provide grout when required by the manufacturer's instructions.

E. Check, align, and certify base mounted pumps prior to start-up.

3.4 CONNECTIONS

A. Install suction diffuser and line sized shutoff valve on suction side of pumps. Decrease from line size at pump connections with suction diffusers where specified.

B. Install a line sized combination valve.

C. Install flexible pipe connections on suction and discharge sides of base mounted pumps between pump casing and valves.

D. Install pressure gauges on pump suction, pump discharge, and suction diffuser. Install a single gauge with multiple input selector valve.

3.5 START-UP SERVICE

A. Perform the following start-up service.

1. Complete installation and start-up checks according to manufacturer's instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping.
4. Perform the following start-up checks for each pump before starting:
   a. Verify bearing lubrication.
   b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
   c. Verify that pump is rotating in the correct direction.
5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
6. Start motor.
7. Open discharge valve slowly.

B. Prepare start-up reports indicating that items listed have been completed.

END OF SECTION 23 21 23

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SECTION 23 25 00
WATER TREATMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Manual chemical feed equipment.
B. Chemicals.

1.2 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, and furnished specialties and accessories for the following products:
   1. Bypass pot feeders.
   2. Chemical material safety data sheets.

1.3 OPERATION & MAINTENANCE SUBMITTALS

A. Training: Provide training to instruct the Owner in the operation of the system.
B. Chemical Treatment Field Report: Indicate start-up of treatment systems when completed and operating properly. Indicate analysis of system water after cleaning and after treatment.
C. Contractor shall certify in writing to the Owner that the systems have been cleaned as specified prior to turning the system over to the Owner.
D. Water Treatment Program: Provide a written sequence of operation for the application equipment required to achieve the required water quality.

1.4 QUALITY ASSURANCE

A. HVAC Water Treatment Service Provider Qualifications: An experienced HVAC water treatment service provider capable of analyzing water quality, installing water treatment equipment, and applying water treatment as specified in this Section.

1.5 MAINTENANCE SERVICE

A. Furnish chemicals, service, and maintenance of treatment system equipment to maintain water quality for one (1) year from date of chemical system start-up.
B. Provide four (4) technical service visits, during this one (1) year period, 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 a copy of this field service report to the Owner after each visit.
C. Include a one (1) hour training course for operating personnel, instructing them on installation, care, maintenance, testing, and operation of water treatment systems. Arrange course to occur at time of start-up of systems.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. HOH.
C. Nalco.
D. Chem-Tech.
E. Watertech.

2.2 PERFORMANCE REQUIREMENTS

A. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or to the environment.
B. Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

2.3 MANUAL CHEMICAL FEED EQUIPMENT

A. Pot Feeder: Steel, with corrosion resistant exterior coating, minimum 3-1/2” fill opening in the top, and 3/4” bottom inlet and top side outlet. Quarter turn or threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel.
   1. Capacity: Five (5) gallons.
   2. Minimum Working Pressure: 125 PSIG.

2.4 CHEMICALS

A. Chemicals shall be as recommended by water treatment system manufacturer that are compatible with piping system components and connected equipment.
B. System Cleaner:
   1. Blend of organic alkaline penetrants, emulsifiers, surfactants, and corrosion inhibitors that remove grease and petroleum products from the interior of piping systems.
C. System Treatment:
   1. Closed Systems:
      a. Scale and corrosion inhibitor compatible with all metals found in the system.
      b. Sequestering agent to reduce deposits and adjust pH.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Pot Feeders:
   1. Install pot feeder in a bypass circuit around circulating pumps unless otherwise indicated on Drawings.
   2. Install dual station, test coupon rack in a bypass circuit around circulating pumps unless otherwise indicated on Drawings.
   3. Install a shutoff valve on the inlet, outlet, and drain connections.
   4. Install a swing check on the inlet after the shutoff valve.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Where installing piping adjacent to equipment, allow space for service and maintenance.
C. Make piping connections between HVAC water treatment equipment and dissimilar metal piping with dielectric fittings.

3.3 CLEANING SEQUENCE

A. Sequence: Systems are to be cleaned before they are used for any purpose except to conduct a pressure test before cleaning.
B. Concentration: As recommended by manufacturer.
C. Cleaning:
   1. Hot Water Systems:
      a. Fill system with cleaner and water.
      b. Apply heat while circulating, slowly raising temperature to 160°F and maintain for twelve (12) hours minimum.
      c. Remove heat and circulate until temperature drops to 100°F or less; drain systems as quickly as possible and refill with clean water.
      d. Circulate for six (6) hours at design temperatures, then drain.
      e. Refill with clean water and repeat until system cleaner is removed.
      f. If permanent heat producing equipment cannot be fired, fill with cleaner and water of concentration recommended for cold systems, circulate for forty-eight (48) hours, drain, refill with clean water, circulate for twenty-four (24) hours, drain, refill with clean water, and repeat until system cleaner is removed.
D. Remove, clean, and replace all strainer screens.
E. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.
F. If system is constructed in phases, Contractor shall provide all means to clean and flush sections of the system by isolating portions of the system. Provide temporary circulating pumps, piping, chemicals, and electrical power to flush portions of the system. Remove all temporary piping, pumps, equipment, and electrical power wiring after cleaning and flushing is completed.

END OF SECTION 23 25 00

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SECTION 23 31 00
DUCTWORK

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Sheet metal materials.
B. Ducts and fittings.
C. Sealants and gaskets.
D. Hangers and supports.

1.2 REFERENCE STANDARDS

A.	ASTM A 90 -	Weight of Coating on Zinc Coated (Galvanized) Iron or Steel Articles
B.	ASTM E 84 -	Test Method for Surface Burning Characteristic of Building Materials
C.	ASTM A 527 -	Steel Sheet, Zinc Coated (Galvanized) by Hot Dip Process, Lock Forming Quality
D.	ASTM A 623 -	General Requirements for Steel Sheet, Zinc Coated (Galvanized) by the Hot Dip Process
E.	NFPA 90A -	Installation of Air Conditioning and Ventilating Systems
F.	NFPA 90B -	Installation of Warm Air Heating & Air Conditioning Systems
G.	SMACNA -	HVAC Air Duct Leakage Test Manual
H.	SMACNA -	HVAC Duct Construction Standards - Metal and Flexible
I.	UL 181 -	Factory Made Air Ducts and Connectors
J.	SMACNA -	Rectangular Industrial Duct Construction Standards
K.	SMACNA -	Round Industrial Duct Construction Standards

1.3 SUBMITTALS

A. Product Data: For each type of the following products:
   1. Sealants and gaskets.
   2. Duct hanger and support systems.
B. Provide schedule of duct systems including:
   1. Materials of construction including gauge of metal.
   2. SMACNA pressure and seal class.
   3. Method of reinforcement.
   4. Joint and fitting construction.

1.4 OPERATION & MAINTENANCE SUBMITTALS

A. As-Built Drawings: Plans, double line, drawn to scale, on which the all ductwork, fittings, and accessories are shown. Plan shall have complete layout including sizes, elevations, equipment locations, equipment tags, and clearances shown.

1.5 DESIGN REQUIREMENTS

A. Comply with SMACNA's HVAC Duct Construction Standards - Metal and Flexible for acceptable materials, material thicknesses, duct construction, and installation methods unless otherwise indicated.
B. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

C. Construct all ductwork to be free from vibration, chatter, objectionable pulsations, and leakage under all operating conditions.
D. Ductwork sizes indicated on the Drawings are net inside dimensions; where duct liner is specified, dimensions are net, inside of liner. Double wall ductwork indicates clear dimension on the interior duct.
E. Use products with confirm to NFPA 90A, possessing a flame spread rating of not over twenty-five (25) and a smoke developed rating no higher than fifty (50).
F. Round ducts may be substituted for rectangular ducts if sized in accordance with ASHRAE tables of equivalent rectangular and round ducts.

1.6 DELIVERY, STORAGE, & HANDLING

A. Promptly inspect shipments to ensure the ductwork is undamaged and complies with the Specifications.
B. Product ductwork by storing inside or by durable, waterproof, above ground packaging. Do not store material on grade.
C. Protect ductwork from dirt, dust, construction debris, and foreign material. Where end caps/packaging are provided, take precautions so caps remain in place and free from damage.

PART 2 - PRODUCTS

2.1 DUCTWORK PRESSURE & SEAL CLASS

A. Construct ductwork for duct static pressure and seal class according to SMACNA's HVAC Duct Construction Standards - Metal and Flexible.
B. Ductwork shall be provided for the following pressure and seal class:

DESCRIPTION	PRESSURE CLASS	SEAL CLASS
Combustion Air for Sealed Combustion Boilers	- 1”	A

2.2 SHEET METAL MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A653, lock forming quality.
   1. Galvanized Coating Designation: G90, 1.25 ounces per square foot, both sides of sheet.

2.3 LOW PRESSURE DUCTWORK (2” PRESSURE CLASS & LOWER)

A. Rectangular: Slip and drive or flanged and bolted construction.
B. Round: Spiral lockseam.

2.4 SEALANT & GASKETS

A. Manufacturers:
   1. Hardcast.
   2. United McGill.
   3. Foster.
B. General: Sealant specifically for sealing joints and seams in ductwork as recommended by the manufacturer.
C. Flange Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.

2.5 HANGERS & SUPPORTS

A. Hanger Rods: Provide galvanized rods with threads painted with zinc chromate primer after installation.
B. Strap & Rod Sizes: Comply with SMACNA's HVAC Duct Construction Standards - Metal and Flexible, Rectangular Duct Hangers Minimum Size, and Minimum Hanger Sizes for Round Duct.
C. Steel Cable End Connections: Cadmium plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic locking and clamping device.
D. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
E. Trapeze & Riser Supports: Compatible with duct material.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air handling equipment sizing and for other design considerations. Install duct systems as close as indicated making adjustments and offsets based on coordination with all other trades.
B. Install ducts according to SMACNA's HVAC Duct Construction Standards - Metal and Flexible unless otherwise indicated.
C. Construct and install each duct system in accordance to the pressure and sealing classification indicated.
D. Install ducts in maximum practical lengths and with the fewest possible joints.
E. Install ducts vertically and horizontally, and parallel and perpendicular to building lines unless noted otherwise.
F. Ductwork shall not be used to support any other services such as conduit, junction boxes, fire protection piping, hangers for other systems, or to support the ceiling grid.
G. All joints shall be constructed so as to be airtight, smooth inside, and true to size as indicated.
H. Solder or seal all joints for outside air ductwork watertight. Install ducts to pitch toward outside air intakes and drain to outside of building
I. Install ducts as high as possible unless otherwise indicated
J. Install ducts with a clearance to allow normal operating and maintenance activities.
K. Provide adequate access to ductwork for cleaning purposes.
L. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
M. Where ducts pass through fire rated interior partitions, install firestopping in accordance with Section 23 05 00.
N. Protect temporary capping of ductwork openings with plastic wrap or some other approved form of protection and prevent entry of dirt, dust, and foreign material into the ductwork during construction. Comply with SMACNA's IAQ Guidelines for Occupied Buildings Under Construction, Appendix G, Duct Cleanliness for New Construction Guidelines.
O. Use the following fittings in the ductwork systems, unless noted otherwise:
    1. Elbows:
        a. Round: Use radius elbows with a radius to width ratio of 1.5. Radius to width of 1.0 may be used when 1.5 does not fit.

3.2 DUCTWORK SYSTEM SCHEDULE

A. Provide the following ductwork based on the system description:

SYSTEM DESCRIPTION	MATERIAL
Combustion Air	Galvanized Steel

3.3 SEALANTS & GASKETS

A. Install sealants and gaskets in strict accordance with the manufacturer's recommendations, paying special attention to temperature limitations.
B. Allow sealant to fully cure before applying insulation, pressure testing of ductwork, and before startup of air handling systems.

3.4 HANGER & SUPPORT INSTALLATION

A. Comply with SMACNA's HVAC Duct Construction Standards - Metal and Flexible, Chapter 5, Hangers and Supports.
B. Building Attachments: Concrete inserts, powder actuated fasteners, or structural steel fasteners appropriate for construction materials to which hangers are being attached.
C. Hanger Spacing: Comply with SMACNA's HVAC Duct Construction Standards - Metal and Flexible, Rectangular Duct Hangers Minimum Size, & Minimum Hanger Sizes for Round Duct, for maximum hanger spacing. Install hangers and supports within 24" of each elbow and within 48" of each branch intersection.
D. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets.

3.5 DUCT CLEANING

A. Remove all dirt and foreign matter from the entire duct system before operating fans.
B. Clean duct system(s) before testing, adjusting, and balancing.
C. Use service openings for entry and inspection.
   1. Create new openings and install access panels appropriate for duct static pressure class if required for cleaning access. Provide insulated panels for insulated duct. Patch insulation as recommended by duct liner manufacturer.
   2. Remove and reinstall ceiling to gain access during the cleaning process.

END OF SECTION 23 31 00

SECTION 23 51 00
BREECHINGS, CHIMNEYS, & VENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Double wall positive pressure vents.

1.2 REFERENCE STANDARDS

A.	NFPA 54 -	Natural Fuel Gas Code
B.	NFPA 211 -	Standard for Chimneys, Fireplaces, Vents, & Solid Fuel Burning Appliances
C.	UL 1738 -	Standard for Venting Systems for Category II, III, & IV Gas Burning Appliances

1.3 SUBMITTALS

A. Product Data:
   1. Include construction details, material descriptions, dimensions of individual components and profiles, connection requirements, and finishes for product.

B. Shop Drawings:
   1. Provide site specific venting system sizing calculations.
   2. Include plan and elevation views.
   3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   4. Detail fabrication and assembly of supports and hangers.

1.4 QUALITY ASSURANCE

A. All vent products shall be from the same manufacturer.
B. Factory built gas vents and chimneys shall be UL listed.

1.5 WARRANTY

A. Warranty: Manufacturer agrees to repair or replace components of venting system that fail in materials or workmanship for a period of fifteen (15) years.

PART 2 - PRODUCTS

2.1 DOUBLE WALL POSITIVE PRESSURE VENTS

A. Manufacturers:
   1. DuraVent.
   2. HeatFab.
   3. MetalFab.

B. Description: Vent shall be factory built, special gas type, double wall, engineered and designed for use on Category III and IV appliances, or as specified by the equipment manufacturer.

C. Inner Conduit: AL29-4C stainless steel with a minimum thickness of 0.015” for diameters 3” to 8”.

D. External Conduit: 430 stainless steel.

E. Insulation: 1” between the inner and external conduits.
F. Joints: Overlapping metal to metal connection with mechanical locking strap design. Provide gaskets and sealant per manufacturers requirements.
G. Maximum Temperature: 550°F continuous flue gas temperature for gas burning appliances.
H. Pressure Rating: +2” WG.
I. Provide all accessories for a complete installation including:
   1. Flashing and counterflashing.
   2. Cleanouts.
   3. Drains.
   4. Wall termination caps.
   5. Wall thimble.
   6. Supports and brackets.
   7. Expansion compensation when required per layout.
   8. Adapters as required by the boiler manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install all breechings and vents according to the manufacturer’s instructions.
B. Install with a minimum number of joints. Align connections and maintain a smooth internal surface.
C. Support breechings independent from their appliance connection, from the building structure with bolts, concrete inserts, steel expansion anchors, welded studs, C-clamps, or beam clamps.
D. Pitch all breechings as recommended by the manufacturer. Direct condensate back to the appliance.
E. Locate exhaust termination a minimum of 10’-0” away from operable windows or openings to the building.
F. Extended horizontal venting away from the roof soffit and fascia with sufficient clearance from the roof overhang.
G. All joints shall be leak tight. Lap joints in direction of flow.

3.3 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.
B. Clean breechings internally, during and after installation, to remove dust and debris. Clean external surfaces and apply touch-up finish to match factory finish.
C. Provide temporary closures at ends of breechings that are not completed or connected to equipment.

END OF SECTION 23 51 00

SECTION 23 52 16
CONDENSING BOILERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Hot water boilers.
B. Boiler management system.

1.2 REFERENCE STANDARDS

A.	AGA -	Directory of Certified Appliances and Accessories
B.	AGA Z21.13 -	Gas Fired Low Pressure Steam and Hot Water Boilers
C.	ASME -	Boiler and Pressure Vessel Codes - Rules for Construction of Heating Boilers, Power Boilers and Pressure Vessels
D.	ASME CSD-1 -	Control and Safety Devices for Automatically Fired Boilers
E.	ASHRAE 90.1 -	Energy Efficiency Standard
F.	BTS 2000 -	Method to Determine Efficiency of Commercial Space Heating Boilers
G.	NFPA 54 -	National Fuel Gas Code
H.	NFPA 70 -	National Electrical Code
I.	UL 726 -	Gas and Oil Equipment Directory

1.3 SUBMITTALS

A. Product Data:
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for boilers.
   2. Include rated capacities, operating characteristics, and furnished specialties and accessories.
   3. Provide efficiency curves based on varying input rates and water temperatures.
   4. Provide pressure drop curves based on the entire operating range.
B. Shop Drawings: For boilers, boiler trim, and accessories.
   1. Include plans, elevations, sections, and mounting details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include diagrams for power, signal, and control wiring.
C. Manufacturers Statement:
   1. It shall be the responsibility of the boiler manufacturer to provide all system calculations and vent sizing to provide a single point of responsibility for the entire boiler system. The manufacturer and/or representative shall supply a written statement that the entire system has been engineered and shall work as a complete system.
   2. The boiler manufacturer shall provide in writing that the boiler selected is sufficient for variable primary flow.

1.4 OPERATION & MAINTENANCE SUBMITTALS

A. Manufacturer's Field Reports: Letter of compliance from manufacturer's representative indicating condition of equipment and installation.
B. Operation & Maintenance Data: For boilers to include in the Operation and Maintenance manuals.

C. Test Report: Field test and inspection reports.

1.5 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.
   1. Warranty Period for Condensing Boilers:
      a. Leakage & Materials: Ten (10) years.
      b. Heat Exchanger Damaged by Thermal Stress & Corrosion: Ten (10) years.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, & Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.
C. ASHRAE/IES 90.1 Compliance: Boilers shall have minimum efficiency according to Gas and Oil Fired Boilers - Minimum Efficiency Requirements.
D. UL Compliance: Test boilers for compliance with UL 795. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.
E. CSA Compliance: Test boilers for compliance with CSA B51.
F. Factory Tested: Boilers shall be factory tested.

1.7 COORDINATION

A. Coordinate sizes and location of concrete bases. Cast anchor bolts into bases.

PART 2 - PRODUCTS

2.1 CONDENSING BOILERS

A. Manufacturers:
   1. Aerco.
   2. Or Approved Equal.
B. Description: Factory fabricated, assembled, and tested, fully condensing, single pass firetube boiler with the heat exchanger sealed pressure tight, built on a steel base, including insulated jacket; flue gas vent and combustion air intake connections suitable for sealed combustion; water supply, return, and condensate drain connections; and controls.
C. Heat Exchanger: Stainless steel, fully welded, single pass firetubes and tubesheets.
D. Combustion Chamber: Stainless steel, sealed.
E. Burner:
   1. Natural gas fired, fully modulating, forced draft drawing from gas pre-mixing valve.
   2. Metal fiber mesh covering a stainless steel body.
   3. Maximum NOx emissions under 20 ppm at 3% excess air.
F. Blower: Variable speed, centrifugal fan to operate during each burner firing sequence and to pre-purge and post-purge the combustion chamber.
   1. Motors: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified per Section 23 05 13.
G. Gas Train: Combination gas valve with manual shutoff, pressure regulator, and safety valves.
H. Ignition: Spark or pilot ignition with flame safety supervision and 100% main valve shutoff.
I. Turndown: 20:1.
J. Rating: ASME stamped for 150 PSIG working pressure.

K. Casing:
   1. Control Compartment Enclosures: NEMA 250, Type 1A.
   2. Finish: Baked enamel or stainless steel removeable panels for maintenance access.
   3. Insulation: Minimum 2” thick, mineral fiber insulation surrounding the heat exchanger.

2.2 TRIM

A. Safety Relief Valve: ASME rated with setting at 100 PSIG.
B. Pressure & Temperature Gauge: Minimum 3-1/2” diameter, combination water pressure and temperature gauge. Gauges shall have operating pressure and temperature ranges, so normal operating range is about 50% of full range.
C. Drain Valve: Combustion chamber drain valve with a built-in trap to allow condensate to drain from heat exchanger.
D. Condensate Neutralization Basin: One (1) limestone bed per boiler.
E. Oxygen Sensor: Installed in the boiler combustion chamber.
F. Boiler Isolation Valves: Per Section 23 09 14.

2.3 CONTROLS

A. Coordinate with Sections 23 09 14, 23 09 23, and 23 09 93.
B. 24VAC control circuit and components.
C. Operator Interface: Keypad with LCD display.
D. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.
   1. High Cutoff: Manual reset stops burner if operating conditions rise above maximum boiler design temperature or pressure.
   2. Low Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be manual reset type.
   3. Blocked Inlet Safety Switch: Manual reset pressure switch field mounted on boiler combustion air inlet.
   4. Flow Switch: For proving water flow prior to boiler operation.
   5. Alarms: Provide remote fault alarm contacts.
E. Boiler Management System (BMS):
   1. Provide a microprocessor based boiler management system (BMS) panel or integral boiler control capable of staging multiple boilers to maintain peak efficiency.
   2. Sequence boilers in parallel or sequential operation
   3. The BMS shall include a sensor to monitor main loop system temperature and a sensor to monitor outside air temperature.
   4. The BMS shall have the capability to stage boilers based on loop temperature and outdoor air reset for the highest operating efficiencies.
   5. The BMS shall be capable of starting and stopping the system based on a remote contact closure and change the setpoint from a remote location.
F. Building Automation System Interface:
   1. Factory install hardware and software to enable building automation system to monitor, control, and display boiler status and alarms.
   2. A communication interface with building automation system shall enable building automation system operator to remotely control and monitor the boiler from the building automation system. Control features available, and monitoring points displayed, locally at boiler control panel shall be available through building automation system.

2.4 ELECTRICAL POWER

A. Single Point Field Power Connection: Factory installed and wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single point field power connection to boiler.
   1. House in NEMA 250, Type 1 enclosure.
   2. Wiring shall be numbered and color coded to match wiring diagram.
   3. Install factory wiring outside of an enclosure in a raceway.
   4. Field power interface shall be to nonfused disconnect switch.
   5. Provide each motor with overcurrent protection.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine rough-in for concrete equipment bases, anchor bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting performance of the Work.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 BOILER INSTALLATION

A. Equipment Mounting:
   1. Install boilers on cast-in-place concrete equipment base(s).
   2. Comply with requirements for vibration isolation as specified per Section 230548.
B. Install gas fired boilers according to NFPA 54.
C. Assemble and install boiler trim.
D. Install electrical devices furnished with boiler but not specified to be factory mounted.
E. Install control wiring to field mounted electrical devices.
F. Install piping adjacent to boiler to allow service and maintenance.
G. Install piping from exhaust vent and condensate drain connection to a condensate neutralization basin. Piping shall be at least the same size as the connection.
H. Connect gas piping to boiler gas train inlet with union. Piping shall be at least full size of gas train connection. Provide a reducer if required.
I. Connect hot water piping to supply and return boiler tappings with shutoff valve and union or flange at each connection.
J. Install piping the from safety relief valves to the floor.
K. Boiler Venting: Per Section 23 51 00.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
B. Perform the following tests and inspections with the assistance of a factory authorized service representative:
   1. Perform installation and startup checks according to the manufacturer's instructions.
   2. Leak Test: Complete a hydrostatic test. Repair leaks and retest until no leaks exist.
   3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-to-fuel ratio and combustion.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
      a. Check and adjust initial operating set points and high and low limit safety set points of fuel supply, water level, and water temperature.

b. Set field adjustable switches and circuit breaker trip ranges.

C. The boiler manufacturer shall, in addition to initial start-up, provide parts, service and adjustment of the boiler for a period of one (1) year after final acceptance of boilers. A qualified representative of the manufacturer shall perform all service work. Copies of certified service agreement shall accompany the boiler shop drawings submitted for approval.

D. The boiler manufacturer shall and verify that the boiler burner unit is piped and controlled in accordance with the manufacturer's recommendations. The Mechanical Contractor shall provide modifications recommended by the manufacturer.

3.4 TRAINING

A. Provide two (2) hours of training from a factory authorized service representative to Owner's maintenance personnel to adjust, operate, and maintain boilers.

END OF SECTION 23 52 16

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SECTION 26 05 00
COMMON WORK RESULTS

PART 1 - GENERAL

The electrical work included in all other divisions is the responsibility of the contractor performing the Division 26 work unless noted otherwise.

PROJECT OVERVIEW

This project will demolish two existing air handling units and condensing units and gas furnaces and replace with new rooftop unit and hot water heating system. Demolish existing electrical branch circuits and re-feed new hot water powered mechanical equipment from existing and new electrical panel boards.

SCOPE

The work under this section includes basic electrical requirements, which are applicable to all Division 26 sections. 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:

PART 1 - GENERAL
- Project Overview
- Scope
- Related Work
- Reference Standards
- Regulatory Requirements
- Quality Assurance
- Continuity of Existing Services and Systems
- Protection of Finished Surfaces
- Approved Electrical Testing Laboratories
- Sleeves and Openings
- Sealing and Fire Stopping
- Work by User Agency
- Intent
- Submittals
- Project/Site Conditions
- Work Sequence and Scheduling
- Offsite Storage
- Salvage Materials
- Certificates and Inspections
- Operating and Maintenance Data
- Record Drawings

PART 2 - PRODUCTS
- Identification
- Sealing and Fire Stopping

PART 3 - EXECUTION
- Cutting and Patching
- Building Access
- Equipment Access
- Coordination
- Sealing and Fire Stopping
- Housekeeping and Clean Up

RELATED WORK

Applicable provisions of Division 01 govern work under this Section.

REFERENCE STANDARDS

Abbreviations of standards organizations referenced in this and other sections are as follows:

ANSI American National Standards Institute
ETL Electrical Testing Laboratories, Inc.
IEEE Institute of Electrical and Electronics Engineers

NEC National Electric Code
NEMA National Electrical Manufacturers Association
NESC National Electrical Safety Code
NFPA National Fire Protection Association
UL Underwriters Laboratories Inc.
DSPS Wisconsin Department of Safety and Professional Services

REGULATORY REQUIREMENTS
All work and materials are to conform in every detail to applicable rules and requirements of the Wisconsin State Electrical Code (SPS 316), the National Electrical Code (NFPA 70), other applicable National Fire Protection Association codes, the National Electrical Safety Code, and present manufacturing standards (including NEMA).

All Division 26 work shall be done under the direction of a currently licensed State of Wisconsin Master Electrician.

QUALITY ASSURANCE
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 the assigned space, and for obtaining the performance from the system into which these items are placed.

Manufacturer references used herein are intended to establish a level of quality and performance requirements unless more explicit restrictions are stated to apply.

All materials, except medium voltage equipment and components, shall be listed by and shall bear the label of an approved electrical testing laboratory. If none of the approved electrical testing laboratories has published standards for a particular item, then other national independent testing standards, if available, applicable shall apply and such items shall bear those labels. Where one of the approved electrical testing laboratories has an applicable system listing and label, the entire system, except for medium voltage equipment and components, shall be so labeled.

CONTINUITY OF EXISTING SERVICES AND SYSTEMS
No outages shall be permitted on existing systems except at the time and during the interval specified by the user agency. The institution may require written approval. Any outage must be scheduled when the interruption causes the least interference with normal institutional schedules and business routines. No extra costs will be paid to the Contractor for such outages which must occur outside of regular weekly working hours.

This Contractor shall restore any circuit interrupted as a result of this work to proper operation as soon as possible. Note that institutional operations are on a seven-day week schedule.

PROTECTION OF FINISHED SURFACES
Furnish one can of touch-up paint for each different color factory finish furnished by the Contractor. Deliver touch-up paint with other "loose and detachable parts" as covered in the General Requirements.

APPROVED ELECTRICAL TESTING LABORATORIES
The following laboratories are approved for providing electrical product safety testing and listing services as required in these specifications:

Underwriters Laboratories Inc.
Electrical Testing Laboratories, Inc..

SEALING AND FIRE STOPPING
Sealing and fire stopping of sleeves/openings between conduits, cable trays, wireways, troughs, cablebus, busduct, 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.

WORK BY USER AGENCY
PCB equipment (other than light fixture ballasts) removal and disposal, if required.

INTENT
The Contractor shall furnish and install all the necessary materials, apparatus, and devices to complete the electrical equipment and systems installation herein specified, except such parts as are specifically exempted herein.

If an item is either called for in the specifications or shown on the plans, it shall be considered sufficient for the inclusion of said item in this contract. If a conflict exists within the Specifications or exists within the Drawings, the Contractor shall furnish the item, system, or workmanship, which is the highest quality, largest.

It must be understood that the details and drawings are diagrammatic. The Contractor shall verify all dimensions at the site and be responsible for their accuracy.

All sizes as given are minimum except as noted.

Materials and labor shall be new (unless noted or stated otherwise), first class, and workmanlike, tests and approval from the commencement until the acceptance of the completed work.

Whenever a particular manufacturer's product is named, it is intended to establish a level of quality and performance requirements unless more explicit restrictions are stated to apply.

SUBMITTALS
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. Failure to do this may result in the submittal(s) being returned to the Contractor for correction and resubmission. Failing to follow these instructions does not relieve the Contractor from the requirement of meeting the project schedule.

Submittals shall be grouped to include complete submittals of related systems, products, and accessories in a single submittal. Mark dimensions and values in units to match those specified. Include wiring diagrams of electrically powered equipment.

The submittals must be approved before fabrication is authorized.

Submit sufficient quantities of submittals to allow the following distribution:

Operating and Maintenance Manuals	2 copies
User agency	1 copy
A/E	1 copy

PROJECT/SITE CONDITIONS
Install Work in locations shown on drawings, unless prevented by project conditions.

Prepare drawings showing proposed rearrangement of work to meet project conditions, including changes to work specified in other sections.

Tools, materials and equipment shall be confined to areas designated by the user agency.

WORK SEQUENCE AND SCHEDULING
Install work in phases to accommodate user agency's occupancy requirements.

OFFSITE STORAGE
Prior approval the A/E will be needed. In general, building wire, conduit, fittings and similar rough-in material will not be accepted for off-site storage. No material will be accepted for off-site storage unless shop drawings for the material have been approved.

SALVAGE MATERIALS
No materials removed from this project shall be reused. All materials removed shall become the property of and shall be disposed of by the Contractor.

CERTIFICATES AND INSPECTIONS
Obtain and pay for all required State installation inspections, in accordance with the Wisconsin Administrative Code.

This contractor is responsible for coordination of electrical inspection. Inspection requirements will be issued at a pre-installation meeting, arranged by this contractor.

OPERATION AND MAINTENANCE DATA
All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

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

1. Manufacturer's wiring diagrams for electrically powered equipment.

RECORD DRAWINGS
The Contractor shall maintain at least one copy each of the specifications and drawings on the job site at all times.

Dimensions and elevations on the record drawings shall locate all buried or concealed piping, conduit, or similar items.

The daily record of changes shall be the responsibility of Contractor's field superintendent. No arbitrary mark-ups will be permitted.

At completion of the project, the Contractor shall submit the marked-up record drawings to the Architect/Engineer prior to final payment.

PART 2 - PRODUCTS

IDENTIFICATION
See Electrical section 26 05 53 – Identification for Electrical Systems.

SEALING AND FIRE STOPPING
FIRE AND/OR SMOKE RATED PENETRATIONS:
Provide all fire stopping of fire rated penetrations and sealing of smoke rated penetrations.

NON-RATED PENETRATIONS:
Conduit and Cable Tray Penetrations:
At conduit and cable tray penetrations of non-rated interior partitions, floors and exterior walls above grade, use urethane caulk in annular space between conduit and sleeve, or the core drilled opening.

PART 3 - EXECUTION

CUTTING AND PATCHING
Refer to Division 01, General Requirements, Cutting and Patching.

BUILDING ACCESS
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.

EQUIPMENT ACCESS
Install all piping, conduit, ductwork, and accessories to permit access to equipment for maintenance.

COORDINATION
The Contractor shall cooperate with other trades in locating work in a proper manner. Should it be necessary to raise or lower or move longitudinally any part of the electrical work to better fit the general installation, such work shall be done at no extra cost, provided such decision is reached prior to actual installation. The Contractor shall check location of electrical outlets with respect to other installations before installing.

The Contractor shall verify that all devices are compatible for the surfaces on which they will be used. This includes, but is not limited to light fixtures, panelboards, devices, etc. and recessed or semi-recessed heating units installed in/on architectural surfaces.

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.

Cooperate with the testing consultant in ensuring specification Section 26 05 04 compliance. Verify system completion to the testing consultant. Demonstrate the starting, interlocking and control features of each system so the testing contractor can perform their work.

SLEEVES AND OPENINGS
Conduit penetrations in existing concrete floors: Core drill openings.

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

SEALING AND FIRE STOPPING
FIRE AND/OR SMOKE RATED PENETRATIONS:
Provide all fire stopping of fire rated penetrations and sealing of smoke rated penetrations.

NON-RATED PENETRATIONS:

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

PENETRATIONS SUBJECT TO WATER INTRUSION:
For penetrations (both rated and non-rated) in floors subject to water intrusion or in rooms housing electrical equipment (but not within walls) provide one of the following:

- Conduit penetration where steel pipe sleeve is used extend steel sleeve 2” above the floor.
- Conduit penetration where there is no steel sleeve or cast in place fire stopping device/sleeve, provide 2”x 2” x 1/8” galvanized steel angles fastened to floor surrounding the penetration or group of penetrations to prevent water from getting to penetration. Provide urethane caulk between angles and floor and fasten angles to floor minimum 8”on center. Seal corners water tight with urethane caulk.

Floors subject to water intrusion or rooms housing electrical equipment include the following locations:

- Mechanical/Plumbing Equipment Rooms
- Data/Telecommunications Rooms
- Electrical Equipment Rooms

HOUSEKEEPING & CLEAN UP
The Contractor shall clean up and remove from the premises, on a daily basis, all debris and rubbish resulting from its work and shall repair all damage to new and existing equipment resulting from its work. When job is complete, this Contractor shall remove all tools, excess material and equipment, etc., from the site.

END OF SECTION 26 05 00

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SECTION 26 05 02
DEMOLITION FOR REMODELING

PART 1 - GENERAL

SCOPE
The work under this section includes demolition and removal of existing circuit breakers, and motor branch circuits. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work

PART 2 - PRODUCTS
- Materials and Equipment

PART 3 - EXECUTION
- Examination
- Preparation
- Demolition and Extension of the Existing Electrical Work

RELATED WORK
Applicable provisions of Division 01 govern work under this Section.

PART 2 - PRODUCTS

MATERIALS AND EQUIPMENT
Materials and equipment for patching and extending work as specified in the individual Sections.

PART 3 - EXECUTION

EXAMINATION
Verify field measurements and circuiting arrangements as shown on Drawings.

Verify that abandoned wiring and equipment serve only abandoned facilities.

Demolition Drawings are based on casual field observation and/or existing record documents. Report discrepancies to the User Agency, Architect/Engineer and Field Representative before disturbing existing installation.

Beginning of demolition means installer accepts existing conditions.

PREPARATION
Disconnect electrical systems scheduled for removal.

Coordinate outages with the User Agency, Field Representative, and Architect/Engineer.

Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations and follow the safe working practice requirements of NFPA 70E.

DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK
Demolish and extend existing electrical work to meet all requirements of these specifications.

If certain raceways and boxes are abandoned but not scheduled for removal, those items must be shown on the "As Built Drawings".

Remove, relocate, and extend existing installations to accommodate new construction.

Remove abandoned wiring to source of supply.

Provide revised typed circuit directory in panelboards that have circuits removed.

Remove exposed abandoned conduit and abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.

Disconnect and remove abandoned panelboards and distribution equipment.

Repair adjacent construction and finishes damaged during demolition and extension work.

Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.

END OF SECTION 26 05 02

SECTION 26 05 04
CLEANING, INSPECTION, & TESTING

PART 1 - GENERAL

SCOPE
The work under this section includes the required cleaning, repair, adjustment, calibration, maintenance and testing of electrical equipment, as specified herein. This applies only to new electrical and existing electrical equipment being furnished, modified, worked on or serviced by this contractor for this project. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work

PART 2 - PRODUCTS
- Not Used

PART 3 - EXECUTION
- General Inspection and Cleaning of All Equipment
- Grounding Systems
- Panelboards
- Motor Starters and Motor Control Centers
- Cables

RELATED WORK
Applicable provisions of Division o1 govern work under this Section.

PART 2 - PRODUCTS
Not Used.

PART 3 - EXECUTION

GENERAL INSPECTION AND CLEANING OF ALL ELECTRICAL EQUIPMENT
Inspect for physical damage and abnormal mechanical and electrical conditions.

Any item found to be out of tolerance, or in any other way defective as a result of the required inspection or testing, shall be reported to the owner. Procedure for repair and/or replacement will be outlined. After appropriate corrective action is completed the item shall be re-tested.

Compare equipment nameplate information with the latest single line diagram and report any discrepancies.

Verify proper auxiliary device operation and indicators.

Check tightness of accessible bolted electrical joints. Use torque wrench method.

Make a close examination of equipment and remove any shipping brackets, insulation, packing, etc. that may not have been removed during original installation.

Make a close examination of equipment and remove any dirt or other forms of debris that may have collected in existing equipment or in new equipment during installation.

Clean All Equipment:
- Vacuum inside of panelboards, switchboards, switchgear, transformer core and coils, bus ducts, MCC's, etc.
- Loosen attached particles and vacuum them away.
- Wipe all insulators with a clean, dry, lint free rag.
- Clean insulator grooves.
- Re-vacuum inside surfaces as directed by the Inspector

Inspect equipment anchorage.

Inspect equipment and bus alignment.

Check all heater elements for operation and control.

Lubricate nonelectrical equipment per manufacturer's recommendations.

GROUNDING SYSTEMS
Inspect the ground system for adequate termination at all devices.

PANELBOARDS
Torque all the connections per the manufacturers spec. Verify phase wires, color coding, separate neutral and mechanical bonding. Verify circuit breaker operation. Verify the directory.

MOTOR STARTERS AND MOTOR CONTROL CENTERS
Verify the control circuits. Confirm the fusing and the grounding of the control transformers. Torque all of the connections. Confirm the overload elements and the circuit breakers (fuse) for proper sizing. Verify all grounding. Operate and test each motor starter for proper operation.

CABLES
600 Volt cable:
Visually inspect cables, lugs, connectors and all other components for physical damage and proper connections.

Check all cable connectors for tightness (with a torque wrench) and clearances. Torque test conductor terminations to manufacturer's recommendations.

Perform a 1000 Vdc megger test on all secondary cables from the substation transformers to the secondary switchboards and on all switchboard feeders.

END OF SECTION 26 05 04

SECTION 26 05 19
LOW-VOLTAGE POWER CONDUCTORS & CABLE

PART 1 - GENERAL

SCOPE
The work under this section includes furnishing and installing required wiring and cabling systems including pulling, terminating and splicing. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- References
- Submittals
- Project Conditions

PART 2 - PRODUCTS
- General
- Building Wire
- Aboveground Wire for Exterior Work
- Wiring Connectors

PART 3 - EXECUTION
- General Wiring Methods
- Wiring Installation in Raceways
- Wiring Connections and Terminations
- Field Quality Control
- Wire Color
- Branch Circuits

RELATED WORK
Applicable provisions of Division 01 govern work under this Section.

Section 26 05 33 – Raceway & Boxes.
Section 26 05 53 – Identification.

REFERENCES
Wisconsin Administrative Code SPS 316 - Electrical

SUBMITTALS
Submit product data: Provide for each cable assembly type.

Submit factory test reports: Indicate procedures and values obtained.

Submit manufacturer's installation instructions. Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements.

PROJECT CONDITIONS
Verify that field measurements are as shown on Drawings.

Conductor sizes are based on copper.

Wire and cable routing shown on Drawings is approximate unless dimensioned. Route wire and cable as required to meet project conditions.

Where wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required.

PART 2 - PRODUCTS

GENERAL
All wire shall be new, delivered to the site in unbroken cartons and shall be less than one year old out of manufacturer's stock.

All conductors shall be copper.

Insulation shall have a 600 volt rating.

All conductors shall be stranded.

> Stranded conductors may only be terminated with UL OR ETL Listed type terminations or methods: e.g. stranded conductors may not be wrapped around a terminal screw but must be terminated with a crimp type device or must be terminated in an approved back wired method.

BUILDING WIRE
Description: Single conductor insulated wire 90 degree C.

Insulation: Type THHN/THWN-2, XHHW-2 insulation.

ABOVE GROUND WIRE FOR EXTERIOR WORK
Description: Single conductor insulated wire, 90 degree C.

Insulation: Type THHN/THWN-2, XHHW-2 insulation.

WIRING CONNECTORS
Split Bolt Connectors: Not acceptable.

Solderless Pressure Connectors: High copper alloy terminal. May be used only for cable termination to equipment terminals. Not approved for splicing.

Twist Type Wire Connectors: Solderless twist type spring connector (wire-nut) with insulating cover for copper wire splices and taps. Use for conductor sizes 10 AWG and smaller. The manufacturer’s wire fill capacity must be followed.

> All wire connectors used in underground or exterior pull boxes or hand holes shall be gel filled twist connectors or a connector designed for damp and wet locations. Gel filled twist type connectors can be used for copper conductor sizes 6 AWG and smaller for site lighting applications. The manufacturer’s wire fill capacity must be followed.

Mechanical Connectors: Bolted type tin-plated; high conductivity copper alloy; spacer between conductors; beveled cable entrances.

Compression (crimp) Connectors: Long barrel; seamless, tin-plated electrolytic copper tubing; internally beveled barrel ends. Connector shall be clearly marked with the wire size and type and proper number and location of crimps. Connector must be installed with a crimper tool listed for use with the manufacturer and type of compression connector.

Insulation Piercing Connectors: Molded insulated body, copper teeth, wrench tightened, UL 486B Listed. May be used only for connection of a tap conductor in run and tap type applications when main conductor is 8 AWG and larger.

PART 3 - EXECUTION

GENERAL WIRING METHODS
All wire and cable shall be installed in conduit.

Do not use wire smaller than 12 AWG for power and lighting circuits.

All phase, neutral and ground conductors shall be sized to prevent excessive voltage drop at rated circuit ampacity. As a minimum use 10 AWG conductors for 20 ampere, 120 volt branch circuit home runs

longer than 100 feet (30 m), and for 20 ampere, 277 volt branch circuit home runs longer than 200 feet (61 m).

Make conductor lengths for parallel conductors equal.

Splice only in junction or outlet boxes.

Identify ALL low voltage wire, 600V and lower, per Section 26 05 53.

Neatly train and lace wiring inside boxes, equipment, and panelboards.

WIRING INSTALLATION IN RACEWAYS
Pull all conductors into a raceway at the same time. Use Listed water or silicone based wire pulling lubricant for pulling 4 AWG and larger wires and for other conditions when necessary. Wax based lubricants are not allowed. Pulling lubricant is not required for low friction type products where the cable manufacturer recommends that cables be pulled without lube.

Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.

Completely and thoroughly swab raceway system before installing conductors.

Place all conductors of a given circuit (this includes phase wires, neutral (if any), and ground conductor) in the same raceway. If parallel phase and/or neutral wires are used, then place an equal number of phase and neutral conductors in same raceway or cable.

VFD Installations: Install VFD input wiring and output wiring in separate conduit systems. Do not mix VFD input power and output power, or control wiring in a common raceway.

In high ambient spaces, mechanical rooms, utility rooms and exterior exposed conduit, 90 degree C conductors shall be utilized.

WIRING CONNECTIONS AND TERMINATIONS
Splice only in accessible junction boxes.

Wire splices and taps shall be made firm, and adequate to carry the full current rating of the respective wire without soldering and without perceptible temperature rise.

All splices shall be so made that they have an electrical resistance not in excess of two feet (600 mm) of the conductor.

Use solderless twist type spring connectors (wire nuts) with insulating covers for wire splices and taps, 10 AWG and smaller.

Use mechanical or compression connectors for wire splices and taps, 8 AWG and larger. Tape uninsulated conductors and connectors with electrical tape to 150 percent of the insulation value of the wiring.

Thoroughly clean wires before installing lugs and connectors.

At all splices and terminations, leave tails long enough to cut splice out and completely re-splice.

FIELD QUALITY CONTROL
Field inspection and testing will be performed under provisions of Section 26 05 04.

Additional testing as follows shall be performed if aluminum conductors are used:

Feeders terminated with aluminum conductors shall be tested with a thermal imager and recorded.

Conductors shall be closely checked for loose or poor connections, and for signs of overheating or corrosion.

Test procedures shall meet NETA guidelines.

Test results and report shall be provided to the engineer and included in O&M manual under AL conductors/ tests.

Contractor shall correct all deficiencies reported in the test report.

WIRE COLOR

General:

Solid colored insulation is required for all THHN/THWN-2 wire. For other wire types use colored wire or identify wire with colored tape at all terminals, splices and boxes. Wire shall be colored as indicated below.

In existing facilities, use existing color scheme.

In new facilities, use black and red for single phase circuits at 120/240 volts, use Phase A black, Phase B red and Phase C blue for circuits at 120/208 volts single or three phase, and use Phase A brown, Phase B orange and Phase C yellow for circuits at 277/480 volts single or three phase. Note: This includes fixture whips except for Listed whips mounted by the fixture manufacturer on the fixture and Listed as a System.

Switch legs shall be the same color as their associated circuit, except for the second switch leg used for dual-level switching. The second switch leg shall be the next phase color, e.g. if the first switch leg is brown (277/480V phase A), the second switch leg shall be orange (277/480V phase B).

Traveler conductors run between 3 and 4 way switches shall be colored pink or purple.

Neutral Conductors: White for 120/208V and 120/240V systems, Gray for 277/480V systems. Where there are two or more neutrals in one conduit, each shall be individually identified with a different stripe.

Branch Circuit Conductors: Three or four wire home runs shall have each phase uniquely color coded.

Feeder Circuit Conductors: Each phase shall be uniquely color coded.

Ground Conductors: Green colored insulation for THHN/THWN-2 wire. For other wire types use green colored wire or identify wire with green tape at both ends and at all access points, such as panelboards, motor starters, disconnects and junction boxes. When isolated grounds are required, contractor shall provide green with yellow tracer.

BRANCH CIRCUITS

The use of single-phase, multi-wire branch circuits with a common neutral is not permitted. All single-phase branch circuits shall be furnished and installed with an individual accompanying neutral, sized the same as the phase conductors.

END OF SECTION 26 05 19

SECTION 26 05 26
GROUNDING & BONDING

PART 1 - GENERAL

SCOPE
The work under this section includes grounding electrodes and conductors, equipment grounding conductors, and bonding. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- References
- Submittals
- Regulatory Requirements

PART 2 - PRODUCTS
- Mechanical Connectors
- Compression Connectors
- Conductors
- Bus/Busbar

PART 3 - EXECUTION
- Examination
- General
- Less Than 600 Volt System Grounding
- Field Quality Control
- Identification and Labeling

All hardware, cables and related termination and support hardware shall be furnished, installed, wired, tested, labeled, and documented by the Contractor, as detailed in this and related sections.

RELATED WORK
Applicable provisions of Division 01 govern work under this Section.

REFERENCES
Wisconsin Administrative Code SPS 316 - Electrical
ANSI/IEEE 142 (Latest edition) - Recommended Practice for Grounding of Industrial and Commercial Power Systems
UL 467 Electrical Grounding and Bonding Equipment

PERFORMANCE REQUIREMENTS
Grounding System Resistance:
- Equipment Rated 500 KVA and Less: 10 ohms maximum at building service entrance.
- Equipment Rated 500 to 1000 KVA: 5 ohms maximum at building service entrance.
- Equipment Rated more than 1000 KVA: 3 ohms building service entrance.

Testing of grounding system resistance is to be witnessed by the Field Representative. Provide test report of grounding system resistance in final O&M manuals.

SUBMITTALS
Product Data: Provide data for grounding connections.

Test Reports: Indicate overall resistance to ground.

Manufacturer's Instructions: Include instructions for preparation, installation and examination of exothermic connectors.

REGULATORY REQUIREMENTS
Conform to requirements of NFPA 70.

Furnish products listed and classified by Underwriters Laboratories, Inc. or testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.

PART 2 - PRODUCTS

MECHANICAL CONNECTORS
The mechanical connector bodies shall be manufactured from high strength, high conductivity cast copper alloy material. Bolts, nuts, washers and lock washers shall be made of Silicon Bronze and supplied as a part of the connector body and shall be of the two bolt type.

Split bolt connector types are NOT allowed. Exception: the use of split bolts is acceptable for grounding of wire-basket type cable tray, and for cable shields/straps of medium voltage cable.

The connectors shall meet or exceed UL 467 and be clearly marked with the catalog number, conductor size and manufacturer.

COMPRESSION CONNECTORS
The compression connectors shall be manufactured from pure wrought copper. The conductivity of this material shall be no less than 99% by IACS standards.

Each connector shall be factory filled with an oxide-inhibiting compound.

The connectors shall meet or exceed the performance requirements of IEEE 837, latest revision.

The connectors shall be clearly marked with the manufacturer, catalog number, conductor size and the required compression tool settings.

The installation of the connectors shall be made with a compression tool and die system, as recommended by the manufacturer of the connectors, and shall be irreversible.

CONDUCTORS
Material: Stranded copper (aluminum not permitted).

Grounding Electrode Conductor: Size as shown on drawings, specifications or as required by NFPA 70, whichever is larger.

Main Switchgear room and Vault Bonding: No. 4/0 minimum.

Feeder and Branch Circuit Equipment Ground: Size as shown on drawings, specifications or as required by NFPA 70, whichever is larger. Differentiate between the normal ground and the isolated ground when both are used at the same facility.

Branch Circuit Equipment Grounds shall be increased in size when routed with phase conductors increased in size due to voltage drop calculations.

BUS/BUSBAR
Material: Copper (aluminum not permitted).

Size:

All Power systems: 1/4" X 2", length as needed (24” minimum).

Busbars:

Be pre-drilled to accommodate two-hole lugs.
3/8” stud hole size; hole spacing per ANSI J-STD-607-A.
Incorporate insulators and stand-off brackets that electrically isolate busbar from mounting surface.

PART 3 - EXECUTION

EXAMINATION

GENERAL
Install Products in accordance with manufacturer's instructions.

Mechanical connections shall be accessible for inspection and checking. No insulation shall be installed over mechanical ground connections.

Ground connection surfaces shall be cleaned and all connections shall be made so that it is impossible to move them.

Attach grounds permanently before permanent building service is energized.

Terminate each grounding conductor on its own terminal lug. Sharing a single lug by multiple conductors is not allowed.

All grounding electrode conductors and individual grounding conductors shall be installed in PVC conduit, in exposed locations.

LESS THAN 600 VOLT ELECTRICAL SYSTEM GROUNDING

Equipment Grounding Conductor: Provide separate, insulated equipment grounding conductor within each raceway. Terminate each end on suitable lug, bus, enclosure or bushing. Provide a ground wire from each device to the respective enclosure.

Bond together system neutrals, service equipment enclosures, exposed non-current carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, receptacle ground connectors, and plumbing systems.

FIELD QUALITY CONTROL
Inspect grounding and bonding system conductors and connections for tightness and proper installation.

IDENTIFICATION & LABELING
Label Grounds at point of termination.

END OF SECTION 26 05 26

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SECTION 26 05 29
HANGERS & SUPPORTS

PART 1 - GENERAL

SCOPE
The work under this sections includes conduit and equipment supports, straps, clamps, steel channel, etc., and fastening hardware for supporting electrical work. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- Submittals
- Quality Assurance

PART 2 - PRODUCTS
- Material

PART 3 - EXECUTION
- Installation

RELATED WORK
Applicable provisions of Division 01 govern work under this Section.

Section 26 05 53 – Identification

SUBMITTALS
Product Data: Provide data for support channel.

QUALITY ASSURANCE
Support systems shall be adequate for weight of equipment and conduit, including wiring, which they carry.

PART 2 - PRODUCTS

MATERIAL
Support Channel: Steel, Galvanized, Enameled or other corrosion resistant.

Hardware: Corrosion resistant.

Minimum sized threaded rod for supports shall be 3/8” for trapezes and single conduits 1-1/4” and larger, and ¼” for single conduits 1” and smaller.

Conduit clamps, straps, supports, etc., shall be steel or malleable iron. One-hole straps shall be heavy duty type. All straps shall have steel or malleable backing plates when rigid steel conduit is installed on the interior or exterior surface of any exterior building wall.

Nylon anchors: Nylon anchors may only be used in limited applications with the pre-approval of the owner. See Part 3 – Execution for examples of applications of where nylon anchors may be allowed.

> Nylon wall plugs shall be designed for 2-way expansion, providing rapid fixing with high pull-out values. Nylon wall plugs shall be molded with protruding side fins which restrict rotation and prevent fall out from overhead holes. Examples of these include Mungo types MN or MU, or Fischer type S nylon plugs.
>
> Nylon one-piece self-drilling anchors designed for use in hollow gypsum wallboard for light duty loads. Anchors shall be engineered nylon or Zamac alloy. Examples of these are the Zip-It ® or Zip-It Jr. self-drilling anchors.

Manufacturer's names and catalog numbers are used for quality and performance only. Anchors manufactured by others shall be equally acceptable provided they meet or exceed in performance and quality as specified.

PART 3 - EXECUTION

INSTALLATION

Fasten hanger rods, conduit clamps, outlet, junction and pull boxes to building structure using pre-cast insert system, preset inserts, beam clamps, expansion anchors, or spring steel clips (interior metal stud walls only).

Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls; expansion anchors or preset inserts in solid masonry walls; self-drilling anchors or expansion anchors on concrete surfaces; sheet metal screws in sheet metal studs and wood screws in wood construction. If nail-in anchors are used, they must be removable type anchors.

Nylon anchor applications:

Nylon anchors may only be used in limited light duty applications with the pre-approval of owner.

Nylon anchors shall be designed for the construction material in which they are intended to be installed, and shall be designed for the weight in which the anchors are intended to support.

Nylon wall plug applications may include attaching 4” square boxes or conduit straps to plaster-covered clay tile, drywall, or hollow concrete block. Screws used with nylon wall plugs shall be #10 minimum and shall be longer than the anchor.

Nylon one-piece self-drilling anchor applications may include attaching 4” square boxes or conduit straps to hollow gypsum wallboard for light duty loads. Use No. 8 screws with one-piece self-drilling anchors designed for 3/8” to 1” thick wallboard. Use No. 6 screws with anchors designed for 3/8” to 5/8” wallboard.

Powder-actuated fasteners are not permitted. Compressed-air power-actuated fasteners may ONLY be used for the installation of separate ceiling wires required for support of conduits and aircraft cable hung light fixtures.

File and de-bur cut ends of support channel and spray paint with cold galvanized paint to prevent rusting.

Do not fasten supports to piping, ductwork, mechanical equipment, cable tray or conduit. Do not fasten to suspended ceiling grid system.

Support wires that are installed in addition to the ceiling grid support wires to provide secure support for raceways, cables assemblies, boxes, cabinets, and fittings shall be secured at both ends (e.g. the ceiling structure at the top and the ceiling grid at the bottom) per NEC 300.11(A).

Support wires shall be identified per specification Section 26 05 53.

Do not drill structural steel members unless approved by owner.

Fabricate supports from galvanized structural steel or steel channel, rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under all nuts.

In wet locations, mechanical rooms, and electrical rooms, install free-standing electrical equipment on 3.5-inch (89 mm) concrete pads.

Install surface-mounted cabinets and panelboards with a minimum of four anchors. At all cabinet and panelboard locations on concrete or concrete block walls, and at ALL locations below grade, provide steel channel supports to stand cabinet one inch (25 mm) off wall (7/8” Uni-strut or 3/4” painted fire-retardant

plywood is acceptable). In above-grade equipment rooms that have drywall walls, the cabinets and panelboards may be mounted to the drywall if backing is provided in the stud walls behind the equipment.

Bridge studs top and bottom with channels to support flush-mounted cabinets and panelboards in stud walls.

Furnish and install all supports as required to fasten all electrical components required for the project, including free standing supports required for those items remotely mounted from the building structure, catwalks, walkways etc.

END OF SECTION 26 05 29

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SECTION 26 05 33
RACEWAY & BOXES

PART 1 - GENERAL

SCOPE
This section describes the products and execution requirements relating to furnishing and installing raceways and boxes and related systems as part of a raceway system for electrical, communications, and other low-voltage systems for the project. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- References
- Submittals

PART 2 - PRODUCTS
- General
- Rigid Metal Conduit (RMC) and Fittings
- Electrical Metallic Tubing (EMT) and Fittings
- Flexible Metal Conduit (FMC) and Fittings
- Liquidtight Flexible Metal Conduit (LFMC) and Fittings
- Conduit Supports
- Conduit Water Sealant
- Pull and Junction Boxes

PART 3 - EXECUTION
- Conduit Sizing, Arrangement, and Support
- Conduit Installation
- Conduit Installation Schedule
- Coordination of Box Locations
- Pull and Junction Box Installation

RELATED WORK
Applicable provisions of Division 01 govern work under this section.

Section 26 05 26 – Grounding & Bonding
Section 26 05 29 – Hangers & Supports

REFERENCES
Wisconsin Administrative Code SPS 316 - Electrical

SUBMITTALS
Boxes - provide product data showing configurations, finishes, dimensions, and manufacturer's instructions.

PART 2 - PRODUCTS

GENERAL
All steel fittings and conduit bodies shall be galvanized.

No cast metal or split-gland type fittings permitted.

Mogul-type condulets larger than 2 inch (50 mm) not permitted except as approved or detailed.

All condulet covers must be fastened to the condulet body with screws and be of the same manufacture.

C-condulets shall not be used in lieu of pull boxes.

All boxes shall be of sufficient size to provide free space for all conductors enclosed in the box and shall comply with NEC requirements.

RIGID METAL CONDUIT (RMC) AND FITTINGS
Conduit: Heavy wall threaded, galvanized steel, schedule 40.
Fittings and Conduit Bodies: Use all steel threaded fittings and conduit bodies.

Expansion Fittings/Expansion Joints: Expansion Fittings shall be Internal Grounding type and shall not rely on external bonding jumpers to maintain grounding continuity between raceway components.

ELECTRICAL METALLIC TUBING (EMT) AND FITTINGS
Conduit: Steel, Unthreaded thin wall galvanized tubing.

Fittings: All steel, compression or set screw type. No push-on or indenter types permitted.
Conduit Bodies: All steel conduit bodies.

FLEXIBLE METAL CONDUIT (FMC) AND FITTINGS
Conduit: steel, galvanized, spiral strip.

Fittings and Conduit Bodies: All steel, galvanized or malleable iron (except as allowed in specification 26 51 13).

LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC) AND FITTINGS
Conduit: flexible, steel, galvanized, spiral strip with an outer Liquidtight, nonmetallic, sunlight-resistant jacket.

Fittings and Conduit Bodies: ANSI/NEMA FB 1, compression type. There shall be a metallic cover/insert on the end of the conduit inside the connector housing to seal the cut conduit end.

CONDUIT SUPPORTS
See section 26 05 29.

CONDUIT WATER SEALANT
Description: Conduit sealant used to prevent water from entering buildings via conduits.

Sealant shall seal conduits against water and gas intrusion, such as Polywater® FST™-250 Foam Duct Sealant, Raychem RDSS Rayflate Duct Sealing System, or approved alternate. Sealant shall be re-enterable, shall be compatible with the conduit and conductor types being used, and shall comply with NEC 225.27, 230.8, and 300.5(G).

Manufacturer names and catalog numbers are used to develop quality and performance requirements only. Products manufactured by others may be acceptable provided they meet or exceed the specifications.

PULL AND JUNCTION BOXES
Interior Sheet Metal Boxes: code gauge galvanized steel, screw covers, flanged and spot welded joints and corners.

Interior Sheet Metal Boxes larger than 12 inches (300 mm) in any dimension shall have a hinged cover or a chain installed between box and cover.

Exterior Boxes and Wet Location Installations: Type 4 and Type 6, flat-flanged, surface-mounted junction box, UL listed as rain-tight. Galvanized cast iron box and cover with ground flange, neoprene gasket, and stainless steel cover screws.

Box extensions and adjacent boxes within 48 inches of each other are not allowed for the purpose of creating more wire capacity.

Junction boxes 6 inch-by-6 inch or larger size shall be without stamped knock-outs.

Wireways shall not be used in lieu of junction boxes.

PART 3 - EXECUTION

CONDUIT SIZING, ARRANGEMENT, AND SUPPORT

Size power conductor raceways for conductor type installed. Conduit size shall be 1/2 inch (16 mm) minimum except **all homerun conduits shall be 3/4 inch (21 mm),** or as specified elsewhere. **Caution: Per the NEC, the allowable conductor ampacity is reduced when more than three current-carrying conductors are installed in a raceway. Contractor must take the NEC ampacity adjustment factors into account when sizing the raceway and wiring system.**

Arrange conduit to maintain 6'-8" clear headroom and present a neat appearance.

Route exposed conduit and conduit above accessible ceilings parallel and perpendicular to walls and adjacent piping.

Maintain minimum 6 inch (150 mm) clearance between conduit and piping. Maintain 12 inch (300 mm) clearance between conduit and heat sources such as flues, steam pipes, and heating appliances.

Arrange conduit supports to prevent distortion of alignment by wire pulling operations. Fasten conduit using galvanized pipe straps, conduit racks (lay-in adjustable hangers), clevis hangers, or bolted split stamped galvanized hangers.

Group conduit in parallel runs where practical and use conduit rack (lay-in adjustable hangers) constructed of steel channel with conduit straps or clamps. Provide space for 25 percent additional conduit.

Do not fasten conduit with wire or perforated pipe straps. Before conductors are pulled, remove all wire used for temporary conduit support during construction.

Support and fasten metal conduit at a maximum of 8 feet (2.4 m) on center.

Supports shall be independent of the installations of other trades, e.g. ceiling support wires, HVAC pipes, other conduits, etc., unless so approved or detailed.

Conceal all conduits except where noted on the drawings or approved by the Architect/Engineer. Contractor shall verify with Architect/Engineer all surface conduit installations except in mechanical rooms.

Changes in direction shall be made with symmetrical bends, cast steel boxes, stamped metal boxes or cast steel conduit bodies.

For indoor conduits, no continuous conduit run shall exceed 100 feet (30 meters) without a junction box.

All conduits installed in exposed areas shall be installed with a box offset before entering box.

CONDUIT INSTALLATION

Cut conduit square; de-burr cut ends.

Conduit shall not be fastened to the corrugated metal roof deck.

Bring conduit to the shoulder of fittings and couplings and fasten securely.

Use conduit hubs for fastening conduit to cast boxes. Use sealing locknuts or conduit hubs for fastening conduit to sheet metal boxes in damp or wet locations.

Terminate all conduit (except for terminations into conduit bodies) using conduit hubs, or connectors with one locknut, or utilize double locknuts (one each side of box wall).

Provide bushings for the ends of all conduit not terminated in box walls. Refer to Section 26 05 26 – Grounding & Bonding for grounding bushing requirements.

Provide insulated bushings where raceways contain 4 AWG or larger conductors.

Install no more than the equivalent of:

Three 90 degree bends between boxes for electrical systems.
No single bend may exceed 90 degrees.

Use hydraulic one-shot conduit bender or factory elbows for bends in conduit larger than 2 inch (50 mm) size unless sweep elbows are required.

Bend conduit according to manufacturer's recommendations. Use suitable conduit caps or other approved seals to protect installed conduit against entrance of dirt and moisture.

Provide 1/8 inch (3 mm) nylon pull string in empty conduit, except sleeves and nipples.

Install expansion-deflection joints where conduit crosses building expansion joints. Note: expansion-deflection joints are not required where conduit crosses building control joints if the control joint does not act as an expansion joint.

Avoid moisture traps where possible. Where moisture traps are unavoidable, provide junction boxes with drain fittings at conduit low points.

Where conduit passes between areas of differing temperatures such as into or out of cool rooms, freezers, unheated and heated spaces, buildings, etc., provide condulet or box with duct seal or other means to prevent the passage of moisture and water vapor through the conduit.

Route conduit through roof openings for piping and ductwork where possible.

Use NRTL listed metallic grounding clamps when terminating conduit to cable tray.

Ground and bond conduit under provisions of Section 26 05 26.

CONDUIT INSTALLATION SCHEDULE
Conduit other than that specified below for specific applications shall not be used.

- Exposed Outdoor Locations: Rigid Metal conduit.
- Wet Interior Locations: Exposed: Rigid metal conduit.
- Concealed Dry Interior Locations: Rigid metal conduit, Electrical metallic tubing.
- Exposed Dry Interior Locations: Rigid metal conduit, Electrical metallic tubing.
- Motor and equipment connections: Liquidtight flexible metal conduit (LFMC) in all locations except in Mechanical equipment plenum spaces where Flexible Metal Conduit (FMC) shall be utilized. Minimum length shall be one foot (300 mm); maximum length shall be three feet (900 mm). Conduit must be installed perpendicular to direction of equipment vibration to allow conduit to freely flex.
- Exposed Dry Interior Locations for HVAC control devices with Conduit Connections: Electrical metallic tubing, Flexible Metal Conduit (FMC). For FMC installations, Minimum length shall be one foot (300 mm), Maximum length shall be three feet (900 mm). Minimum size FMC of 3/8".
- Exposed Dry Interior Locations for HVAC control devices without Conduit Connections: Where HVAC equipment control panels or devices do not provide for the direct connection of conduits, exposed Class 2 wiring may be extended to complete the final connections in dry locations, provided it does not exceed 18 inches in length.
- Plenum Spaces: Installation shall comply with requirements of NEC 300.22.

COORDINATION OF BOX LOCATIONS
Provide electrical boxes as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections, and code compliance.

Electrical box locations shown on Contract Drawings are approximate unless dimensioned. Verify location of floor boxes and outlets in offices and work areas prior to rough-in.

No junction, or pull boxes shall be located where it will be obstructed by other equipment, piping, lockers, benches, counters, etc.

Conduit and boxes shall not be fastened to the metal roof deck. If conduit and boxes are required to be located and installed on roof decks, the conduit and boxes are required to be spaced minimum 1-5/8 inch off the lowest part of the metal roof decking material, per NEC 300.4 (E).

It shall be the Contractor's responsibility to study drawings pertaining to other trades, to discuss location of outlets with workmen installing other piping and equipment and to fit all electrical outlets to job conditions.

In case of any question or argument over the location of an outlet, the Contractor shall refer the matter to the Architect/Engineer and install outlet as instructed by the Architect/Engineer.

The proper location of each outlet is considered a part of this contract and no additional compensation will be paid to the Contractor for moving outlets which were improperly located.

Locate and install boxes to allow access to them. Where installation is inaccessible, coordinate locations and provide 18 inch (450 mm) by 24 inch (600 mm) access doors. Boxes must be installed within 12” from edge of the access door.

Locate and install to maintain headroom and to present a neat appearance.

Install boxes to preserve fire resistance rating of partitions and other elements, using approved materials and methods.

PULL & JUNCTION BOX INSTALLATION
Pull boxes and junction boxes shall be minimum 4 inches square (100 mm) by 2 1/8 inches (54 mm) deep for use with 1 inch (25 mm) conduit and smaller. On conduit systems using 1 1/4 inch (31.75 mm) conduit, minimum junction box size shall be 4 11/16 inches square by 2 1/8 inches deep.

Where used with raceway(s) containing conductors of 4 AWG or larger, pull box shall be sized as required unless otherwise noted on the drawings.

Where used with raceway(s) containing conductors on systems over 600V, pull box shall be sized per NEC 314 Part IV unless otherwise noted as larger on the drawings.

Locate pull boxes and junction boxes above accessible ceilings, in unfinished areas or furnish and install approved access panels in non-accessible ceilings where boxes are installed. All boxes are to be readily-accessible.

Support pull and junction boxes independent of conduit.

END OF SECTION 26 05 33

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SECTION 26 05 53
IDENTIFICATION

PART 1 - GENERAL

SCOPE
The work under this section includes the products and execution requirements relating to labeling of power, control, and signal wiring. Further, this section includes the installation of labels, nameplates, and directories for electrical junction boxes, wiring devices, and electrical equipment. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- Submittals

PART 2 - PRODUCTS
- Materials

PART 3 - EXECUTION
- General
- Junction and Pullbox Identification
- Power, Control and Signal Wire Identification
- Wiring Device Identification
- Nameplate Engraving For Electrical Equipment
- Panelboard Directories

RELATED WORK
Applicable provisions of Division 01 shall govern work under this section.

Section 26 05 19 – Low-Voltage Electrical Power Conductors & Cables

SUBMITTALS
Include schedule for nameplates.

Prior to installation, the Contractor shall provide samples of all label types planned for the project. These samples shall include examples of the lettering to be used. Samples shall be mounted on 8 1/2” x 11” sheets annotated, explaining their purposed use.

PART 2 - PRODUCTS

MATERIALS
Labels: All labels shall be permanent, and machine generated. NO HANDWRITTEN OR NON-PERMANENT LABELS ARE ALLOWED.

All wiring labels shall be white/transparent vinyl or vinyl-cloth, self-laminating, wraparound type. Flag type labels are not allowed. The labels shall be of adequate size to accommodate the circumference of the cable being labeled and properly self-laminate over the full extent of the printed area of the label.

Tape (wiring phase identification only): Scotch #35 tape in appropriate colors for system voltage and phase.

Nameplates: Engraved three-layer laminated plastic. Normal system shall use nameplates with black letters on white background, emergency system (NEC 700) shall use white letters on red background, legally required standby system (NEC 701) shall use white letters on blue background, and optional standby system (NEC 702) shall use white letters on yellow background.

Adhesive type labels not permitted except for identification of wires, wiring devices (device plates), 8” square and smaller junction boxes, and control devices.

See Junction and Pullbox Identification and Wiring Device Identification sections for allowed usage of permanent marker.

PART 3 - EXECUTION

GENERAL
Where mixed voltages are used in one building (e.g. 4160 volt, 480 volt, 208 volt) each switch, switchboard, junction box, equipment, etc., on each system shall be labeled for voltage in addition to other requirements listed herein.

All branch circuit and power panels shall be identified with the same symbol used in circuit directory in main distribution center.

Clean all surfaces before attaching labels with the label manufacturer's recommended cleaning agent. Install all labels firmly as recommended by the label manufacturer. Labels shall be installed plumb and neatly on all equipment.

Install nameplates parallel to equipment lines. Secure nameplates to equipment fronts using screws, rivets or manufacturer approved adhesive or cement.

Embossed tape will not be permitted for any application.

JUNCTION AND PULLBOX IDENTIFICATION
The following junction and pullboxes shall be identified utilizing spray painted covers:

System	Color(s)
Secondary Power – 480Y/277V	Brown
Secondary Power – 208Y/120V, 240/120V	White
Emergency System – Life Safety Branch (NEC 700) – 480Y/277V	Brown/Red
Emergency System – Life Safety Branch (NEC 700) – 208Y/120V	White/Red
Legally Required Standby System (NEC 701) – 480Y/277V	Brown/Blue
Legally Required Standby System (NEC 701) – 208Y/120V	White/Blue
Optional Standby System (NEC 702) – 480Y/277V	Brown/Yellow
Optional Standby System (NEC 702) – 208Y/120V	White/Yellow
Temperature Control	Green

Additional required junction and pullbox identification shall include:

Provide circuit numbers and source panel designations for power wiring junction boxes. Other system junction boxes shall be identified as shown on details or approved shop drawings.

Where exposed, junction boxes larger than 8" square shall utilize engraved nameplates with ½" minimum letter height. Identify system source(s) and load(s) served.

Where exposed, 8" square and smaller junction boxes shall utilize machine generated, adhesive labels.

Where located above an accessible ceiling, junction boxes may be neatly identified using a permanent marker.

POWER, CONTROL AND SIGNAL WIRE IDENTIFICATION
Provide wire labels on each conductor in panelboard gutters, pull boxes, outlet and junction boxes, and at load connection. Identify with branch circuit or feeder number for power and lighting circuits, and with wire number as indicated on schematic and interconnection diagrams or equipment manufacturer's shop drawings for control and signal wiring.

All wiring shall be labeled within 2 to 4 inches of terminations. Each end of a wire or cable shall be labeled as soon as it is terminated including wiring used for temporary purposes.

NAMEPLATE ENGRAVING FOR ELECTRICAL EQUIPMENT
Provide nameplates of minimum letter height as scheduled below.

Distribution Panelboards, Branch Panelboards, Switchboards and Motor Control Centers: 1 inch (25 mm); identify equipment designation. 1/2 inch (13 mm); identify voltage rating, source and room location of the source. Panelboards serving NEC 700, 701 or 702 loads shall identify which branch they serve.

Circuit Breakers, Switches, and Motor Starters in Distribution Panelboards, Switchboards and Motor Control Centers: 1/2 inch (13 mm); identify circuit and load served, including location.

Individual Circuit Breakers, Disconnect Switches, Enclosed Switches, and Motor Starters: ½ inch (13 mm); identify source and load served.

Transformers: 1 inch (25 mm); identify equipment designation. 1/2 inch (13 mm); identify primary and secondary voltages, primary source and location, and secondary load and location.

PANELBOARD DIRECTORIES
Typed directories for panels must be covered with clear plastic, and have a metal frame. Room number on directories shall be Owner's numbers, not Plan numbers unless Owner so specifies.

END OF SECTION 26 05 53

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SECTION 26 24 16
PANELBOARDS

PART 1 - GENERAL

SCOPE
The work under this section includes main, distribution and branch circuit panelboards. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- References
- Submittals
- Operation and Maintenance Data
- Spare Parts

PART 2 - PRODUCTS
- Power Distribution Panelboards
- Branch Circuit Panelboards
- Coordination Branch Panelboards
- Coordination of Overcurrent Protective Devices

PART 3 - EXECUTION
- Installation
- Field Quality Control

REFERENCES
ANSI C57.13 – Instrument Transformers
NEMA AB 1 - Molded Case Circuit Breakers
NEMA KS 1 - Enclosed Switches
UL-891 - Dead Front Switchboards

SUBMITTALS
Include outline and support point dimensions, voltage, main bus ampacity, circuit breaker arrangement and sizes, and interrupting ratings confirming a fully-rated system for all equipment and components.

OPERATION AND MAINTENANCE DATA
All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

SPARE PARTS
Keys: Furnish 2 keys for each panelboard to Owner.

Handle lock-off: Furnish (2) 20/1P circuit breaker handle lock-off devices for each panelboard to Owner.

One set of three spare fuses of each size and type utilized.

PART 2 - PRODUCTS

POWER DISTRIBUTION PANELBOARDS
Panelboards: Circuit breaker or fusible switch type.

The panelboard and overcurrent devices contained within shall be **fully-rated.**

Enclosure: NEMA Type 1.Minimum cabinet size: 6.5 inches (165 mm) deep; 26 inches (660 mm) wide. Constructed of galvanized code gauge steel.

Power distribution panelboards installed in electrical rooms and mechanical rooms shall utilize a standard dead front cover. In all other areas provide cabinet front with hinged door, flush lock and hinged trim (door-in-door) to allow access to wiring gutters without removal of panel front. Hinged trim shall be held in place with screw fasteners. Finish in manufacturer's standard gray enamel.
Provide metal directory holders with clear plastic covers. Holder to be factory mounted.

Provide panelboards with copper bus (phase buses, bus fingers, etc.), ratings as scheduled on Drawings. Provide ground bars in all panelboards. Neutral and ground bars can be dual rated ALCU9. All spaces shall have bus fully extended and drilled for the future installation of breakers.

Minimum System (i.e. individual component) Short Circuit Rating: As shown on the Drawings and as required by short circuit/coordination study.

Main breakers shall be individually mounted. Back feed mains shall NOT be utilized.

The circuit breakers are to be totally front accessible and mounted in the panelboard to permit installation, maintenance and testing without reaching over line side bussing. The circuit breakers are to be removable by the disconnection of only the load side terminations and line and load side connections are to be individual to each circuit breaker. Common mounting brackets or electrical bus connectors are not acceptable.

Circuit breakers shall be provided with provisions for mounting handle padlock attachments.

Breaker feeder lugs shall be dual rated for use with either aluminum or copper conductors.

Each circuit breaker is to be furnished with an externally operable mechanical means to trip the circuit breaker, enabling maintenance personnel to verify the ability of the circuit breaker trip mechanism to operate, as well as exercise the circuit breaker operating mechanisms.

A minimum of 20% future circuit breaker spaces shall be included. Spaces for future circuit breakers shall be “prepared” spaces. These spaces shall be provided with the necessary mounting hardware and bus extensions so that when future breakers are added, only the breaker itself needs to be purchased by the installer.

Circuit breakers serving single motor loads shall be magnetic only, instantaneous trip. Overload protection shall be shall be part of the motor combination controller.

Circuit breakers in 480V power distribution panelboards shall be fully adjustable LSI circuit breakers with electronic trip for frame sizes 400A and greater.

Circuit Breakers:

Electronic Trip Circuit Breakers: As scheduled on the drawings, electronic circuit breakers shall have, at a minimum, adjustments for long time, short time and instantaneous trip. Provide integral ground fault sensing with adjustable ground fault trip where indicated on the drawings.

Molded Case Circuit Breakers: As scheduled on the drawings, integral thermal and instantaneous magnetic trip elements in each pole.

Fusible Distribution Switches:

Fusible switches shall be quick make, quick break and shall be group mounted in panel type construction. Switches of 30 amperes to 200 amperes shall have plug-on line side connections. Each switch is to be contained in a separate steel enclosure. The enclosure shall employ a hinged cover for access to the fuses which shall be interlocked with the operating handle to prevent opening the cover when the switch is in the "ON" position.

This interlock shall be constructed so that it can be released with a standard electrician's tool for testing fuses without interrupting service. Units shall have padlocking provisions in "OFF" position and operating handle position shall give positive switch position indication, i.e. red for "ON" and black for "OFF". Switches shall pass industry standard I^2t with-stand tests and fuse tests.

A minimum of 20% future fusible switch spaces shall be included. Spaces for future fusible switches shall be “prepared” spaces. These spaces shall be provided with the necessary mounting hardware and bus extensions so that when future fusible switches are added, only the fusible switch itself needs to be purchased by the installer.

BRANCH CIRCUIT PANELBOARDS
Lighting and Appliance Branch Circuit Panelboards: Circuit breaker type.

The panelboard and overcurrent devices contained within shall be **fully-rated.**

Enclosure: Type 1.Minimum cabinet size: 5-3/4 inches (144 mm) deep; 20 inches (508 mm) wide with 5" minimum gutter space top and bottom. Constructed of galvanized code gauge steel. Panel enclosure (back box) shall be of non-stamped type (without KO's) to avoid concentric break out problem.

Provide surface cabinet front with concealed trim clamps, concealed hinge and flush cylinder lock all keyed alike. Front cover shall be hinged to allow access to wiring gutters without removal of panel trim. Hinged trim shall be held in place with screw fasteners. Finish in manufacturer's standard gray enamel.

Provide metal directory holders with clear plastic covers. Holder to be factory mounted.

Provide panelboards with copper bus (phase buses, bus fingers, etc.), ratings as scheduled on Drawings. Provide ground bars in all panelboards. Phase, neutral and ground bar terminations can be dual rated ALCU9. All spaces shall have bus fully extended and drilled for the future installation of breakers.

Incoming conductors shall terminate at lug landing pads rated for the panelboard.

Provide compression type lugs to accommodate the conductor shown on drawings.

Minimum System (i.e. individual component) Short Circuit Rating: As shown on the Drawings and as required by short circuit/ coordination study.

Molded Case Circuit Breakers: Bolt-on type thermal magnetic trip circuit breakers. Provide UL Class A ground fault interrupter circuit breakers where shown on Drawings. Provide circuit breakers UL listed as Type HACR for air conditioning equipment branch circuits.

Do not use tandem circuit breakers.

Circuit breakers shall be bolt-on type with common trip handle for all poles. No handle ties of any sort will be approved.

Provide a minimum of 10% spare circuit breakers in branch panelboards.

All of the panelboards provided under this section shall be by the same manufacturer.

All panelboards installed side by side (double tub) shall utilize same enclosure height.

Double tub panelboard installations shall identify type of feed to adjacent panelboard- sub-feed or feed-thru. Identification shall be integral with panel label.

PART 3 - EXECUTION

INSTALLATION
See Section 26 05 29 for support requirements.

Install panelboards plumb with wall finishes.

Height:

Power Distribution panelboards: Minimum 12” above finished floor and maximum of 6’-7” to center of the grip of the operating handle of the top most mounted switch or circuit breaker, when at its highest position.

Branch panelboards: 6’-0” to top of panelboard.

Install a crimp type stud termination to stranded conductor when terminating on circuit breakers without a captive assembly rated for terminating stranded conductors.

Provide filler plates for unused spaces in panelboards.

See section 26 05 53 for identification requirements. Provide typed circuit directory for each panelboard per NEC 408.4(A). Revise directory to reflect circuiting changes required to balance phase loads.

Stub three (3) empty 3/4" conduits to accessible location above ceiling or below floor out of each recessed panelboard. Cap these conduits to prevent material from entering them.

FIELD QUALITY CONTROL
If aluminum conductors size #1/0 and larger (per Section 26 05 19) are to be used as panelboard feeders, it is the responsibility of the contractor to provide panelboards with adequate wire bending space to accommodate the aluminum conductors and terminators to meet allowable code requirements. The Contractor shall circuit the panelboards as shown on the drawings. Measure steady state load currents at each panelboard feeder. Should the difference at any panelboard between phases exceed 10 percent, rearrange circuits in the panelboard to balance the phase loads within 10 percent.

Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections.

END OF SECTION 26 24 16

SECTION 26 27 28
DISCONNECT SWITCHES

PART 1 - GENERAL

SCOPE
The work under this section includes disconnect switches, fuses and enclosures. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- References
- Submittals
- Operation and Maintenance Data
- General

PART 2 - PRODUCTS
- Disconnect Switches
- Fuses

PART 3 - EXECUTION
- Installation

RELATED WORK
Applicable provisions of Division 01 govern work under this Section.

REFERENCES
NECA (National Electrical Contractors Association) "Standard of Installation."
NEMA ICS 2 – Industrial Control Devices, Controllers, and Assemblies.
NEMA KS 1 – Enclosed Switches.
UL 50 – Enclosures for Electrical Equipment.
UL 98 – Enclosed and Dead-front Switches.
NFPA 70 – National Electrical Code
Wisconsin Administrative Code SPS 316 - Electrical

SUBMITTALS
Include outline drawings with dimensions, and equipment ratings for voltage, ampacity, horsepower, and short circuit.

OPERATION AND MAINTENANCE DATA
All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

GENERAL
Provide disconnect switches for loads required by code. It is the Electrical Contractors responsibility to determine the need for a disconnect switch for each load. The contractors shall include in their bid the code required disconnect switches whether indicated on the drawings or not.

PART 2 - PRODUCTS

DISCONNECT SWITCHES
Fusible Switch Assemblies (use only when overcurrent protection is required): NEMA Type Heavy Duty; quick-make, quick-break, load interrupter, enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position. Fuse Clips: designed to accommodate Class R, Class J or Class CC (motors) cartridge type fuses.

Nonfusible Switch Assemblies: NEMA Type Heavy Duty; quick-make, quick-break, load interrupter, enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position.

Enclosure:
- Indoor: NEMA 1 code gauge steel with rust inhibiting primer and baked enamel finish

Outdoors: NEMA 3R code gauge zinc coated steel with baked enamel finish or NEMA 4 when indicated on drawings.

Provide manufacturer's equipment ground kit in all disconnect switches.

In applications where the switch serves as the service entrance disconnect, provide service ground kit, label as service disconnect and provide UL listing for service disconnect.

FUSES
Fuses 600 Amperes and Less: Dual element, time delay, 600volt, UL Class RK 1. Interrupting Rating: 200,000 rms amperes.

Fuses 601 Amperes and Larger: Low Peak, time delay, 600 volt, UL Class L. Interrupting Rating: 200,000 rms amperes.

Fuses 30 Amperes and less: Time-Delay, 600 volt, UL Class CC. Interrupting rating: 200,000 rms amperes.

Provide three (3) spares of each size and type fuse.

PART 3 - EXECUTION

INSTALLATION
Install disconnect switches where indicated on Drawings or required by NEC.

Provide identification as specified in Section 26 05 53.

Provide label on inside of disconnect cover identifying the type and size of fuse to be utilized.

END OF SECTION 26 27 28

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