SECTION 00 01 05

CERTIFICATIONS PAGE

KFI Engineers
Mechanical Engineer

I hereby certify that this plan, specification or report was prepared by me or under my direct supervision, and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Zachary C. Thompson 08/18/2022 57835

Zachary C. Thompson, P.E. Date License No.

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INSTRUCTIONS TO BIDDERS

INVITATION

1.01 INTRODUCTION

A. Goodhue County is seeking bids for the demolition and removal of the existing boilers and water heaters at the Law Enforcement Center and replacement with new systems.

1.02 GENERAL

A. Each bid must represent the entire cost to perform the services described and meet the requirements outlined in the specifications. The entire cost must include all fees, permits, taxes, and any other costs associated with demolition, removal, and replacement of the Goodhue County Law Enforcement Center boiler and water heater systems.

1.03 MANDATORY PRE-BID MEETING AND FACILITY WALK THROUGH

A. A mandatory pre-bid meeting and walk through will be on September 14, 2022 at 9:00 a.m. in the Lower Level Conference Room at the Goodhue County Government Center. 509 West 5th Street, Red Wing, MN 55066. All interested bidders must have representatives at this meeting to be able to bid on this project. Prospective bidders are strongly encouraged to review this document and the specifications prior to the meeting.

1.04 INVITATION FOR BIDS

A. In accordance with the Request for Bids, sealed bids will be received until 11:00 a.m. on September 28th, 2022, at the Goodhue County Government Center. 509 West 5th Street, Red Wing, MN 55066.

1.05 SUBMISSION OF BIDS

A. Bidders must submit one complete hard copy of their bid.
   1. The envelope containing the bids shall be addressed as specified in these instructions. All bids shall be submitted on the Bid Forms included as part of these Bid Documents and Specifications. E-mailed, telegraphic, and faxed bids will not be accepted.

1.06 BIDDING PROCEDURES AND CONTRACT REQUIREMENTS

A. Format of BID
   1. Bidders must respond to this Request for Bids on the form contained in this document titled "REPLACEMENT OF THE GOODHUE COUNTY LAW ENFORCEMENT CENTER BOILER AND WATER HEATER SYSTEMS".

B. BID Requirements
   1. Bids are to be securely sealed, labeled “Bids for Law Enforcement Center Boiler Replacement” and delivered to Goodhue County Administration at the Goodhue

County Government Center, 509 West 5th Street, Red Wing, MN 55066, no later than 11:00 a.m. on September 28, 2022, at which time they will be opened and publicly read.

2. Each bid must be accompanied by a bid bond, certified check, or cashier check, payable to the County of Goodhue in an amount equal to at least five (5) percent of the total net bid.

C. Consideration of Bids
   1. The County reserves the right to accept or reject any or all bids or any part of any bid, to waive minor defects or technicalities, or to advertise for new bids, as it may deem best for its interest.
   2. In case of difference between written words and figures in a bid, the amount stated in written words shall govern.
   3. In case of unit price difference from an extended figure, the unit price shall govern.
   4. Alterations or erasures must be crossed out and the corrections thereof printed in ink or typewritten adjacent thereto. The corrections must be initialed in ink by each person signing the bid.
   5. Changes to the bid may be cause for rejection of said bid.
   6. All bids must comply with and not deviate from the provisions of the specifications and/or other bid or contract documents, if any.
   7. If any questions or interpretations, discrepancies, omissions or conflicts occur during the examination of contract documents, the bidder shall submit a request for interpretation not less than seven (7) working days prior to the due date for bids. Any interpretation or changes of the documents will be made only by addendum. The County will not be responsible for any oral instructions or interpretations.
   8. Revisions or interpretations made by the County shall be by addendum issued before the date set for bid opening.

D. Time for Receiving Bids
   1. Bids received before the time of opening will be securely kept unopened. The officer whose duty it is to open them will decide when the specified time has arrived and no bid received thereafter will be considered. Bids received after the time set for opening will be returned to the bidder unopened. No responsibility will be attached to an officer for the premature opening of a bid not properly addressed and identified.
   2. Bidders are cautioned that telegraphic and faxed modifications of bids are prohibited.

E. Withdrawal/MODIFICATION of Bids
   1. Delivered bids may be withdrawn by written request dispatched by the bidder and received in the normal course of business prior to the time fixed for opening.
   2. Delivered bids may be modified by written request dispatched by the bidder in time for delivery in the normal course of business prior to the time fixed for opening provided it is received prior to the time set for bid opening.
   3. Any written request for withdrawal or modification must be signed in the same manner by the same person who signed the bid.

4. All bids once opened shall be held firm until the award has been made. No bid may be withdrawn for a period of ninety (90) days from the official opening thereof.

F. Bid Guarantee
   1. The bid must be accompanied by a Bid Guarantee which will not be less than five (5) percent of the amount of the bid and at the option of the bidder, may be a certified check, cashier's check, or a bid bond secured by a corporation authorized to contract as a surety in the State of Minnesota. A Bid Guarantee in the form of a Bid Bond, Certified Check, or Cashier's Check shall be made payable to the order of the County of Goodhue. Cash deposits and personal checks will not be accepted. The Bid Guarantee shall insure the execution of the Contract. No bid will be considered unless it is so guaranteed. Revised bids, whether forwarded by mail or telegram, if representing an increase of the original bid, must have the bid guarantee adjusted accordingly, and in the case of a revision by telegram the envelope containing the adjusted bid deposit must be postmarked prior to the time set for the opening of bids; otherwise the revision of the bid will not be considered and the original bid shall remain in force.

G. Joint Bids/Prime CONTRACTOR
   1. Joint bids submitted by more than one bidder must designate one bidder as the prime contractor. All other bidders will be considered subcontractors to the prime contractor. The County will consider the prime contractor to be the sole point of contact with regard to contract matters, placing of calls for service and tendering payments. The prime contractor is totally responsible for adherence by the subcontractors to all provisions of the document.

H. Incorporation into Contract
   1. The County reserves the right to incorporate this Request for Bids, the Specifications, and the Bidder's response (or portions of either) into subsequent contract by reference or otherwise.

I. Legal Rights of Material
   1. The successful Bidder(s) hereby guarantee that they will have full legal right of material delivered under this agreement, and agree(s) to pay all rents and royalties of every description on any and all patents or patent rights covering said material, or covering any process or machinery used in its construction and agree(s) to indemnify and save the County entirely harmless from any and all claims, demands, damages, actions, or causes of action, arising, or to arise against said County by reason of the construction or delivery of said material or the use of any process, machinery or material in the construction of same.

J. Indemnification
   1. The Bidder shall defend, indemnify and save the County, its officers, affiliates and employees from any and all claims, suits, losses, damages, or expenses on account of injuries or death of any or all persons or property damages sustained and caused by an act, omission, neglect, or misconduct of said Bidder.

K. Contract and Term
   1. The contract shall be executed in two copies.

2. Term of the contract shall be from the effective date to the completion of all work associated with the demolition, removal, and replacement of the Goodhoue County Law Enforcement Center boiler and water heater systems, unless sooner terminated as hereinafter provided.

1.07 BID AND AWARD

A. In awarding the contract, the County will select the responsible, qualified Contractor whose compliance with the specifications, experience, and costs will provide the greatest efficiency to the County. Selection will be weighted based on compliance with the technical requirements and costs.

1.08 CANCELLATION AND TERMINATION

A. The County reserves the right in its sole discretion to terminate this contract immediately without cause at any time within the term of this Contract. In the event of such termination, the County shall provide Contractor written notice of termination and upon receipt of same, Contractor shall immediately cease and desist Contractor's provision of services under this Contract and County shall have no further obligation under this Contract to pay any further compensation to Contractor except for compensation due and owing for services prior to Contractor's receipt of the written notice of termination.

1.09 RESPONSIBLE CONTRACTOR

A. Any prime contractor or subcontractor that does not meet the minimum criteria established for a "responsible contractor" as defined in Minn. Stat. § 16C.285, subd. 3, or fails to verify that it meets those criteria is not a responsible contractor and is not eligible to be awarded a construction contract for the Project or to perform work on the Project.
   1. Responding contractors shall submit to the County a signed statement under oath by an owner or officer verifying compliance with each of the minimum criteria in Minn. Stat. § 16C.285, subd. 3, at the time that it responds to this solicitation document.
   2. A prime contractor shall submit to the City, upon request, copies of the signed verifications of compliance from all subcontractors.
   3. A false statement under oath verifying compliance with any of the minimum criteria shall make the prime contractor or subcontractor that makes the false statement ineligible to be awarded a construction project and may result in termination of a contract awarded to a prime contractor or subcontractor that submits a false statement.

1.10 PROTEST PROCEDURES

A. GENERAL
   1. In the interest of the public and in the interest of fairness and equity to all Bidders, County acknowledges its responsibility to promptly and fairly investigate all procurement protests to avoid undue delays in the procurement process.
      a. To ensure the interests of the public and the Bidders are best served, all protests pertaining to competitively bid projects and services are required to:
         1) be filed in a timely manner;

2) be carefully and completely documented; and
3) conform to the requirements of this section.

2. APPLICABILITY
   a. This procedure is applicable to all protests arising from County procurements $50,000 and over, except for violation of Federal Law or Regulation.
   b. Violation of Federal Law or Regulation will be handled by the complaint process as stated in that Law or Regulation.
3. DEFINITIONS
   a. Award Phase Protest: a protest received after the bid opening or proposal due date.
   b. Offeror: the Bidder or proposer responding to a solicitation request, or other parties who may have an interest in the potential outcome of a protest or a procurement decision.
   c. Protest: an offeror's remedy for correcting a perceived wrong in the procurement process.
   d. Protest Authority: the County employee assigned to review the individual protest decision.
   e. Solicitation Phase Protest: a protest received prior to the bid opening or the proposal due date.
   f. Working Days: office business days for County staff.
4. PRELIMINARY STEPS
   a. The offeror is encouraged to resolve the questions or disputes informally before pursuing a written protest.
   b. For informal resolution of questions or disputes arising during the solicitation phase, contact the Goodhue County Facilities Maintenance Director at 651-385-3208.
   c. For informal resolution of questions of disputes arising during the award phase, contact Goodhue County Administration at 651-385-3001.
5. COUNTY'S RIGHTS
   a. County reserves the right to continue with the procurement based on County business needs.
6. BASIS FOR FILING A PROTEST
   a. Solicitation Phase Protest: if a bid or proposal documents are believed to be incorrect or inappropriate.
   b. Award Phase Protest: if the procurement was believed to be awarded inappropriately, unfairly, or in violation of prevailing laws or regulations.
7. INITIAL STEPS
   a. Verbally advise the County by contacting County's Finance Director during the appropriate phase of the bid or proposal process.
8. PROTEST CONTENTS
   a. Protests must be in writing.
   b. Protests must include and specify:
      1) The protester's name, protester's company name, address, phone number, FAX number, and e-mail address (if available).
      2) The project name, project number, and contract number or other solicitation identifier.
      3) Complete and accurate identification of the grounds for the protest, including references to the portion of the documents under protest, to all

laws and regulations or other legal authority the protester claims were violated.

4) All evidence known to support allegations of protest including, but not limited to, names of individuals involved; a description of relevant occurrences; the documents upon which the protester relied; the particular language in the documents alleged to be defective or illegal; and a description of the bidder's material, component, or product adversely affected by allegedly defective or illegal language.
5) Complete identification of the relief the protester is seeking.

9. PROTEST FILING DEADLINES
   a. Solicitation Phase Protests: must be filed no later than 3 working days prior to the scheduled bid opening or the solicitation due date.
   b. Award Phase Protests: must be filed within 5 working days of County Board action for those items which, by policy, require County Board action.
   c. All written protests must be delivered to:

      GOODHUE COUNTY
      Attn: County Administration
      509 West 5th Street
      Red Wing, MN 55066

B. PROTEST REVIEW
   1. The Finance Director will:
      a. Notify the appropriate Department Director and the County's Attorney.
         1) If the protest is a Solicitation Phase Protest, determine if the scheduled bid opening date/proposal due date should be extended to allow for resolution of the protest.
         2) Notify funding authorities as required by rule or regulation.
         3) Distribute the protest filing, as appropriate, and initiate immediate review.
         4) Advise other offerors who may be impacted by the protest.
         5) Ensure that the protest is reviewed promptly, but no later than 10 working days after the receipt of the written protest.
         6) Distribute the written decision rendered by the Protest Authority.
         7) Issue an addendum, if required, to all plan holders of record.

C. REQUEST TO RECONSIDER PROTEST
   1. If the protester feels the protest decision is not valid, based on new information NOT previously known or an error of law or regulation, the protester may seek reconsideration by filing a request for reconsideration within 5 working days of receipt of the written decision.
   2. The request for reconsideration must be filed with the Finance Director.

D. REVIEW OF REQUEST TO RECONSIDER
   1. The Protest Authority will reconsider a protest decision and:
      a. Determine if the grounds for reconsideration are valid.
      b. If valid, render a decision.
      c. If invalid, reject the request for reconsideration.
      d. Issue, in writing, a final decision.

E. FAILURE TO FILE

1. Failure to file a protest within the time period indicated above shall result in waiver of the protest.

GENERAL SPECIFICATIONS

2.01 SCOPE

A. Work for this project comprisesthe demolition and removal of the existing boilers and water heaters at the Law Enforcement Center and replacement with new systems.

2.02 CONTRACTOR USE OF PREMISES.

A. Limit use of premises for work and for storage to allow for work by other contractors, County occupancy, and public use.

B. Coordinate use of premises under direction of the County. Contractor shall confine construction, equipment, storage of materials and equipment, and shall not unreasonably encumber premises with construction equipment or other material or equipment

C. Assume full responsibility for protection and safekeeping of items under this Contract, stored on site.

D. Move any stored items, under Contractor's control, which interfere with operations of the County or separate contractor.

2.03 BUILDING OCCUPANCY.

A. County staff will occupy premises during the entire period of this project for conduct of its normal operations. Cooperate with the County in all construction operations to minimize conflict and to facilitate use by the County.

B. Contractor shall at all times conduct its operations as to ensure least inconvenience to the general public.

2.04 WORK HOURS.

A. Work hours are between 7:00 a.m. and 4:00 p.m. Monday through Friday. Contractor personnel must leave the premises not later than 4:00 p.m.

B. The Contractor must coordinate arrival times and any special work hour requirements with the Facility Maintenance Director or the Facility Maintenance Supervisor.

2.05 BUILDING ACCESS.

A. All Contractor personnel must sign in with the Facility Maintenance Director or Facility Maintenance Supervisor each day.

B. Contractor personnell must be escorted by Goodhue County staff at all times when inside the facility.

2.06 DEMOLITION AND REMOVAL OF EXISTING BOILERS AND WATER HEATERS.

A. Obtain necessary approvals and permits for the removal.

B. Prevent injury to people and damage to the facility. Ensure safe passage of people around the work area.

C. Protect the existing facility from damage by debris, dust, and construction operations. Promptly repair any damage that occurs.

D. Perform removal in a manner that will minimize dust, noise, and other nuisances. Maintain haul routes for disposal of material clean and free of debris.

E. Transport the removed boiler and any other debris off property and legally reuse, salvage, recycle, or dispose of materials.

F. Storage of removed material on site is not permitted.

G. The Contractor is responsible for damage to structures, utilities, facilities, vehicles, and equipment caused by demolition, removal, and replacement of the boiler and water heaters and shall repair any damage at its own expense or replace items beyond repair.

END OF SECTION 00 21 13

SECTION 00 41 00

BID FORM

GOODHUE COUNTY LAW ENFORCEMENT CENTER BOILER REPLACEMENT

A. The undersigned Contractor proposes and agrees, if this Bid is accepted, to enter into an Agreement with the City in the form included in the Request for Bid documents, and to perform all work as specified or indicated in the Request for Bid documents for the prices and within the times indicated in this Bid and in accordance with the other terms and conditions of the bid documents.

B. Contractor accepts all terms and conditions of the Request for Bid. This Bid will remain subject to acceptance for 90 days after the Bid opening.

C. In submitting this Bid, the Bidder represents that:
   1. Bidder has examined and carefully studied the Request for Bid documents, and any data and reference items identified in the Request for Bid documents, and hereby acknowledges receipt of the following addenda:

Addendum No.	Addendum Date

   1. Bidder has visited the Site and become familiar with and is satisfied as to the general, local, and site conditions that may affect cost, progress, and performance of the work.
   2. Bidder is familiar with and is satisfied as to all laws and regulations that may affect cost, progress, and performance of the work.
   3. Bidder has considered the information known to the Bidder itself; information commonly known to contractors doing business in the locality of the site; information and observations obtained from visits to the site; the Request for Bid documents; and any site-related reports and drawings identified in the bid documents, with respect to the effect of such information, observations, and documents on (1) the cost, progress, and performance of the work; (2) the means, methods, techniques, sequences, and procedures to be employed by the Bidder; and (3) Bidder's safety precautions and programs.
   4. Bidder agrees, based on the information and observations referred to in the preceding paragraph, that no further examinations, investigations, explorations, test, studies, or data are necessary for the determination of this Bid or performance of the work at the price proposed and within the times required, and in accordance with the other terms and conditions of the Request for Bid documents.
   5. Request for Bid documents are generally sufficient to indicate and convey understanding of all terms and conditions for the performance and furnishing of the work.

6. Submission of this Bid constitutes an incontrovertible representation by the Contractor that the Contractor has complied with all of the requirements of this paragraph, and that without exception the Bid and all prices in the Bid are premised upon performing and furnishing the work required by the Request for Bid documents.

D. The Bidder certifies that:
   1. This Bid is genuine and not made in the interest of or on behalf of any undisclosed individual or entity and is not submitted in conformity with any agreement or rules or any group, association, organizations, or corporation,
   2. Bidder has not directly or indirectly induced or solicited any other Bidder to submit a false or sham Bid;
   3. Bidder has not solicited or induced any individual or entity to refrain from submitting a Bid; and
   4. Bidder has not engaged in corrupt, fraudulent, collusive, or coercive practices in competing for the contract. For the purposes of this paragraph:
      a. “corrupt practice” means the offering, giving, receiving, or soliciting of anything of value likely to influence the action of a public official in the bid process;
      b. “fraudulent practice” means an intentional misrepresentation of facts made (a) to influence the bid process to the detriment of the City, (b) to establish Bid prices at artificial non-competitive levels, or (c) to deprive the City of the benefits of free and open competition;
      c. “collusive practice” means a scheme or arrangement between two or more Contractors, with or without the knowledge of the City, a purpose of which is to establish Bid prices at artificial non-competitive levels; and
      d. “Coercive practice” means harming or threatening to harm, directly or indirectly, persons or their property to influence their participation in the bid process or affect the execution of the Contract.

E. The Bidder will complete the work in accordance with the contract documents for the following price:

GOODHUE COUNTY LAW ENFORCEMENT CENTER BOILER AND WATER HEATER REPLACEMENT

Cost

Demolition and removal of existing boilers and water heaters _____

Installation of new boilers and water heaters _____

Boiler Manufacturer _____

Boiler Model Number _____

Water Heater Manufacturer _____

Water Heater Model Number _____

Total Project Cost: _____

Firm: _____
(indicate correct name of proposing entity)

By: _____
Signature

_____
Printed Name

Attest: _____
Signature

_____
Printed Name

Title: _____

Submittal Date: _____

Address for giving notices:

_____

_____

_____

Telephone No. _____

Contact Name and Email _____

_____

CONTRACTOR VERIFICATION OF COMPLIANCE

The undersigned, being first duly sworn, as a responding contractor on the Project, represents and swears as follows:

Now, and at all times during the duration of the Project, the undersigned complies with each of the minimum criteria in Minn. Stat. § 16C.285, Subd. 3, the Responsible Contractor statute.

The undersigned understands that a failure to meet or verify compliance with the minimum criteria established for a "responsible contractor" as defined in Minn. Stat. § 16C.285, Subd. 3 renders a bidder ineligible to be awarded a construction contract for the Project or to perform work on the Project.

Upon request, the undersigned will submit copies of the signed verifications of compliance from all subcontractors.

The undersigned understands that a false statement under oath verifying compliance with any of the minimum criteria shall make the undersigned or its subcontractor that makes the false statement ineligible to be awarded a construction project and may result in termination of a contract awarded to a the undersigned or its subcontractor that submits a false statement.

CONTRACTOR:

_____

By:_____

Its:_____

REQUEST FOR BACKGROUND INFORMATION

Goodhue County requests a background investigation on the person named below in his/her capacity as a contractor's employee doing business with the County. As such, we may be requesting information classified as private, confidential, nonpublic or protected nonpublic under the Minnesota Data Practices Act (MSS Chapter 13).

TENNESSEN WARNING

The purpose and intended use of the information requested is to assist in determining your eligibility and suitability as a contractor's employee with Goodhue County. You may legally refuse to give the information. If you give the information, that information, or further investigation based on it, could result in cause for rejection of use as a contractor's employee for the project. Other persons or entities authorized to receive the information you supply are: Staff of the County Sheriff Department, Bureau of Criminal Apprehension, County Warrant Office, State of Minnesota, Driver's License Section and other government agencies necessary.

FULL NAME: _____

DATE OF BIRTH: _____ / _____ /_____ **DRIVER'S LICENSE #** _____

Have you been convicted of a crime for which a jail sentence of more than 90 days could have been imposed?

YES _____ NO _____

Have you ever been convicted of a felony? YES _____

NO _____

(You may answer "NO" to these questions if the conviction or criminal records thereof have been annulled, expunged, sealed, set aside or purged, or if you have been pardoned by law.)

SIGNATURE: _____ DATE: _____

END OF SECTION 00 41 00

SECTION 00 52 00

AGREEMENT FORM

PART 1 GENERAL

1.01 FORM OF AGREEMENT

1.02 THE AGREEMENT TO BE EXECUTED IS ATTACHED FOLLOWING THIS PAGE.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 00 52 00

CONTRACT FOR REPLACEMENT OF THE GOODHUE COUNTY LAW ENFORCEMENT CENTER BOILER AND WATER HEATER SYSTEMS

THIS AGREEMENT made this _____ day of _____ 2022, by and between the **COUNTY OF GOODHUE**, hereinafter referred to as the "County", and _____, hereinafter referred to as the "Contractor".

THE COUNTY AND THE CONTRACTOR, FOR THE CONSIDERATION HEREINAFTER STATED, AGREE AS FOLLOWS:

1. **SCOPE OF SERVICES.** The scope of services is detailed in the Contract Documents but generally consists of demolition, removal, and replacement of the Goodhue County Law Enforcement Center boiler and water heater systems. The Contractor agrees to perform the services as detailed in the Contract Documents.

2. **CONTRACT DOCUMENTS.** The following documents shall be referred to as the "Contract Documents", all of which shall be taken together as a whole as the contract between the parties as if they were set verbatim and in full herein:

   A. This document entitled "CONTRACT FOR REPLACEMENT OF THE GOODHUE COUNTY LAW ENFORCEMENT CENTER BOILER AND WATER HEATER SYSTEMS"

   B. Instructions to Contractors

   C. General and Technical Specifications and Plan Sheets

   D. Contractor's Bid

   If there is a conflict among the provisions of the Contract, the order in which they are listed above shall control in resolving any such conflicts with Contract Document "A" having the first priority and Contract Document "D" having the last priority.

3. **OBLIGATIONS OF THE CONTRACTOR.** The Contractor agrees that the work contemplated by the Contract shall be fully and satisfactorily completed in accordance with the terms of the Contract Documents.

4. PAYMENT.

A. The County agrees to pay and the Contractor agrees to receive and accept payment in accordance with the prices quoted as set forth in the completed Bid Form. Payment to the Contractor shall be made based on submission and approval of an invoice.

B. Payments to Subcontractor. Pursuant to Minn. Stat. § 471.25, Subd. 4a, the Contractor must pay any subcontractor within ten (10) days of the Contractor's receipt of payment from the County for undisputed services provided by the subcontractor. The Contractor must pay interest of 1½ percent per month or any part of a month to the subcontractor on any undisputed amount not paid on time to the subcontractor. The minimum monthly interest penalty payment for an unpaid balance of $100.00 or more is $10.00. For an unpaid balance of less than $100.00, the Contractor shall pay the actual penalty due to the subcontractor.

5. INDEMNIFICATION.

A. The Contractor shall indemnify, defend and hold harmless the County and its officials, agents, representatives, and employees from any loss, claim, liability and expense (including reasonable attorney's fees and expenses of litigation) with respect to: (a) Worker's Compensation benefits payable on account of injury or death to any Contractor employee or to any employee of Contractor's subcontractors, where the injury or death arises out of or is in any way related to the work performed or to be performed under the Contract; (b) claims for personal injury, death, or property damage or loss asserted by a Contractor or subcontractor or any of their officers, agents, representatives, or employees where the injury, death, damage, or loss arises out of or is in any way related to the work performed or to be performed under the Contract; and (c) claims for personal injury, death, or property damage or loss as asserted by third-parties at the work site, where the claim is based in the whole or in any part on, or is in any way related to, any act or omission by Contractor, or Contractor's subcontractors, agents, employees or delegates.

B. Contractor shall agree that the indemnities stated above shall be construed and applied in favor of indemnification. To the extent permitted by law, the stated indemnities shall apply regardless of any strict liability or negligence attributable to the County and regardless of the extent to which the underlying harm is attributable to the negligence or otherwise wrongful act or omission (including breach of contract) of Contractor, its subcontractors, agents, employees or delegates. Contractor also agrees that if applicable law limits or precludes any aspect of the stated indemnities, then the indemnities will be considered limited only to the extent necessary to comply with that applicable law. The stated indemnities continue until all applicable statutes of limitations have run.

C. If a claim arises within the scope of the stated indemnity, the County may require Contractor to furnish a written acceptance of tender of defense and indemnity from Contractor's insurance company. Contractor will take the action required by County within fifteen (15) days of receiving notice from County.

6. RIGHTS AND REMEDIES.

A. The duties and obligations imposed by the Contract Documents and the rights and remedies available thereunder shall be in addition to and not a limitation of any duties, obligations, rights and remedies otherwise imposed or available by law.

B. No action or failure to act by the County or the Contractor shall constitute a waiver of any right or duty afforded by any of them under the Contract, nor shall any such action or failure to act constitute an approval of or acquiescence in any breach thereunder, except as may be specifically agreed in writing.

7. GOVERNING LAW. The Contract shall be governed by the laws of the State of Minnesota.

8. INSURANCE. Prior to commencing work on the Contract, the Contractor shall furnish the County a certificate of insurance. The Contractor shall furnish and maintain during the project such public liability and property damage insurance as shall protect Contractor and any subcontractors performing work covered by the Contract from claims for damages by Workers Compensation Statute, and from claims for property damages or personal injury which may arise from operations under this Contract, whether such operations are by Contractor or by any subcontractor or anyone directly or indirectly employed by either of them and the amounts of insurance shall be as follows:

Worker's Compensation

Employer's Liability

Bodily Injury by Disease per employee - $500,000

Bodily Injury by Disease aggregate - $500,000

Bodily Injury by Accident - $500,000

Commercial General Liability – 2,000,000 annual aggregate.

Business Automobile Liability - $2,000,000 per occurrence combined single limit.

Excess/Umbrella Liability - 2,000,000 each occurrence/aggregate

All insurance policies (or riders) required by this Agreement shall:

(i) Be taken out by the Contractor and maintained with responsible insurance companies organized under the laws of one of the states of the United States and qualified to do business in the State of Minnesota,

(ii) Contain a provision that the insurer shall give thirty (30) days written notice of cancellation or in the case of non-payment of premium, at least ten (10) days written notice,

(iii) Name Contractor as an insured party and City as an additional insured with respect to General Liability, Auto Liability, and umbrella policies on a primary and non-contributory basis,

(iv) Be in accordance with specifications approved by the insurance advisory for County, and

(v) Be evidenced by a Certificate of Insurance listing County as an additional insured which shall be filed with the county. Certificates of Insurance that do not meet these requirements will not be accepted. **Certificates of Insurance shall include the policy endorsements showing the County named as additional insured on a primary and non-contributory basis.**

An Umbrella or Excess Liability insurance policy may be used to supplement the Contractor's policy limits on a follow-form basis to satisfy the full policy limits required by the Contract.

The County reserves the right to immediately terminate the contract if the Contractor is not in compliance with the insurance requirements and retains all rights to pursue any legal remedies against the contractor.

All insurance policies must be open to inspection by the County, and copies of policies must be submitted to the County 's authorized representative upon written request.

9. **PERFORMANCE AND PAYMENT BONDS.** Performance and payment bonds in amounts equal to 100 percent of the contract price will be delivered to the County prior to the commencement of work on this project.

10. **TERM.** The term of this Contract shall begin on the effective date and end at the completion of all work associated with demolition, removal, and replacement of the Goodhue County Law Enforcement Center boiler and water heater systems, unless sooner terminated as hereinafter provided.

11. **SUPPLIES, EQUIPMENT, AND INCIDENTALS.** The County and Contractor agree that the Contractor shall furnish any and all supplies, equipment, and incidentals necessary for Contractor's performance of this Contract.

12. **TERMINATION WITHOUT CAUSE BY County.** The County reserves the right at its sole discretion to terminate this Contract at will immediately without cause at any time within the term of this Contract. In the event of such termination, the County shall provide Contractor written notice of termination and upon receipt of same, Contractor shall immediately cease and desist Contractor's provision of services under this Contract and County shall have no further obligation under this Contract to pay any further compensation to Contractor except for compensation due and owing for services prior to Contractor's receipt of the written notice of termination.

13. **INDEPENDENT CONTRACTOR.** County and Contractor agree that Contractor, while engaged in carrying out and complying with the terms and conditions of this Contract and the provision of services thereunder, shall be considered at all times an independent contractor and not an officer, employee, or agent of the County. County and Contractor further agree that Contractor shall not at any time or in any manner represent that Contractor or any of the Contractor's agents or employees are in any manner agents or employees of the County. County and Contractor further agree that Contractor shall be exclusively responsible under this Contract for Contractor's own FICA payment, workers compensation payments, unemployment compensation payments, withholding amounts, and/or self-employment taxes or other taxes if any such payments, amounts, or taxes are required to be paid by law or regulations

14. **WRITTEN NOTICE OR OTHER CORRESPONDENCE.** Any written notice or other correspondence to be provided by or between the County and the Contractor in accordance with this Contract shall be hand delivered or mailed by registered or certified mail to the following address:

County:

Goodhue County
Facilities Maintenance Director
509 West 5th Street
Red Wing, MN 55066

VENDOR:

15. **WAIVER OF DEFAULT.** Any waiver by County of a default under the provisions of this Contract by Contractor shall not operate or be construed as a waiver of a subsequent default by the Contractor. No waiver shall be valid unless in writing and signed by the Facilities Maintenance Director on behalf of the County.

16. **NO ASSIGNMENT OR SUBCONTRACTING.** The County and Contractor agree that the services to be rendered by the Contractor under this Contract are unique and personal. Accordingly, the Contractor may not assign or subcontract out any of the Contractor's rights or any of the Contractor's duties or obligations under this Contract.

17. **INVALIDITY OF PROVISIONS.** If any term or provision of this Contract or any application hereof to any person or circumstances, shall to any extent be invalid or unenforceable, the remainder of this Contract or the application of such term or provision to persons or circumstances other than those as to which it is held invalid or unenforceable shall not be effected hereby and each term and provision of this Contract shall be valid and be enforced to the fullest extent permitted by law.

18. DATA PRACTICES/RECORDS.

A. All data created, collected, received, maintained, or disseminated for any purpose in the course of this Contract is governed by the Minnesota Government Data Practices Act, Minn. Stat. Ch. 13, any other applicable state statute, or any state rules adopted to implement the act, as well as federal regulations on data privacy.

B. All books, records, documents, and accounting procedures and practices of the Contractor and its subcontractors, if any, relative to this Contract are subject to examination by the County.

19. WARRANTY. The Contractor shall be held responsible for any and all defects in workmanship, materials, and equipment which may develop in any part of the contracted service, and upon proper notification by the County shall immediately replace, without cost to the County, any such faulty part or parts and damage done by reason of the same in accordance with the bid specifications.

20. CHANGE ORDERS. Without invalidating the Contract, the County may, at any time or from time to time, order additions, deletions, or revisions in the Work; these will be authorized by Change Orders. Upon receipt of a Change Order, the Contractor shall proceed with the work involved.

21. ENTIRE AGREEMENT. This instrument herein contains the entire and only agreement between the parties and no oral statement or representation or prior written matter not contained in this instrument shall have any force and effect. This Contract shall not be modified in any way except by writing executed by both parties.

22. WORK HOURS. Work hours are between 7:00 a.m. and 4:00 p.m., Monday through Friday. Contractor personnel must leave the premises not later than 4:00 p.m. The schedule of work and any special work hour requirements shall be coordinated with the Facilities Maintenance Supervisor.

23. DISCRIMINATION. Contractor agrees to comply with Minnesota Statute 181.59 that states:

Subsection A. That, in the hiring of common or skilled labor for the performance of any work under any contract, or any subcontract, no contractor, material Contractor or vendor, shall, by reason of race, creed, or color, discriminate against the person or persons who are citizens of the United States or resident aliens who are qualified and available to perform the work to which the employment relates;

Subsection B. That no contractor, material Contractor, or vendor, shall, in any manner, discriminate against, or intimidate, or prevent the employment of any person or persons identified in clause (1) of this section, or on being hired, prevent, or conspire to prevent the person or persons from the performance of work under any contract on account of race, creed, or color;

Subsection C. That a violation of this section is a misdemeanor; and

Subsection D. That this contract may be canceled or terminated by the state, county, city, town, school board, or any other person authorized to grant the contracts for

employment, and all money due, or to become due under the contract, may be forfeited for a second or any subsequent violation of the terms or conditions of this contract.

24. **BACKGROUND CHECKS.** The County may require criminal history background checks of the Contractor's employee's for purposes of access to County facilities. The County reserves the right to deny access to County facilities to those Contractors or Contractor's employees that it deems inappropriate.

GOODHUE COUNTY

BY: Jason Majerus
Its: County Board Chair

AND: Scott Arneson
Its: County Administrator

CONTRACTOR:

_____

BY: _____
Its

SECTION 01 12 16

WORK SEQUENCE

PART 1 GENERAL

1.01 SUMMARY

A. This Section Includes:
   1. Sequence of Construction
   2. Completion Dates

1.02 SEQUENCE OF CONSTRUCTION

A. The building will remain fully occupied throughout construction. Contractor shall coordinate required domestic hot water and building heating system shut-downs with the Owner. A minimum of 7 days notice to Owner is required.

B. Existing Boiler B-1 and associated pump P-7 can be isolated and demolished wile Existing Boiler B-2 remains operational. Existing Boiler B-1 shall be demolished and new Boiler B-1 shall be fully operational prior to Existing Boiler B-2 being demolished.

C. The return water isolation valve for Existing Boiler B-2 is located such that the valve and associated piping will have to be demolished in order to install the the new Boiler B-2. This will require a temporary shut-down of the boiler system while the existing piping is demolished and a new isolation valve is put in place in a location that will not impede installation of the new Boiler B-2. Coordinate heating system shut-down with Owner.

D. The County intends to contract with Innovational Water Systems (IWS) for supply of cleaning, treatment chemicals, and glycol for the hydronic system fluid.Coordinate construction schedule with IWS.

E. Demolition and replacement of the water heaters can occur at any point during construction. If construction sequence requires the domestic hot water sytem to be shut down during normal building occupancy hours, the contractor shall provide temporary means of providing domestic hot water to the building.

1.03 COMPLETION DATES

A. Construction can begin at any time after 3/1/2023. Coordinate start date with Owner.

B. Construction shall be substantially complete by 6/30/2023. Notify Engineer of substantial completion date.

C. Project completion by 7/31/2023 following completion of any punch list items noted during Engineer's substantial completion walkthrough.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 01 12 16

SECTION 01 25 00

SUBSTITUTION PROCEDURES

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

2.01 GENERAL REQUIREMENTS

A. A Substitution Request for products, assemblies, materials, and equipment constitutes a representation that the submitter:
   1. Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product, equipment, assembly, or system.
   2. Agrees to provide the same warranty for the substitution as for the specified product.
   3. Agrees to coordinate installation and make changes to other work that may be required for the work to be complete, with no additional cost to Owner.
   4. Waives claims for additional costs or time extension that may subsequently become apparent.

B. Document each request with complete data substantiating compliance of proposed substitution with Contract Documents. Burden of proof is on proposer.

C. Content: Include information necessary for tracking the status of each Substitution Request, and information necessary to provide an actionable response.

D. Limit each request to a single proposed substitution item.

2.02 RESOLUTION

2.03 ACCEPTANCE

END OF SECTION 01 25 00

SECTION 01 31 14

FACILITY SERVICES COORDINATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Services of a coordinator for facility services construction.

B. Coordination documents.

1.02 MECHANICAL AND ELECTRICAL COORDINATOR

A. Employ and pay for services of a firm, technically qualified and administratively experienced in field coordination of the type of work required to be coordinated, for the duration of the Work.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 COORDINATION REQUIRED

A. Coordinate the work listed below:
   1. Plumbing: Division 22.
   2. Heating, Ventilating, and Air Conditioning: Division 23.
   3. Electrical: Division 26.

B. Coordinate progress schedules, including dates for submittals and for delivery of products.

C. Conduct meetings among subcontractors and others concerned, to establish and maintain coordination and schedules, and to resolve coordination matters in dispute.

D. Participate in progress meetings. Report on progress of work to be adjusted under coordination requirements, and any required changes in schedules. Transmit minutes of meetings and reports to concerned parties.

3.02 COORDINATION DOCUMENTS

A. Prepare coordination drawings to organize installation of products for efficient use of available space, for proper sequence of installation, and to identify potential conflicts.

B. Prepare a master schedule identifying responsibilities for activities that directly relate to this work, including submittals and temporary utilities; organize by specification section.

C. Identify electrical power characteristics and control wiring required for each item of equipment.

D. Maintain documents for the duration of the work, recording changes due to site instructions, modifications or adjustments.

E. After Architect review of original and revised documents, reproduce and distribute copies to concerned parties.

3.03 COORDINATION OF SUBMITTALS

A. Review shop drawings, product data, and samples for compliance with Contract Documents and for coordination with related work. Transmit copies of reviewed documents to Engineer.

B. Check field dimensions and clearances and relationship to available space and anchors.

C. Check compatibility with equipment and work of other sections, electrical characteristics, and operational control requirements.

D. Check motor voltages and control characteristics.

E. Coordinate controls, interlocks, wiring of switches, and relays.

F. Coordinate wiring and control diagrams.

G. When changes in the work are made, review their effect on other work.

H. Verify information and coordinate maintenance of record documents.

3.04 COORDINATION OF SUBSTITUTIONS AND MODIFICATIONS

A. Review proposals and requests for substitution prior to submission to Architect.

B. Verify compliance with Contract Documents and for compatibility with work of other sections.

C. Submit with recommendation for action.

3.05 OBSERVATION OF WORK

A. Observe work for compliance with Contract Documents.

B. Maintain a list of observed deficiencies and defects; promptly submit.

3.06 DOCUMENTATION

A. Observe and maintain a record of tests. Record:
   1. Specification section number and product name.
   2. Name of Contractor and subcontractor.
   3. Name of testing agency and name of inspector.
   4. Name of manufacturer's representative present.
   5. Date, time, and duration of tests.

6. Type of test, and results.
7. Retesting required.

B. Submit copies of documentation to Engineer upon request.

3.07 EQUIPMENT START-UP

A. Verify utilities, connections, and controls are complete and equipment is in operable condition as required by Section 01 70 00.

B. Observe start-up and adjustments, test run, record time and date of start-up, and results.

C. Observe equipment demonstrations made to Owner; record times and additional information required for operation and maintenance manuals.

3.08 INSPECTION AND ACCEPTANCE OF EQUIPMENT

A. Prior to inspection, verify that equipment is tested, operational, clean, and ready for operation.

B. Assist Engineer with review. Prepare list of items to be completed and corrected.

END OF SECTION 01 31 14

SECTION 01 40 00

QUALITY REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Submittals.

B. Quality assurance.

C. References and standards.

D. Testing and inspection agencies and services.

E. Control of installation.

F. Defect Assessment.

1.02 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Design Data: Submit for Engineer's knowledge as contract administrator for the limited purpose of assessing compliance with information given and the design concept expressed in the Contract Documents, or for Owner's information.

C. Test Reports: After each test/inspection, promptly submit one electronic copy of report to Engineer and to Contractor.
   1. Test report submittals are for Engineer's knowledge as contract administrator for the limited purpose of assessing compliance with information given and the design concept expressed in the Contract Documents, or for Owner's information.

D. Certificates: When specified in individual specification sections, submit certification by the manufacturer and Contractor or installation/application subcontractor to Engineer, in quantities specified for Product Data.
   1. Indicate material or product complies with or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.

E. Manufacturer's Instructions: When specified in individual specification sections, submit printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, for the Owner's information. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.

F. Manufacturer's Field Reports: Submit reports for Engineer's benefit as contract administrator or for Owner.
   1. Submit for information for the limited purpose of assessing compliance with information given and the design concept expressed in the Contract Documents.

1.03 REFERENCES AND STANDARDS

A. For products and workmanship specified by reference to a document or documents not included in the Project Manual, also referred to as reference standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.

B. Comply with reference standard of date of issue current on date of Contract Documents, except where a specific date is established by applicable code.

C. Obtain copies of standards where required by product specification sections.

D. Maintain copy at project site during submittals, planning, and progress of the specific work, until Substantial Completion.

E. Should specified reference standards conflict with Contract Documents, request clarification from Engineer before proceeding.

F. Neither the contractual relationships, duties, or responsibilities of the parties in Contract nor those of Engineer shall be altered from Contract Documents by mention or inference otherwise in any reference document.

1.04 TESTING AND INSPECTION AGENCIES AND SERVICES

A. Contractor shall employ and pay for services of an independent testing agency to perform other specified testing.

B. Employment of agency in no way relieves Contractor of obligation to perform Work in accordance with requirements of Contract Documents.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 CONTROL OF INSTALLATION

A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce work of specified quality.

B. Comply with manufacturers' instructions, including each step in sequence.

C. Should manufacturers' instructions conflict with Contract Documents, request clarification from Engineer before proceeding.

D. Comply with specified standards as minimum quality for the work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

E. Have work performed by persons qualified to produce required and specified quality.

F. Verify that field measurements are as indicated on shop drawings or as instructed by the manufacturer.

G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, and disfigurement.

3.02 TESTING AND INSPECTION

A. See individual specification sections for testing and inspection required.

B. Testing Agency Duties:
   1. Provide qualified personnel at site. Cooperate with Engineer and Contractor in performance of services.
   2. Perform specified sampling and testing of products in accordance with specified standards.
   3. Ascertain compliance of materials and mixes with requirements of Contract Documents.
   4. Promptly notify Engineer and Contractor of observed irregularities or non-compliance of Work or products.
   5. Perform additional tests and inspections required by Engineer.
   6. Submit reports of all tests/inspections specified.

C. Limits on Testing/Inspection Agency Authority:
   1. Agency may not release, revoke, alter, or enlarge on requirements of Contract Documents.
   2. Agency may not approve or accept any portion of the Work.
   3. Agency may not assume any duties of Contractor.
   4. Agency has no authority to stop the Work.

D. Contractor Responsibilities:
   1. Deliver to agency at designated location, adequate samples of materials proposed to be used that require testing, along with proposed mix designs.
   2. Cooperate with laboratory personnel, and provide access to the Work and to manufacturers' facilities.
   3. Provide incidental labor and facilities:
      a. To provide access to Work to be tested/inspected.
      b. To obtain and handle samples at the site or at source of Products to be tested/inspected.
      c. To facilitate tests/inspections.
      d. To provide storage and curing of test samples.
   4. Notify Engineer and laboratory 24 hours prior to expected time for operations requiring testing/inspection services.
   5. Employ services of an independent qualified testing laboratory and pay for additional samples, tests, and inspections required by Contractor beyond specified requirements.
   6. Arrange with Owner's agency and pay for additional samples, tests, and inspections required by Contractor beyond specified requirements.

E. Re-testing required because of non-compliance with specified requirements shall be performed by the same agency on instructions by Engineer.

F. Re-testing required because of non-compliance with specified requirements shall be paid for by Contractor.

3.03 DEFECT ASSESSMENT

A. Replace Work or portions of the Work not complying with specified requirements.

B. If, in the opinion of Owner, it is not practical to remove and replace the work, Owner will direct an appropriate remedy or adjust payment.

END OF SECTION 01 40 00

SECTION 01 60 00

PRODUCT REQUIREMENTS

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

A. Section 01 25 00 - Substitution Procedures: Substitutions made during procurement and/or construction phases.

B. Section 01 74 19 - Construction Waste Management and Disposal: Waste disposal requirements potentially affecting product selection, packaging and substitutions.

1.02 SUBMITTALS

A. Product Data Submittals: Submit manufacturer's standard published data. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.

B. Shop Drawing Submittals: Prepared specifically for this Project; indicate utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

C. Sample Submittals: Illustrate functional and aesthetic characteristics of the product, with integral parts and attachment devices. Coordinate sample submittals for interfacing work.
   1. For selection from standard finishes, submit samples of the full range of the manufacturer's standard colors, textures, and patterns.

PART 2 PRODUCTS

2.01 NEW PRODUCTS

A. Provide new products unless specifically required or permitted by Contract Documents.

2.02 PRODUCT OPTIONS

A. Products Specified by Reference Standards or by Description Only: Use any product meeting those standards or description.

B. Products Specified by Naming One or More Manufacturers: Use a product of one of the manufacturers named and meeting specifications, no options or substitutions allowed.

C. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit a request for substitution for any manufacturer not named.

PART 3 EXECUTION

3.01 SUBSTITUTION LIMITATIONS

A. See Section 01 25 00 - Substitution Procedures.

3.02 TRANSPORTATION AND HANDLING

A. Package products for shipment in manner to prevent damage; for equipment, package to avoid loss of factory calibration.

B. If special precautions are required, attach instructions prominently and legibly on outside of packaging.

C. Coordinate schedule of product delivery to designated prepared areas in order to minimize site storage time and potential damage to stored materials.

D. Transport and handle products in accordance with manufacturer's instructions.

E. Transport materials in covered trucks to prevent contamination of product and littering of surrounding areas.

F. Promptly inspect shipments to ensure that products comply with requirements, quantities are correct, and products are undamaged.

G. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage, and to minimize handling.

H. Arrange for the return of packing materials, such as wood pallets, where economically feasible.

3.03 STORAGE AND PROTECTION

A. Designate receiving/storage areas for incoming products so that they are delivered according to installation schedule and placed convenient to work area in order to minimize waste due to excessive materials handling and misapplication. See Section 01 74 19.

B. Store and protect products in accordance with manufacturers' instructions.

C. Store with seals and labels intact and legible.

D. Store sensitive products in weathertight, climate-controlled enclosures in an environment favorable to product.

E. For exterior storage of fabricated products, place on sloped supports above ground.

F. Protect products from damage or deterioration due to construction operations, weather, precipitation, humidity, temperature, sunlight and ultraviolet light, dirt, dust, and other contaminants.

G. Comply with manufacturer's warranty conditions, if any.

H. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.

I. Prevent contact with material that may cause corrosion, discoloration, or staining.

J. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.

K. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.

END OF SECTION 01 60 00

SECTION 01 70 00

EXECUTION AND CLOSEOUT REQUIREMENTS

PART 1 GENERAL

PART 2 PRODUCTS

2.01 PATCHING MATERIALS

A. New Materials: As specified in product sections; match existing products and work for patching and extending work.

B. Type and Quality of Existing Products: Determine by inspecting and testing products where necessary, referring to existing work as a standard.

C. Product Substitution: For any proposed change in materials, submit request for substitution described in Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that existing site conditions and substrate surfaces are acceptable for subsequent work. Start of work means acceptance of existing conditions.

B. Verify that existing substrate is capable of structural support or attachment of new work being applied or attached.

C. Examine and verify specific conditions described in individual specification sections.

D. Take field measurements before confirming product orders or beginning fabrication, to minimize waste due to over-ordering or misfabrication.

E. Verify that utility services are available, of the correct characteristics, and in the correct locations.

F. Prior to Cutting: Examine existing conditions prior to commencing work, including elements subject to damage or movement during cutting and patching. After uncovering existing work, assess conditions affecting performance of work. Beginning of cutting or patching means acceptance of existing conditions.

3.02 PREPARATION

A. Clean substrate surfaces prior to applying next material or substance.

B. Seal cracks or openings of substrate prior to applying next material or substance.

C. Apply manufacturer required or recommended substrate primer, sealer, or conditioner prior to applying any new material or substance in contact or bond.

3.03 GENERAL INSTALLATION REQUIREMENTS

A. Install products as specified in individual sections, in accordance with manufacturer's instructions and recommendations, and so as to avoid waste due to necessity for replacement.

B. Make vertical elements plumb and horizontal elements level, unless otherwise indicated.

C. Install equipment and fittings plumb and level, neatly aligned with adjacent vertical and horizontal lines, unless otherwise indicated.

D. Make consistent texture on surfaces, with seamless transitions, unless otherwise indicated.

E. Make neat transitions between different surfaces, maintaining texture and appearance.

3.04 CUTTING AND PATCHING

A. Whenever possible, execute the work by methods that avoid cutting or patching.

B. Perform whatever cutting and patching is necessary to:
   1. Complete the work.
   2. Fit products together to integrate with other work.
   3. Provide openings for penetration of mechanical, electrical, and other services.
   4. Match work that has been cut to adjacent work.
   5. Repair areas adjacent to cuts to required condition.
   6. Repair new work damaged by subsequent work.
   7. Remove samples of installed work for testing when requested.
   8. Remove and replace defective and non-complying work.

C. Execute work by methods that avoid damage to other work and that will provide appropriate surfaces to receive patching and finishing. In existing work, minimize damage and restore to original condition.

D. Employ original installer to perform cutting for weather exposed and moisture resistant elements, and sight exposed surfaces.

E. Cut rigid materials using masonry saw or core drill. Pneumatic tools not allowed without prior approval.

F. Restore work with new products in accordance with requirements of Contract Documents.

G. Fit work air tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.

H. At penetrations of fire rated walls, partitions, ceiling, or floor construction, completely seal voids with fire rated material in accordance with Section 07 84 00, to full thickness of the penetrated element.

I. Patching:
   1. Finish patched surfaces to match finish that existed prior to patching. On continuous surfaces, refinish to nearest intersection or natural break. For an assembly, refinish entire unit.
   2. Match color, texture, and appearance.
   3. Repair patched surfaces that are damaged, lifted, discolored, or showing other imperfections due to patching work. If defects are due to condition of substrate, repair substrate prior to repairing finish.

3.05 PROGRESS CLEANING

A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition.

B. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces, and other closed or remote spaces, prior to enclosing the space.

C. Broom and vacuum clean interior areas prior to start of surface finishing, and continue cleaning to eliminate dust.

D. Collect and remove waste materials, debris, and trash/rubbish from site periodically and dispose off-site; do not burn or bury.

3.06 PROTECTION OF INSTALLED WORK

A. Protect installed work from damage by construction operations.

B. Provide special protection where specified in individual specification sections.

C. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.

D. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.

E. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.

F. Prohibit traffic or storage upon waterproofed or roofed surfaces. If traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.

G. Remove protective coverings when no longer needed; reuse or recycle coverings if possible.

3.07 SYSTEM STARTUP

A. Coordinate schedule for start-up of various equipment and systems.

B. Notify Engineer and Owner seven days prior to start-up of each item.

C. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions that may cause damage.

D. Verify tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.

E. Verify that wiring and support components for equipment are complete and tested.

F. Execute start-up under supervision of applicable Contractor personnel and manufacturer's representative in accordance with manufacturers' instructions.

G. Submit a written report that equipment or system has been properly installed and is functioning correctly.

3.08 DEMONSTRATION AND INSTRUCTION

A. See Section 01 79 00 - Demonstration and Training.

3.09 ADJUSTING

A. Adjust operating products and equipment to ensure smooth and unhindered operation.

3.10 FINAL CLEANING

A. Use cleaning materials that are nonhazardous.

B. Clean interior and exterior glass, surfaces exposed to view; remove temporary labels, stains and foreign substances, polish transparent and glossy surfaces,

C. Remove all labels that are not permanent. Do not paint or otherwise cover fire test labels or nameplates on mechanical and electrical equipment.

D. Clean equipment and fixtures to a sanitary condition with cleaning materials appropriate to the surface and material being cleaned.

E. Clean filters of operating equipment.

F. Clean debris from area drains and drainage systems.

G. Clean site; sweep paved areas, rake clean landscaped surfaces.

H. Remove waste, surplus materials, trash/rubbish, and construction facilities from the site; dispose of in legal manner; do not burn or bury.

3.11 CLOSEOUT PROCEDURES

A. Make submittals that are required by governing or other authorities.

B. Accompany Project Coordinator on preliminary inspection to determine items to be listed for completion or correction in the Contractor's Correction Punch List for Contractor's Notice of Substantial Completion.

C. Notify Engineer when work is considered ready for Engineer's Substantial Completion inspection.

D. Conduct Substantial Completion inspection and create Final Correction Punch List containing Engineer's and Contractor's comprehensive list of items identified to be completed or corrected and submit to Engineer.

E. Correct items of work listed in Final Correction Punch List and comply with requirements for access to Owner-occupied areas.

F. Complete items of work determined by Engineer listed in executed Certificate of Substantial Completion.

END OF SECTION 01 70 00

SECTION 01 74 19

CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 GENERAL

1.01 WASTE MANAGEMENT REQUIREMENTS

A. Owner requires that this project generate the least amount of trash and waste possible.

B. Employ processes that ensure the generation of as little waste as possible due to error, poor planning, breakage, mishandling, contamination, or other factors.

C. Minimize trash/waste disposal in landfills; reuse, salvage, or recycle as much waste as economically feasible.

D. Contractor shall submit periodic Waste Disposal Reports; all landfill disposal, incineration, recycling, salvage, and reuse must be reported regardless of to whom the cost or savings accrues; use the same units of measure on all reports.

E. Methods of trash/waste disposal that are not acceptable are:
   1. Burning on the project site.
   2. Burying on the project site.
   3. Dumping or burying on other property, public or private.
   4. Other illegal dumping or burying.

F. Regulatory Requirements: Contractor is responsible for knowing and complying with regulatory requirements, including but not limited to Federal, state and local requirements, pertaining to legal disposal of all construction and demolition waste materials.

1.02 DEFINITIONS

A. Clean: Untreated and unpainted; not contaminated with oils, solvents, caulk, or the like.

B. Construction and Demolition Waste: Solid wastes typically including building materials, packaging, trash, debris, and rubble resulting from construction, remodeling, repair and demolition operations.

C. Hazardous: Exhibiting the characteristics of hazardous substances, i.e., ignitibility, corrosivity, toxicity or reactivity.

D. Nonhazardous: Exhibiting none of the characteristics of hazardous substances, i.e., ignitibility, corrosivity, toxicity, or reactivity.

E. Nontoxic: Neither immediately poisonous to humans nor poisonous after a long period of exposure.

F. Recyclable: The ability of a product or material to be recovered at the end of its life cycle and remanufactured into a new product for reuse by others.

G. Recycle: To remove a waste material from the project site to another site for remanufacture into a new product for reuse by others.

H. Recycling: The process of sorting, cleansing, treating and reconstituting solid waste and other discarded materials for the purpose of using the altered form. Recycling does not include burning, incinerating, or thermally destroying waste.

I. Return: To give back reusable items or unused products to vendors for credit.

J. Reuse: To reuse a construction waste material in some manner on the project site.

K. Salvage: To remove a waste material from the project site to another site for resale or reuse by others.

L. Sediment: Soil and other debris that has been eroded and transported by storm or well production run-off water.

M. Source Separation: The act of keeping different types of waste materials separate beginning from the first time they become waste.

N. Toxic: Poisonous to humans either immediately or after a long period of exposure.

O. Trash: Any product or material unable to be reused, returned, recycled, or salvaged.

P. Waste: Extra material or material that has reached the end of its useful life in its intended use. Waste includes salvageable, returnable, recyclable, and reusable material.

1.03 SUBMITTALS

A. Waste Disposal Reports: Submit at specified intervals, with details of quantities of trash and waste, means of disposal or reuse, and costs; show both totals to date and since last report.
   1. Submit updated Report with each Application for Progress Payment; failure to submit Report will delay payment.
   2. Submit Report on a form acceptable to Owner.
   3. Landfill Disposal: Include the following information:
      a. Identification of material.
      b. Amount, in tons or cubic yards, of trash/waste material from the project disposed of in landfills.
      c. State the identity of landfills, total amount of tipping fees paid to landfill, and total disposal cost.
      d. Include manifests, weight tickets, receipts, and invoices as evidence of quantity and cost.
   4. Incinerator Disposal: Include the following information:
      a. Identification of material.
      b. Amount, in tons or cubic yards, of trash/waste material from the project delivered to incinerators.
      c. State the identity of incinerators, total amount of fees paid to incinerator, and total disposal cost.

d. Include manifests, weight tickets, receipts, and invoices as evidence of quantity and cost.

5. Recycled and Salvaged Materials: Include the following information for each:
   a. Identification of material, including those retrieved by installer for use on other projects.
   b. Amount, in tons or cubic yards, date removed from the project site, and receiving party.
   c. Transportation cost, amount paid or received for the material, and the net total cost or savings of salvage or recycling each material.
   d. Include manifests, weight tickets, receipts, and invoices as evidence of quantity and cost.
   e. Certification by receiving party that materials will not be disposed of in landfills or by incineration.
6. Material Reused on Project: Include the following information for each:
   a. Identification of material and how it was used in the project.
   b. Amount, in tons or cubic yards.
   c. Include weight tickets as evidence of quantity.
7. Other Disposal Methods: Include information similar to that described above, as appropriate to disposal method.

PART 3 EXECUTION

2.01 WASTE MANAGEMENT PROCEDURES

A. See Section 01 70 00 for trash/waste prevention procedures related to demolition, cutting and patching, installation, protection, and cleaning.

2.02 WASTE MANAGEMENT PLAN IMPLEMENTATION

A. Manager: Designate an on-site person or persons responsible for instructing workers and overseeing and documenting results of the Waste Management Plan.

B. Communication: Distribute copies of the Waste Management Plan to job site foreman, each subcontractor, Owner, and Architect.

C. Instruction: Provide on-site instruction of appropriate separation, handling, and recycling, salvage, reuse, and return methods to be used by all parties at the appropriate stages of the project.

D. Meetings: Discuss trash/waste management goals and issues at project meetings.
   1. Prebid meeting.
   2. Preconstruction meeting.
   3. Regular job-site meetings.

E. Facilities: Provide specific facilities for separation and storage of materials for recycling, salvage, reuse, return, and trash disposal, for use by all contractors and installers.
   1. Provide containers as required.
   2. Provide adequate space for pick-up and delivery and convenience to subcontractors.

3. Keep recycling and trash/waste bin areas neat and clean and clearly marked in order to avoid contamination of materials.

F. Hazardous Wastes: Separate, store, and dispose of hazardous wastes according to applicable regulations.

G. Recycling: Separate, store, protect, and handle at the site identified recyclable waste products in order to prevent contamination of materials and to maximize recyclability of identified materials. Arrange for timely pickups from the site or deliveries to recycling facility in order to prevent contamination of recyclable materials.

H. Reuse of Materials On-Site: Set aside, sort, and protect separated products in preparation for reuse.

I. Salvage: Set aside, sort, and protect products to be salvaged for reuse off-site.

END OF SECTION 01 74 19

SECTION 01 79 00

DEMONSTRATION AND TRAINING

PART 1 GENERAL

1.01 SUMMARY

A. Demonstration of products and systems where indicated in specific specification sections.

B. Training of Owner personnel in operation and maintenance is required for:
   1. All software-operated systems.
   2. HVAC systems and equipment.
   3. Plumbing equipment.

1.02 RELATED REQUIREMENTS

A. Section 01 91 13 - General Commissioning Requirements: Additional requirements applicable to demonstration and training.

1.03 SUBMITTALS

A. Training Plan: Owner will designate personnel to be trained; tailor training to needs and skill-level of attendees.
   1. Submit to Engineer for transmittal to Owner.
   2. Submit not less than four weeks prior to start of training.
   3. Revise and resubmit until acceptable.
   4. Provide an overall schedule showing all training sessions.
   5. Include at least the following for each training session:
      a. Identification, date, time, and duration.
      b. Description of products and/or systems to be covered.
      c. Name of firm and person conducting training; include qualifications.
      d. Intended audience, such as job description.
      e. Objectives of training and suggested methods of ensuring adequate training.
      f. Methods to be used, such as classroom lecture, live demonstrations, hands-on, etc.
      g. Media to be used, such a slides, hand-outs, etc.
      h. Training equipment required, such as projector, projection screen, etc., to be provided by Contractor.

B. Training Manuals: Provide training manual for each attendee; allow for minimum of two attendees per training session.
   1. Include applicable portion of O&M manuals.
   2. Include copies of all hand-outs, slides, overheads, video presentations, etc., that are not included in O&M manuals.
   3. Provide one extra copy of each training manual to be included with operation and maintenance data.

1.04 QUALITY ASSURANCE

A. Instructor Qualifications: Familiar with design, operation, maintenance and troubleshooting of the relevant products and systems.
   1. Provide as instructors the most qualified trainer of those contractors and/or installers who actually supplied and installed the systems and equipment.
   2. Where a single person is not familiar with all aspects, provide specialists with necessary qualifications.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

3.01 DEMONSTRATION - GENERAL

A. Demonstrations conducted during system start-up do not qualify as demonstrations for the purposes of this section, unless approved in advance by Owner.

B. Demonstration may be combined with Owner personnel training if applicable.

C. Operating Equipment and Systems: Demonstrate operation in all modes, including start-up, shut-down, seasonal changeover, emergency conditions, and troubleshooting, and maintenance procedures, including scheduled and preventive maintenance.
   1. Perform demonstrations not less than two weeks prior to Substantial Completion.
   2. For equipment or systems requiring seasonal operation, perform demonstration for other season within six months.

D. Non-Operating Products: Demonstrate cleaning, scheduled and preventive maintenance, and repair procedures.
   1. Perform demonstrations not less than two weeks prior to Substantial Completion.

3.02 TRAINING - GENERAL

A. Conduct training on-site unless otherwise indicated.

B. Owner will provide classroom and seating at no cost to Contractor.

C. Provide training in minimum two hour segments.

D. Training schedule will be subject to availability of Owner's personnel to be trained; re-schedule training sessions as required by Owner; once schedule has been approved by Owner failure to conduct sessions according to schedule will be cause for Owner to charge Contractor for personnel "show-up" time.

E. Review of Facility Policy on Operation and Maintenance Data: During training discuss:
   1. The location of the O&M manuals and procedures for use and preservation; backup copies.
   2. Typical contents and organization of all manuals, including explanatory information, system narratives, and product specific information.
   3. Typical uses of the O&M manuals.

F. Product- and System-Specific Training:
   1. Review the applicable O&M manuals.
   2. For systems, provide an overview of system operation, design parameters and constraints, and operational strategies.
   3. Review instructions for proper operation in all modes, including start-up, shut-down, seasonal changeover and emergency procedures, and for maintenance, including preventative maintenance.
   4. Provide hands-on training on all operational modes possible and preventive maintenance.
   5. Emphasize safe and proper operating requirements; discuss relevant health and safety issues and emergency procedures.
   6. Discuss common troubleshooting problems and solutions.
   7. Discuss any peculiarities of equipment installation or operation.
   8. Discuss warranties and guarantees, including procedures necessary to avoid voiding coverage.
   9. Review recommended tools and spare parts inventory suggestions of manufacturers.
   10. Review spare parts and tools required to be furnished by Contractor.
   11. Review spare parts suppliers and sources and procurement procedures.

G. Be prepared to answer questions raised by training attendees; if unable to answer during training session, provide written response within three days.

END OF SECTION 01 79 00

SECTION 22 05 00

COMMON WORK RESULTS FOR PLUMBING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Bidding Documents, Condition of the Contract and pertinent portions of Sections in Division 1 of these specifications apply to the work of this section.

B. Before submitting proposal for the work for these specifications and drawings, each bidder shall study the contract documents, examine the site, and familiarize herself/himself with all existing conditions such as utility service pressure, locations, invert elevations, and materials.

C. No extra compensation will be allowed because of a misunderstanding as to the amount of work involved or lack of knowledge of existing conditions.

D. Consult drawings and specifications of other trades for correlating work with that of the other trades.

E. Where a Specification Section refers to other Sections under the Article on “Related Sections”, this is done for Contractor’s convenience only. It shall in no way relieve the Contractor of responsibilities stated in other Sections of the Specifications, even though these Sections are not specifically referenced. The Contractor is responsible for all information contained in this Division’s Specifications as well as for information contained in all other Divisions.

1.02 REFERENCES

A. Refer to Section – Mechanical References for Titles of all referenced standards or codes. Contractor and/or manufacturer shall be aware of all applicable standards that apply to this work.

1.03 WORK INCLUDED

A. The work under this section of the specifications consists of furnishing all labor, equipment and materials necessary for and reasonably incidental to the complete installation of the mechanical systems as herein described and indicated on the drawings, including such minor details not specifically mentioned or shown as may be necessary to complete the system ready for successful operation, and subject to the terms and conditions of the contract.

B. All work under this section shall be done in accordance with the best modern practice, using new first grade equipment and shall be arranged to avoid interference with other trades and existing conditions.

C. All mechanical systems and portions thereof shall be concealed unless otherwise indicated or specified.

D. Concrete foundations, pits and grouting: The Mechanical Contractor shall provide suitable concrete foundations, pads, pits and necessary anchor bolts, tie plates, openings, curbs, caulk, etc. for his systems unless otherwise noted or specified. Refer to Architectural drawings for pads by the General Contractor. All grouting of Mechanical equipment shall be by the Mechanical Contractor.

E. Electrical Work: See Divisions 26, 27 and 28 for related electrical specifications not included in Division 22.

F. All workers involved in the fabrication or installation of any and all mechanical work, both rough in and finish shall carry a journeyman's license in the particular trade involved. General laborers shall not be used for this work

1.04 DRAWINGS & SPECIFICATIONS

A. Furnish all labor, equipment and material for the complete installation of the mechanical systems indicated and specified.
   1. The drawings accompanying the specifications are diagrammatic and are intended to indicate the approximate and relative locations of services and equipment; the drawings shall not be scaled.
   2. Verify building dimensions with dimensions on architectural drawings.
   3. Because the drawings are diagrammatic and on a small scale, all risers, drops, offsets, etc. have not been shown and shall be provided under this contract.

B. Install all systems and individual equipment according to the manufacturer's installation instructions and recommendations.
   1. Where these differ from these Contract Documents, contact the Engineer immediately.

C. All pipes and equipment shall be coordinated and installed to avoid interference with all other trades.
   1. Except for piping in equipment rooms, piping shall be concealed unless specifically indicated otherwise or directed by Engineer.
   2. Field changes necessary or as a result of varying construction conditions shall have the written acceptance of the Architect/Engineer prior to modifications.

D. The Contractor shall maintain an up-to-date record set of drawings and specifications at the job site. Transfer all field changes to one (1) clean set at time of substantial completion and submit to Engineer prior to final acceptance.

E. In specifying particular materials and/or methods, the intent is to indicate the minimum standard of quality acceptable to Owner.
   1. If a case occurs where these Contract Documents do not meet the minimum standards of existing federal, state and local codes regulations and requirements, then those governing codes, regulations and requirements shall prevail.

F. The word "provide" shall mean furnish and install. The words "As required" shall mean as needed to provide a complete and satisfactorily operating system complying with all governing codes and the intent of the project contract documents. The word "indicated" shall mean as shown or noted on the Contract Drawings.

G. Manufacturer Selection
   1. Where one manufacturer, model or brand name is specified alone, no substitution will be allowed, except if approved by Owner as an alternate.
   2. Where more than one manufacturer, model or brand name is specified for the same item, the Contractor may choose between them.
   3. When one or more manufacturers, models or brand names are mentioned and followed by the phrase “or approved equal”, it shall be understood that the names mentioned are to set a standard, and another manufacturer, model brand name may be used if fully equal or superior in all aspects. Contractor shall obtain prior approval from Engineer for substitute manufacturer prior to bid.

H. Should equipment furnished be different from the Model Numbers in the specifications, schedules, or drawings, the Contractor initiating such change will be responsible for all extra costs.
   1. Acceptance of substitutions shall in no way relieve the Contractor from the responsibility for any deficiency, which may exist in the substitute product, or that may result from performing the required work with the substitute.
   2. If the accepted substitutions shall require changes or modifications to the work of any other trades, such changes shall be considered part of the substitution and shall be coordinated and performed by the Contractor at no additional cost to the Owner.
   3. Verify and coordinate all dimensions and other pertinent characteristics of the substituted materials with the requirements of all other parts of the building system and project.
   4. Contractor shall provide submittals for substitute equipment, per Division 1 & Division 22 requirements.

I. References to Contract Documents refers to a complete set of Drawings and Specifications for the entire Project. Drawings and Specifications are intended to supplement one another. Provide items shown on the Drawings but not mentioned in the Specifications and items mentioned but not shown the same as if they were both mentioned and shown. Bid the most expensive interpretation of a conflict between Drawings and Specifications so the conflict can be resolved with a deduct rather than an add to the contract amount

1.05 SUBMITTALS

A. The equipment manufacturer shall submit an electronic copy of Submittals to the Contractor. The Contractor will review, stamp, and send electronic copy to the Engineer for review. The Engineer will retain one (1) reviewed copy for his/her files, forward one (1) copy to the Architect, forward one (1) copy to Owner of the final submittal and return one (1) copy to the Contractor to be incorporated into the Maintenance & Operating Instructions Manuals.

B. If equipment manufacturer or Contractor elects to issue submittals electronically, the equipment manufacturer shall submit one (1) copy of Submittals to the Contractor. The Contractor will review, stamp, and send to the Engineer for review. The Engineer will retain reviewed copies for his/her files and forward copy to the Architect, Owner of the final submittal, and to the Contractor to be incorporated into the Maintenance & Operating Instructions Manuals.

C. Manufacturer's standard dimension drawings, performance and product data shall be edited to delete reference to equipment, features or information which is not applicable to the equipment being supplied for this project.

D. All shop drawings must be reviewed and accepted by the Engineer prior to fabrication and installation.

E. Provide sufficient copies of approved data with the Engineers approved stamp for inclusion in the Operation and Maintenance Manuals as specified in this Section.

F. Submittals on all equipment shall be submitted for approval with-in one month of Contract award.

G. In addition to the hard paper copy shop drawing, supply one (1) copy of the maintenance shop drawing and maintenance data for the respective equipment on electronic format.

H. Allow a minimum of fourteen (14) calendar days for the Engineer to review the shop drawings. Time is from the receipt of drawings in the Engineers office until they are shipped out of the office.

I. If the Engineer rejects (Make corrections as noted/Submit Specified Item, Rejected/Submit specified item) two (2) times for the same section the Engineer will be compensated for the additional reviews. Compensation will be incorporated by Change Order and deducted from the Contractor's application for payment. Contractor is responsible for delays caused by the re-submittal process.

1.06 ELECTRONIC DRAWING FILE

A. The Mechanical CAD drawing files prepared by Karges-Faulconbridge, Inc. for this project are Instruments of KFI for use solely with respect to this project and will not be made available to the Contractor.

B. Request CAD drawing files of Architectural floor plans, elevations, sections, etc directly from the Architect.

1.07 OPERATION AND MAINTENANCE MANUAL

A. The Division 22 Contractors shall compile O&M manuals for every piece of Division 22 equipment, including owner-provided equipment and building operating system.
   1. Format
      a. 8 ½" x 11" loose leaf binders.
      b. Each binder shall be clearly labeled on the spine and cover with printed title "OPERATION AND MAINTENANCE INSTRUCTIONS", title of project and subject matter of binder when multiple binders are required.
      c. Use as many binders as required. Do not overload binders.
      d. There shall be dividers with permanently marked tabs of card stock separating each section and sub section.
      e. Tab labels shall be typed.
      f. Project extraneous information needs to be removed or clearly crossed out.

g. There shall be a title page and table of contents in the front of each binder for each binder's contents. In each binder, there shall be a main tab for each specification section.

2. Submittal
   a. Submit 1 draft copy of completed volumes 60 days prior to substantial completion.
   b. This copy will be reviewed and returned with comments. Revise content of all document sets as required prior to final submission.
   c. Submit three (3) (coordinate number with Owner) hard copies of the Operation and Maintenance Manuals for all systems and equipment and also two (2) electronic copies within 15 days of receipt of review comments. The electronic version shall follow the format of the paper version and be in PDF format.
   d. All O&M manuals shall also be submitted in electronic format, submitted on CD-Rom. Scanned-in information is acceptable only if saved to Adobe "PDF" format and extraneous information has been deleted.
   e. The Owner may with-hold the monthly payment if O & M manuals have not been submitted in accordance with the schedule above.
3. Content
   a. Contacts / Equipment Listing
      1) The first page behind the equipment tab shall contain the name, address and telephone number of the manufacturer, installing contractor and subcontractors and the 24-hour number for emergency warranty service for all equipment in the section identified by equipment. It shall also clearly list each equipment item within that section, using assigned equipment numbering from construction documents.
   b. Submittal and Product Data
      1) Approved submittal data, cut sheets and appropriate shop drawings, including Engineer's review and comments. If submittal was not required for approval, descriptive product data shall be included.
   c. System Description: Descriptive summary of function, normal system operating characteristics and limitations. This will be provided by the Engineer for insertion in binders.
   d. Operation and Maintenance Instructions: These shall be the written manufacturer's data with the model and features of this installation clearly marked and edited to omit reference to products or data not applicable to this installation. This section shall include data on the following:
      1) Manufacturer's printed operating procedures to include start-up, break-in, routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and seasonal operating instructions.
      2) O&M and installation instructions that were shipped with the unit.
      3) Preventative maintenance and service procedures and schedules.
      4) Troubleshooting procedures.
      5) A parts list, edited to omit reference to items which do not apply to this installation.
      6) A list of any special tools required to service or maintain the equipment.
      7) Disassembly, repair, and re-assembly; aligning and adjusting instructions.
      8) Servicing instructions and lubrication charts and schedules.

9) Wiring diagrams
10) Warranty, which clearly lists conditions to be maintained to keep warranty in effect and conditions that, would affect the validity of the warranty.

1.08 WARRANTY

A. This Contractor shall warranty all materials, equipment, workmanship and the successful operation of all apparatus furnished and installed under this contract for a period of one (1) year from the issuance of the final Certificate of Substantial Completion, except if noted otherwise. This Contractor shall guarantee to repair or replace at his own expense, any part of the apparatus which may show defect, in the opinion of the Architect or Engineer, due to imperfect material, equipment, or workmanship. Individual warranties are as per manufacturer's standard unless extended warranties are specified. Copies of manufacturer's warranty for each piece of equipment shall be given to Owner.

B. Warranty related repairs or replacement shall be scheduled within 14 days of notice by the ARCHITECT/ENGINEER. Schedule and perform repairs immediately if delay interferes with Owner occupancy or will result in damage to the Owner facility.

1.09 COMPLAINTS DUE TO ADJUSTMENT OR REPAIR

A. Any complaints received by the Architect or Engineer due to adjustments, repair of operation, difficulties, or the need for replacement within the construction phase or the guarantee time will be turned over to the Contractor.

B. Upon the receipt of complaint by letter, fax or telephone, the Contractor shall investigate complaint immediately, and complete the necessary work within seventy-two (72) hours, or as directed in writing by the Architect or Engineer.
   1. When any delay in repair or replacement would result in damage to the Owner's facility or affect Owner occupancy and intended use, or to maintain design environmental conditions, the Contractor shall respond within four (4) hours of notice.

1.10 UTILITY PERMITS, FEES LICENSES & SERVICES

A. All plan reviews, permits, licenses, fees and service charges required in connection with the work of this division shall be secured and paid for by this Contractor. This includes water, sewer and other utility hookup charges and meter deposits.

B. Schedule and coordinate all work with government agencies and utility companies. Arrange for all inspections and furnish Owner with certification of final inspection and any other approvals as required by enforcement authorities.

C. Arrange with appropriate utility companies to provide temporary and permanent utility services as required and coordinate their installation with construction progress of this project. Pay all fees and costs charged by utility companies for utility services.

1.11 CODES AND STANDARDS

A. Work shall meet or exceed the requirements of the latest codes, ordinances, and regulations applicable to the project.
   1. All installations shall conform to the following codes and regulations amended to this date:
      a. State and Local Heating, Ventilating, Air Conditioning and Refrigeration Codes
      b. State and Local Plumbing Codes
      c. State and Local Building Codes
      d. State and Local Electrical Codes
      e. State and Local Mechanical Codes
      f. State and Local Elevator Codes
      g. Americans with Disabilities Act
      h. Municipal Water and Sewer Regulations
      i. National Electrical Code
      j. State and Local Board of Health Regulations
      k. Local Applicable Ordinances
      l. State and Local Fire Codes and Regulations
      m. Gas Company Requirements
      n. Occupational Safety and Health Act (OSHA)
      o. State and Local Energy Code
   2. All materials and equipment supplied shall conform to the following standards amended to this date:
      a. American Society of Mechanical Engineers (ASME)
      b. American Gas Association (AGA)
      c. Sheet Metal and Air Conditioning Contractors National Association (SMACNA)
      d. Underwriters Laboratories (UL)
      e. National Electrical Manufacturers Association (NEMA)
      f. Manufacturer’s Standardization of the Valve & Fitting Ind.
      g. American Welding Society (AWS)
      h. American Society for Testing Material (ASTM)
      i. American National Standards Institute (ANSI)
      j. American Water Works Association (AWWA)
      k. American Society of Mechanical Engineers Boiler Code
      l. Air Moving and Conditioning Association (AMCA)
      m. Air Conditioning and Refrigeration Institute (ARI)
      n. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
      o. Sheet Metal and Air Conditioning Contractors National Association
      p. Occupational Safety and Health Act (OSHA)

B. Higher quality of workmanship and materials indicated in the Contract Documents takes precedence over that allowed in referenced codes and standards.

C. Inform the Engineer of any discrepancies between the Contract Documents and the prevailing codes and regulations. Correction of any non-compliant work completed prior to notification of the Engineer will be paid for by this Contractor.

1.12 COORDINATION OF WORK

A. The Division 22 Mechanical Contractors shall set up and submit their respective coordination drawings for overall plumbing, hydronic piping, sheet metal, sprinkler, general construction, and electrical coordination. The Mechanical Contractor shall follow Division 1 and Division 22 requirements for the contractor's coordination drawings.

B. Contractor shall proceed to measure, layout, fabricate and install piping systems when mechanical equipment is supplied by either the contractor or the owner, even if mechanical equipment is not yet available to the contractor.
   1. Obtain and review dimensions and installation requirements for the mechanical equipment prior to equipment arrival.
   2. Fabricate and install mock-up units when required to assist with the fabrication and installation of the ductwork and piping systems.

C. Coordinate work with that of other Contractors. Organize work so that it will not interfere with or delay the work of other Contractors.

D. Field verify dimensions on Drawings since actual locations, distances and levels will be governed by actual field conditions. Field verify all conditions before starting work.

E. Consult the Drawings and specifications for work to be provided by other trades for coordinating information including details, dimensions, alignment, elevation, foundations, pits, and other interference's to avoid possible installation or future access for adjustment, operation and maintenance conflicts.
   1. Should changes from the original Drawings be required to resolve such conflicts notify the Engineer and secure approval and agreement on necessary adjustments before the installation is started. Make all arrangements for the entry of equipment to the installed locations.

F. Do not install any mechanical systems or portions thereof above electrical panels and within code clearance distances in front of and on sides of electrical panels.

G. Route all mechanical systems or portions thereof around transformer vaults, other electrical spaces, elevators, elevator equipment rooms, or electrical equipment spaces and enclosures.

H. Layout all piping systems in careful coordination with the Drawings and site conditions.
   1. Determine proper location and elevation of all components.
   2. Install the minimum number of bends possible to produce a satisfactorily functioning system.
   3. Layout all pipes within partitions, walls, roof cavities and ceiling spaces unless furred out spaces or soffits are indicated on the Architectural drawings.

I. Coordinate layout and installation to ensure that clearances are maintained to accommodate future Owner operations, adjustment, maintenance and repair of the equipment.

J. Where coordination or field conditions require considerable deviation from plans, the contractor shall contact the Engineer for approval prior to proceeding.

K. Verify prior to printing, labeling, ordering, or programming that the room names and room numbers utilized match the actual final installed room names and room numbers. Coordinate with Owner and architect for final room numbering to be utilized.

1.13 ELECTRICAL

A. Magnetic starters, disconnects, and power wiring are provided elsewhere, unless otherwise specified.

B. Provide control and interlock wiring, unless otherwise specified.

C. Short Circuit Current Rating (SCCR):
   1. All mechanical equipment shall have SCCR withstand ratings equivalent to or greater than the available fault current (AFC) at the equipment. Under no circumstances may SCCR values be lower than the available fault current.
   2. Refer to ELECTRICAL EQUIPMENT SCHEDULES and MOTOR & EQUIPMENT SCHEDULES for minimum SCCR values of all electrical equipment including starters, disconnects, VFDs, controls, and motors furnished by this contractor.
   3. Where applicable, refer to results from Power Systems Studies in Division 26 for available fault current at equipment.

1.14 PROTECTION OF EQUIPMENT & MATERIALS

A. Receive and properly protect all equipment and material required for this Contract including any or all Owner furnished equipment.
   1. Damaged equipment shall be placed in original operating condition or returned to source of supply for repair or replacement, as determined by the Architect/Engineer.
   2. Equipment, ducts and piping systems shall be protected against entry of foreign matter during fabrication, storage, and installation and shall be cleaned both inside and outside before operation and painting.
   3. Receive and properly store equipment and materials in approved locations away from damaging traffic and interference. Store equipment and materials indoors to prevent water damage.

B. Protect and take precautions to prevent damage to existing equipment, piping, ductwork, electrical, fireproofing, insulation, structure and other building systems, elements and components.
   1. Protect these existing systems against entry of foreign matter during construction from all trades.
   2. Any building systems, elements and components that are accidentally or purposely disturbed or damaged by this Contractor's work shall be restored to the original undisturbed condition, including floor, roof, ceiling, wall and other finished surfaces, stored material, hardware, structure disturbed or otherwise damaged.
   3. Water damage or other subsequent damages caused by this contractor shall also be restored to the original undisturbed condition at this contractor's expense.

C. Cutting and Patching:
   1. Perform all cutting and patching necessary to work, unless specifically delegated to other Contractors. Obtain special permission from the Engineer before cutting

structural members or finished material. Perform all patching in such a manner as to leave no visible trace and return the area affected to the condition of undisturbed work. Perform all patching by workers experienced, skilled, and licensed for the particular type of work involved. Inferior work will not be accepted.

2. Patch all holes left as a result of demolition of mechanical equipment and devices.
3. Drill all holes in masonry with rotary drill. Impact tools are not allowed. Core drill all holes in masonry and concrete for mechanical penetrations. Provide and dispose of all water required for core drilling. Coordinate with other trades to prevent damage from water.
4. Prevent the spread of dust, debris, and other material into adjacent areas.
5. Replace all ceiling tiles damaged during installation of work, with new tile.

D. Painting:
   1. Refinish all mechanical equipment damaged during shipping and/or installation to its original condition. Remove all rust; prime, and paint per manufacturer's recommendations for finish equal to original.

1.15 CONNECTIONS

A. Make connections at terminal points of contact.
   1. Where connections are made to equipment furnished by others, obtain exact locations of connections from persons furnishing the equipment and make the connections.
   2. Provide required connection pieces, including but not limited to, mating flanges, dielectric fittings, fasteners, couplings, supports, insulation and vapor barrier.

1.16 START UP & DEMONSTRATION

A. Confirm that all systems are installed, aligned, adjusted, balanced and operating in accordance with requirements of Contract Documents prior to Architect, Engineer, and Owner Demonstration Tests.

B. Perform repairs required to place all systems in proper operating condition.

C. Provide all lubrication, check, test, and start-up services, supervise the initial operation of all equipment and demonstrate to the Owner's representative that all equipment is properly operating.
   1. Make adjustments and repairs as required for the Owner's complete satisfaction.

D. Mechanical Contractor shall provide a minimum of 4 hours of training on building mechanical systems for personnel selected by the owner. Mechanical contractor shall provide owner 2 weeks' notice when scheduling training, coordinate training with Owner. O&M manuals shall be submitted and approved before training so they are available for reference during training.

1.17 PREPARATION

A. Continuity of Service:

1. Coordinate/schedule all work with the Owner to minimize any disruptions. Confine all interruptions to the smallest possible area. Provide temporary connections if required to provide continuity of service.
2. Inspect all areas affected by the interruptions and return all automatically controlled equipment, electrically operated equipment to the same operating condition prior to the interruption.
3. No fire sprinkler or fire alarm systems are to remain inactive at the end of the work day. Assure that the fire sprinkler or fire alarm system is operational at the end of each work day. Coordinate with Owner.

B. Use of Facility:
1. Do not disturb normal use of the facility, except within the immediate construction area. Keep walks, driveways, entrances, etc. free and clear of equipment, material and debris.
2. Store all equipment and material in a place and manner that minimizes congestion and is approved by Owner.

1.18 RENOVATION & DEMOLITION WORK IN EXISTING BUILDING

A. Verify all existing conditions prior to submitting bid.

B. Remove, relocate and/or reroute existing work as required for the installation of construction.
1. Materials and equipment removed shall be shown to and inspected by the Owner. Those materials and equipment not claimed by the Owner shall be removed from the site.
2. Dust, dirt, noise and vibration from the work shall be controlled as required by the Owner to prevent damage to other facility systems or interfere with Owner occupancy.
3. Provide plastic sheet temporary carrier walls around work where not provided by the General Contractor.
4. Piping and ductwork shall be capped behind finished surfaces.
5. Review and coordinate work with the demolition and abatement contractors.

C. Coordinate the installation of pipe and duct sleeves through floors, walls and foundation wall penetrations.
1. All duct and pipe penetrations to be over cut a minimum of ½” clear and a maximum of 1” clear around perimeter of finished pipe or duct system.
2. Provide dust containment and removal in all areas of work.
3. Repair damaged wall with backup wall and finish to match existing.
4. General Contractor shall provide specialty finishes such as terrazzo, tile or brick finishes unless otherwise indicated. For finishes, refer to Architectural room finish schedule.
5. Above ceiling or in mechanical storage and custodial rooms, repair all areas around penetrations with back up wall to match existing. Provide continuous batt insulation with caulking encapsulation around duct and sheet metal sleeves.
6. Provide fire caulking as required in fire rated walls.
7. Provide lintels at mechanical openings per Architectural lintel schedule unless noted otherwise on structural drawings.

D. Coordinate demolition and construction with General Contractor and Owner asbestos abatement Contractor.
   1. Provide isolation valves and hose bibs during construction as required to drain equipment and piping for demolition and to isolate and maintain operation of existing system.
   2. Water and heating equipment shutdown shall be coordinated with General Contractor and the Owner.
   3. Existing air systems shall not be run after Abatement Contractor starts work.

E. When work areas or spaces are classified as an O.S.H.A. Class I confined space. Contractor shall verify and include requirements, training, procedures and equipment for performing work in those environments.

1.19 CLEAN UP

A. Keep the premises free from accumulation of waste material or rubbish, caused by his employees or work, at all times. Remove rubbish, tools, scaffolding, and surplus materials from and about the building, and leave work areas “broom clean” or its equivalent upon completion of the work. Clean mechanical equipment and remove temporary identification.

B. In case of dispute, the Owner will remove the rubbish and charge the cost to the Contractor.

1.20 COMMISSIONING

A. Work provided under this contract will be commissioned under the direction of the Commissioning Authority who will be retained by the Owner under separate contract.

B. Each subcontractor and supplier of equipment under this contract shall include as part of their work, all-necessary costs and services to participate as required in the Commissioning process.

C. This will include preparation of operation and maintenance manuals, building operator training and participation in system performance testing and pre-functional and functional verification.

D. The respective Division 22 contractors shall certify that systems have been flushed, filled and tested, and is ready for commissioning.
   1. Any re-work by the commissioning agent due to discovery that this work is, in fact, not complete shall be paid for out of the respective Division 22 contract price by deduct change order.
   2. Re-work shall not relieve the respective Division 22 contractor from contractual obligation to meet completion dates.

1.21 RECORD DOCUMENTS

A. Prepare record documents in accordance with the requirements in Division 1. In addition to the requirements specified in Division 1, refer to specific sections for additional record documentation.

1.22 DELIVERY, STORAGE & HANDLING

A. General: Follow procedures specified in Division 1 and as outlined below.
   1. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.
   2. Storage of materials and equipment shall not impede the work of other contracts.
   3. Protect all components of the mechanical installation from becoming contaminated or otherwise damaged in delivery or storage.
   4. Handling of equipment and products shall be according to manufacturer's instructions and in compliance with the articles of their warranty.
   5. Protect products from weather, unless product is slated for exterior installation. If outdoor storage is necessary, support products off the ground or pavement in watertight enclosures that will not result in corrosion, temperature stress, or other damage to the products.

1.23 SURPLUS SPARE PARTS

A. The contractor shall be responsible for providing all spare parts listed in the contract documents and shall coordinate the delivery of the spare parts furnished through the Owner's procurement package.
   1. Schedule delivery of all spare parts to the site.
   2. Deliver spare parts to the project properly identified with names, model numbers, and types.
   3. Protect and store spare parts to protect contamination or damage.
   4. Obtain signature of approval of delivery by the ARCHITECT/ENGINEER and the Owner Project Manager.

1.24 FIRE SAFETY PRECAUTIONS

A. The Contractors shall exercise extreme care to maintain and exercise adequate fire safety precautions throughout the work. This shall include providing sufficient fire extinguishing devices, watchmen, standby helpers or other precautions during construction, in use of temporary heat, welding, brazing, sweating, testing or other phases of work.

B. At all times, access shall be maintained for fire department equipment and personnel access to the building.

C. All welding, brazing, cutting and sweating operations performed in vicinity of or accessible to combustible materials shall be adequately protected to make certain that sparks or hot slag does not reach the combustible material and start a fire.

D. All glass, glazed materials and other finishes, in the vicinity of welding, brazing and cutting, shall be masked and protected from damage by the Contractor performing the welding work.

E. When necessary to do cutting, welding, brazing, sweating and similar work in vicinity of wood, in shafts, or vicinity of any combustible material (and the combustible material cannot be removed), the materials shall be adequately protected with fire resistant blankets or similar approved coverings. In addition, a helper shall be

stationed nearby with proper fire extinguishers (provided by the Contractor performing the work) to guard against sparks and fire.

F. Whenever combustible materials have been exposed to sparks, molten metal, hot slag or splatter, a person shall be kept at the place of work to make sure the smoldering fires have not been started.
   1. Whenever cutting or welding operations are carried on in a vertical pipe shaft, a person to act as a fireguard shall be employed to examine all areas in the area of work and below the point of cutting or welding.
   2. This fireguard shall be kept on duty after completion of work to guard against fires and shall examine each level after this time, prior to leaving.
   3. There shall be no exceptions to this requirement and failure to comply will be construed as negligence.

1.25 SALVAGEABLE MATERIALS

A. Owner may salvage some equipment and materials from the building that are part of system scheduled for mechanical demolition.

B. Owner shall have the opportunity to access and perform the salvage work prior to the contractor's demolition or during demolition work. Owner will coordinate the salvage work with Contractor.

1.26 CONTRACTOR WORK

A. If work does not proceed in a timely manner in the opinion of the Owner and Engineer, the Owner reserves the right to bring in other Contractors to complete specific areas of work. The cost for this work will be deducted from this contract.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION – NOT USED

END OF SECTION 22 05 00

SECTION 22 05 19

METERS AND GAUGES FOR PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Pressure Gauges:
   1. Bourdon tube for liquids and gases.

B. Thermometers.

1.02 REFERENCE STANDARDS

A. ASME B40.100 - Pressure Gauges and Gauge Attachments; 2013.

B. ASTM E1 - Standard Specification for ASTM Liquid-in-Glass Thermometers; 2014.

C. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers; 2014 (Reapproved 2021).

PART 2 PRODUCTS

2.01 PRESSURE GAUGES

A. Manufacturers:
   1. Ashcroft, Inc: www.ashcroft.com/#sle.
   2. Dwyer Instruments, Inc: www.dwyer-inst.com/#sle.
   3. Moeller Instrument Company, Inc: www.moellerinstrument.com/#sle.
   4. Omega Engineering a subsidiary of Spectris, Plc; [_____]: www.omega.com/#sle.
   5. Weksler Glass Thermometer Corp: www.wekslerglass.com/#sle.
   6. Substitutions: See Section 01 60 00 - Product Requirements.

B. Bourdon Tube for Liquids and Gases:
   1. Dial Size and Cover: 4-1/2 inch diameter scale with polycarbonate window.
   2. Dial Text and Markings: Black color on white background with scaled kPa and psi units.
   3. Accuracy: ASME B40.100, adjustable commercial grade (D) with 5 percent of span.
   4. Process Connection: Lower-back, 1/4 inch NPT male except where noted.

2.02 THERMOMETERS

A. Manufacturers:
   1. Dwyer Instruments, Inc: www.dwyer-inst.com/#sle.
   2. Moeller Instrument Company, Inc: www.moellerinstrument.com/#sle.
   3. Watts Water Technologies, Inc: www.watts.com/#sle.
   4. Weiss Instruments, LLC: www.weissinstruments.com/#sle.
   5. Weksler Glass Thermometer Corp: www.wekslerglass.com/#sle.

6. Substitutions: See Section 01 60 00 - Product Requirements.

B. General:
   1. Product Compliance: ASTM E1.
   2. Lens: Clear glass, except where stated.
   3. Accuracy: One percent, when tested in accordance with ASTM E77, except where stated.
   4. Scale: Black markings depicting single scale in degrees F where expected process value falls half-span of standard temperature range.

C. Thermometers - Straight: 5 inch v-shape lead-free brass case with clear glass window scale, 2 inch NPT stem, 3-1/4 inch NPT thermowell, and red or blue non-toxic organic liquid filled glass tube.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install pressure gauges as follows:
   1. At Pumps: Place single gauge before strainer, suction side and discharge side.

B. Install thermometers as follows:
   1. Hot Water Heaters: Place upstream and downstream of heater. Add one on the inlet end when using steam as the water heating medium.

END OF SECTION 22 05 19

SECTION 22 05 53

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Nameplates.

B. Pipe markers.

1.02 RELATED REQUIREMENTS

A. Section 09 91 23 - Interior Painting: Identification painting.

1.03 REFERENCE STANDARDS

A. ASME A13.1 - Scheme for the Identification of Piping Systems; 2015.

PART 2 PRODUCTS

2.01 PLUMBING COMPONENT IDENTIFICATION GUIDELINE

A. Nameplates:
   1. Heat exchangers, water heaters, and other heat transfer products.
   2. Control panels, transducers, and other related control equipment products.
   3. Pumps, tanks, filters, water treatment devices, and other plumbing equipment products.

B. Pipe Markers: 3/4 inch diameter and higher.

2.02 NAMEPLATES

A. Description: Laminated piece with up to three lines of text.
   1. Letter Color: White.
   2. Letter Height: 1/4 inch.

2.03 PIPE MARKERS

A. Flexible Tape Marker: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

B. Identification Scheme, ASME A13.1:
   1. Primary: External Pipe Diameter, Uninsulated or Insulated.
      a. 3/4 to 1-1/4 inches: Use 8 inch field-length with 1/2 inch text height.
      b. 1-1/2 to 2 inches: Use 8 inch field-length with 3/4 inch text height.
      c. 2-1/2 to 6 inches: Use 12 inch field-length with 1-1/4 inch text height.
   2. Secondary: Color scheme per fluid service.
      a. Water; Potable, Cooling, Boiler Feed, and Other: White text on green background.
      b. Natural gas: Black text on yellow background.

PART 3 EXECUTION

3.01 PREPARATION

A. Degrease and clean surfaces to receive identification products.

3.02 INSTALLATION

A. Install flexible nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

B. Install plastic tape pipe marker around pipe in accordance with manufacturer's instructions.

C. Apply ASME A13.1 Pipe Marking Rules:
   1. Place pipe marker adjacent to changes in direction.
   2. Place pipe marker adjacent each valve port and flange end.
   3. Place pipe marker at both sides of floor and wall penetrations.
   4. Place pipe marker every 25 to 50 feet interval of straight run.

END OF SECTION 22 05 53

SECTION 22 07 19

PLUMBING PIPING INSULATION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes insulating the following plumbing piping services:
   1. Domestic cold-water piping.
   2. Domestic hot-water piping.
   3. Domestic recirculating hot-water piping.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied, if any).

1.04 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.07 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.08 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 PRODUCTS

2.01 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Aeroflex USA, Inc.; Aerocel.

b. Armacell LLC; AP Armaflex.
c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.

G. Mineral-Fiber, Preformed Pipe Insulation:
1. Products: Subject to compliance with requirements, provide one of the following:
a. Fibrex Insulations Inc.; Coreplus 1200.
b. Johns Manville; Micro-Lok.
c. Knauf Insulation; 1000-Degree Pipe Insulation.
d. Manson Insulation Inc.; Alley-K.
e. Owens Corning; Fiberglas Pipe Insulation.
2. Type I, 850 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.02 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
1. Products: Subject to compliance with requirements, provide the following:
a. Ramco Insulation, Inc.; Super-Stik.

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
1. Products: Subject to compliance with requirements,:
a. Ramco Insulation, Inc.; Thermokote V.

C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.
1. Products: Subject to compliance with requirements, provide the following:
a. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.

2.03 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Aeroflex USA, Inc.; Aeroseal.
b. Armacell LLC; Armaflex 520 Adhesive.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
d. K-Flex USA; R-373 Contact Adhesive.
e. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
f. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
   b. Eagle Bridges - Marathon Industries; 225.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
   d. Mon-Eco Industries, Inc.; 22-25.
2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. ASJ Adhesive, Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
   b. Eagle Bridges - Marathon Industries; 225.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-20.
   d. Mon-Eco Industries, Inc.; 22-25.
2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. PVC Jacket Adhesive: Compatible with PVC jacket.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Dow Corning Corporation; 739, Dow Silicone.
   b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
   c. P.I.C. Plastics, Inc.; Welding Adhesive.
   d. Speedline Corporation; Polyco VP Adhesive.
2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.04 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
   1. Products: Subject to compliance with requirements, provide the following:
      a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
      b. Vimasco Corporation; 749.
   2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
   3. Service Temperature Range: Minus 20 to plus 180 deg F.
   4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
   5. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.
   1. Products: Subject to compliance with requirements, provide the following:
      a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Encacel.
      b. Eagle Bridges - Marathon Industries; 570.
      c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 60-95/60-96.
   2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
   3. Service Temperature Range: Minus 50 to plus 220 deg F.
   4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
   5. Color: White.

D. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
   1. Products: Subject to compliance with requirements, provide the following:
      a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
      b. Eagle Bridges - Marathon Industries; 550.
      c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
      d. Mon-Eco Industries, Inc.; 55-50.
      e. Vimasco Corporation; WC-1/WC-5.
   2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
   3. Service Temperature Range: Minus 20 to plus 180 deg F.
   4. Solids Content: 60 percent by volume and 66 percent by weight.
   5. Color: White.

2.05 SEALANTS

A. Joint Sealants:

B. Metal Jacket Flashing Sealants:
   1. Products: Subject to compliance with requirements, provide the following:
      a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.

b. Eagle Bridges - Marathon Industries; 405.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
d. Mon-Eco Industries, Inc.; 44-05.
e. Materials shall be compatible with insulation materials, jackets, and substrates.
f. Fire- and water-resistant, flexible, elastomeric sealant.
g. Service Temperature Range: Minus 40 to plus 250 deg F.
h. Color: Aluminum.
i. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
j. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:
1. Products: Subject to compliance with requirements, provide the following:
a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.06 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

2.07 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
1. Products: Subject to compliance with requirements, provide the following:
a. Johns Manville; Zeston.
b. P.I.C. Plastics, Inc.; FG Series.
c. Proto Corporation; LoSmoke.

d. Speedline Corporation; SmokeSafe.
e. Adhesive: As recommended by jacket material manufacturer.
f. Color: White.
g. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
    1) Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

2.08 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
    1. Products: Subject to compliance with requirements, provide the following:
        a. ABI, Ideal Tape Division; 428 AWF ASJ.
        b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
        c. Compac Corporation; 104 and 105.
        d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
        e. Width: 3 inches.
        f. Thickness: 11.5 mils.
        g. Adhesion: 90 ounces force/inch in width.
        h. Elongation: 2 percent.
        i. Tensile Strength: 40 lbf/inch in width.
        j. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
    1. Products: Subject to compliance with requirements, provide the following:
        a. ABI, Ideal Tape Division; 370 White PVC tape.
        b. Compac Corporation; 130.
        c. Venture Tape; 1506 CW NS.
    2. Width: 2 inches.
    3. Thickness: 6 mils.
    4. Adhesion: 64 ounces force/inch in width.
    5. Elongation: 500 percent.
    6. Tensile Strength: 18 lbf/inch in width.

C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
    1. Products: Subject to compliance with requirements, provide the following:
        a. ABI, Ideal Tape Division; 488 AWF.
        b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
        c. Compac Corporation; 120.
        d. Venture Tape; 3520 CW.
    2. Width: 2 inches.
    3. Thickness: 3.7 mils.
    4. Adhesion: 100 ounces force/inch in width.
    5. Elongation: 5 percent.
    6. Tensile Strength: 34 lbf/inch in width.

2.09 SECUREMENTS

A. Bands:
   1. Products: Subject to compliance with requirements, provide the following:
      a. ITW Insulation Systems; Gerrard Strapping and Seals.
      b. RPR Products, Inc.; Insul-Mate Strapping and Seals.
      c. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

C. Wire: 0.062-inch soft-annealed, stainless steel.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. C & F Wire.

2.10 PRE-INSULATED PIPE SUPPORTS

A. Required for insulated pipes conveying fluids below ambient temperature.

B. Material
   1. Properly selected high performance foam, encased in a 360 degree A-527 Galvanized Sheet Metal Jacket. Minimum 100 PSI compressive strength.

C. Insulated Saddles:
   1. Insulated saddles shall be a complete composite assembly.
   2. Saddles for cold applications should have a 360 degree section of properly selected high performance foam insulation.
   3. The Insulation should feature a longitudinal lock joint seam where possible, to provide a longer offset thermal path to the cold pipe surface.
   4. All cold service saddles should have a minimum 6 mil thickness film vapor retarder unless ASTM E84 compliance requires a laminated foil based all service jacket type barrier. This feature should incorporate a self sealing lap.
   5. The 180 degree steel shield used to support the assembly should be flared at both ends to provide maximum insulation (and vapor barrier) protection at all hanger locations and be constructed of highest quality rust resistant G-90 galvanized steel (or type 304 stainless steel alloy where required) in 22 through 12 gauge thickness, depending on pipe size to provide positive hanger security and aid in rapid installation.

D. Wooden blocking is not acceptable.

E. Not required if insulation has higher compressive strength than required to support the pipe. Compressive strength calculations must be submitted and approved by the Engineer

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
   1. Verify that systems to be insulated have been tested and are free of defects.
   2. Verify that surfaces to be insulated are clean and dry.
   3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
   1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
   2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.03 GENERAL INSTALLATION REQUIREMENTS

A. Install piping insulation in accordance with the current edition of the National Commercial & Industrial Insulation Standards Manual.

B. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

C. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

D. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

E. Install insulation with longitudinal seams at top and bottom of horizontal runs.

F. Install multiple layers of insulation with longitudinal and end seams staggered.

G. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

H. Keep insulation materials dry during application and finishing.

I. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

J. Install insulation with least number of joints practical.

K. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

L. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

M. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
      a. For below-ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

N. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

O. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

P. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

Q. For above-ambient services, do not install insulation to the following:
   1. Vibration-control devices.
   2. Testing agency labels and stamps.
   3. Nameplates and data plates.
   4. Cleanouts.

3.04 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
   4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
   4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
   1. Comply with requirements in Division 07 Section "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:
   1. Pipe: Install insulation continuously through floor penetrations.
   2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.05 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
   1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
   2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. 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.
   3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
   4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
   5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
   6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
   7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
   8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
   9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around

the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
   1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
   2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
   3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
   4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
   5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

E. Buried Piping: Provide factory fabricated assembly with inner all-purpose service jacket with self-sealing lap, and asphalt impregnated open mesh glass fabric, with one mil thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with a polyester film.

F. Heat Traced Piping: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer cover with aluminum jacket with seams located on bottom side of horizontal piping.

G. Pre insulated pipe supports: Butt the pipe insulation to each end of the pre-insulated pipe support devices. Care shall be taken in making the butt joint so that the thermal and vapor barrier integrity of the joint is assured. Use extra care on the joints for all cold piping systems.

H. Saddles, Inserts and Shields:
   1. Application: Piping 2” diameter or larger
   2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
   3. Saddles: Carbon steel, designed to support pipe between shield and pipe, notched to minimize heat loss.
   4. Insert location: Between support shield and piping and under the finish jacket.
   5. Insert configuration: Minimum 6” long, of same thickness and contour as adjoining insulation; may be factory fabricated.

I. Insert material (Above Ambient Temperatures): Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.

3.06 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:
   1. Install pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
   4. Secure insulation to flanges and seal seams with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install mitered sections of pipe insulation.
   2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed valve covers manufactured of same material as pipe insulation when available.
   2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Install insulation to flanges as specified for flange insulation application.
   4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.07 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
   2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
   4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.08 INSTALLATION OF POLYOLEFIN INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
1. Seal split-tube longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:
1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as pipe insulation.

C. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
1. Insulation Installation on Pipe Fittings and Elbows:
a. Install mitered sections of polyolefin pipe insulation.
b. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install cut sections of polyolefin pipe and sheet insulation to valve body.

2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.09 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
   1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
   2. Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.
   3. Completely encapsulate insulation with coating, leaving no exposed insulation.
   4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
   5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturers recommended adhesive.
   1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.10 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.
   1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
      a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.11 FIELD QUALITY CONTROL

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

B. Perform tests and inspections.

C. Tests and Inspections:

1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
2. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.12 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
   1. Drainage piping located in crawl spaces.
   2. Underground piping.
   3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.13 PIPING INSULATION SCHEDULE

PIPE LABEL	PIPING DESCRIPTION	PIPE SIZE	INSULATION CODE	INSULATION THICKNESS	JACKET CODE	NOTES
DHW	DOMESTIC HOT WATER (105-140° F)	0 – 1¼” 1½” +	2.1.G.	1” 1½”	-	1, 2, 3
DCW	DOMESTIC COLD WATER	ALL	2.1 F/H/I	1”	-	1, 2, 3

NOTES:

1. For outdoor installations, apply aluminum jacket (Code C) over specified jacket.
2. PVC jacket (Code B) required below 10’ – 0” A.F.F in exposed areas.
3. PVC jacket (Code B) required for all piping in exposed finished areas.

GENERAL NOTES:

No PVC jacket allowed in air plenum ceiling.

PIPING INSULATION CODES:

2.1. F. Flexible Elastomeric

2.1. G. Mineral Fiber

2.1. H. Polyolefin

2.1. I. Polyisocyanurate

PIPING JACKET CODES:

2.9. B. PVC

END OF SECTION 22 07 19

SECTION 22 10 05

PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Pipe, pipe fittings, valves, and connections for piping systems.
   1. Domestic water.
   2. Gas.
   3. Pipe hangers and supports.
   4. Ball valves.
   5. Gas pressure regulators.

1.02 RELATED REQUIREMENTS

A. Section 22 05 53 - Identification for Plumbing Piping and Equipment.

B. Section 22 07 19 - Plumbing Piping Insulation.

1.03 SUBMITTALS

A. See Section 22 05 00 Plumbing General Provisions, for submittal procedures.

B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.

C. Project Record Documents: Record actual locations of valves and cleanouts.

1.04 QUALITY ASSURANCE

A. Perform work in accordance with applicable codes; or applicable State Plumbing and City Standards.

B. Identify pipe with marking including size, ASTM material classification, ASTM specification, potable water certification, water pressure rating.

C. All materials used in potable water systems must meet the requirements of NSF 61. Pipe, valves, and fittings including recirculation piping with lead content must not exceed 0.25 percent lead in the wetted surface material. Solder and flux shall contain less than 0.2 percent lead. Joints must use ASTM B813 non-corrosive non-toxic paste-type flux.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Accept valves and piping on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary inlet and outlet caps.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

E. Store pipe in manner to prevent sagging and bending.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Potable Water Supply Systems: Provide piping, pipe fittings, and solder and flux (if used), that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.

B. Plenum-Installed Acid Waste Piping: Flame-spread index equal or below 25 and smoke-spread index equal or below 50 according to ASTM E84 or UL 723 tests.

2.02 DOMESTIC WATER PIPING, ABOVE GRADE

A. Copper Tube: ASTM B88 (ASTM B88M), Type L Hard Drawn.
   1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
   2. Joints: ASTM B32, alloy Sn95 solder.

2.03 NATURAL GAS PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53/A53M Schedule 40 black.
   1. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M, wrought steel welding type.
   2. Joints: Threaded or welded to ASME B31.1.

B. Copper Tube: ASTM B88 (ASTM B88M), Type L annealed.
   1. Fittings: ASME B16.22, wrought copper.
   2. Joints: Flared. AMSE B16.26 and SAEJ513.

2.04 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions: Description
   1. Description:
      a. Standard: ASSE 1079.
      b. Pressure Rating: 125 psig minimum at 180 deg F.
      c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:
   1. Description:

a. Standard: ASSE 1079.
b. Factory-fabricated, bolted, companion-flange assembly.
c. Pressure Rating: 125 psig minimum at 180 deg F.
d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:
1. Description:
a. Nonconducting materials for field assembly of companion flanges.
b. Pressure Rating: 150 psig.
c. Gasket: Neoprene or phenolic.
d. Bolt Sleeves: Phenolic or polyethylene.
e. Washers: Phenolic with steel backing washers.

2.05 PIPE HANGERS AND SUPPORTS

A. Provide hangers and supports that comply with MSS SP-58.
1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
2. Overhead Supports: Individual steel rod hangers attached to structure or to trapeze hangers.
3. Trapeze Hangers: Welded steel channel frames attached to structure.
4. Vertical Pipe Support: Steel riser clamp.

2.06 BALL VALVES

A. Manufacturers:
1. Conbraco Industries, Inc.
2. Crane, Co.
3. Milwaukee Valve Company.
4. Nibco, Inc.
5. Watts Regulator Co.
6. Substitutions: See Division 01.

B. Construction, 4 Inches and Smaller: MSS SP-110, Class 150, CWP, bronze two piece body, chrome plated brass ball, full port, blow-out proof stem, lever handle, with solder or threaded ends, extended stem.

2.07 SWING CHECK VALVES

A. Manufacturers:
1. Apollo.
2. Crane Company.
3. Hammond Valve.
4. Milwaukee Valve Company.
5. Nibco, Inc.
6. Substitutions: See Division 01.

B. Up to and including 2 Inches:

1. MSS SP-80, Class 125, bronze body and cap, bronze swing disc with rubber seat, solder or threaded ends.

C. Over 2-1/2 Inches:
1. MSS SP-71, Class 125, iron body, bronze swing disc, renewable disc seal and seat, flanged ends.

2.08 GAS PRESSURE REGULATORS

A. Manufacturers:
1. Maxitrol.
2. Fisher.

B. General Requirements:
1. Single stage and suitable for natural gas.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.

C. Service Pressure Regulators: Comply with ANSI Z21.80.
1. Body and Diaphragm Case: Cast iron or die-cast aluminum.
2. Springs: Zinc-plated steel; interchangeable.
3. Diaphragm Plate: Zinc-plated steel.
4. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
5. Orifice: Aluminum; interchangeable.
6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
7. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
8. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
9. Overpressure Protection Device: Factory mounted on pressure regulator.
10. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
11. Maximum Inlet Pressure: 100 psig.

D. Line Pressure Regulators: Comply with ANSI Z21.80.
1. Body and Diaphragm Case: Cast iron or die-cast aluminum.
2. Springs: Zinc-plated steel; interchangeable.
3. Diaphragm Plate: Zinc-plated steel.
4. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
5. Orifice: Aluminum; interchangeable.
6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
7. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
8. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
9. Overpressure Protection Device: Factory mounted on pressure regulator.

10. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
11. Maximum Inlet Pressure: 2 psig, 5 psig, or 10 psig.

E. Appliance Pressure Regulators: Comply with ANSI Z21.18.
1. Body and Diaphragm Case: Die-cast aluminum.
2. Springs: Zinc-plated steel; interchangeable.
3. Diaphragm Plate: Zinc-plated steel.
4. Seat Disc: Nitrile rubber.
5. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
6. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
7. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
8. Maximum Inlet Pressure: 1 psig, 2 psig, or 5 psig.

PART 3 EXECUTION

3.01 PIPING 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 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.

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 copper tubing under building slab according to CDA's "Copper Tube Handbook."

K. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing

Piping" and with requirements for drain valves and strainers in Section 221005 "Plumbing Piping."

L. Install shutoff valve immediately upstream of each dielectric fitting.

M. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.

N. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

O. 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.

P. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

Q. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

R. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

S. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."

T. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.02 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 pipes, tubes, and fittings before assembly.

C. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.

D. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

E. Extruded-Tee Connections: Form tee in copper tube according to ASTM F 2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.

F. 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.

3.03 SPECIALTY PIPE FITTING INSTALLATION

A. Dielectric Fittings:
   1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
   2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric coupling or nipples.
   3. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.
   4. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.04 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.

3.05 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 horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install check valves for proper direction of flow and as follows:
   1. Swing Check Valves: In horizontal position with hinge pin level.
   2. Center-Guided Check Valves: In horizontal or vertical positions, between flanges.
   3. Lift Check Valves: With stem upright and plumb.

F. Shutoff Valves:
   1. Install full-port ball valve for piping NPS 2 and smaller.

G. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

3.06 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

B. Perform the following adjustments before operation:
   1. Close drain valves, hydrants, and hose bibbs.
   2. Open shutoff valves to fully open position.
   3. Open throttling valves to proper setting.
   4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
      a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
      b. Adjust calibrated balancing valves to flows indicated.
   5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
   6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
   7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
   8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.07 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
   1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
      a. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
   2. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
   3. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

F. Make connections according to the following unless otherwise indicated:
   1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.

3.08 IDENTIFICATION

A. Provide identification on new plumbing piping. Refer to Division 23 for identification details.

3.09 FIELD QUALITY CONTROL – DOMESTIC WATER PIPING

A. Perform the following tests and inspections:
   1. Portions of testing and inspecting requirements in this article are taken from model plumbing codes. Verify requirements are applicable to location of this Project.
   2. Piping Inspections:
      a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
      b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
         1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
         2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
      c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
      d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
   3. Piping Tests:
      a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
      b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
      c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
      d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
      e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
      f. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.10 CLEANING

A. Clean and disinfect potable domestic water piping as follows:
   1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
   2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
      a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
      b. Fill and isolate system according to either of the following:
         1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
         2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
      c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
      d. Repeat procedures if biological examination shows contamination.
      e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Clean non-potable domestic water piping as follows:
   1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
   2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
      a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
      b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.11 CLEANING AND 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 ends of uncompleted piping at end of day and when work stops.

D. Consider using other piping or specify protection by shielding or lightweight insulation if piping surface temperatures are expected to exceed 140 deg F (60 deg C).

3.12 HANGER AND SUPPORT INSTALLATION

A. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/2 and Smaller: 72 inches with 3/8-inch rod.
   2. NPS 2 to NPS 4: 120 inches with 3/8-inch rod.
   3. NPS 5-8: 120 inches with 1/2 inch rod

B. Install supports for vertical copper tubing every 10 feet.

C. Install hangers for steel piping for natural gas with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1/2 and Smaller: 6 feet with 3/8-inch rod.
   2. NPS 3/4 to NPS 1: 8 feet with 3/8-inch rod.
   3. NPS 1-1/4 to NPS 4: 10 feet with 3/8-inch rod.
   4. NPS 5 to NPS 8: 10 feet with 1/2-inch rod.
   5. NPS 10 tp NPS 12: 10 feet with 5/8-inch rod.

D. Install supports for natural gas vertical steel piping the following maximum vertical spacing:
   1. NPS 1/2 and Smaller: 6 feet
   2. NPS 3/4 to NPS 1: 8 feet
   3. NPS 1-1/4 and larger: every floor

END OF SECTION 22 10 05

SECTION 22 30 00

PLUMBING EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Water heaters.

1.02 SUBMITTALS

A. Product Data:
   1. Provide dimension drawings of water heaters indicating components and connections to other equipment and piping.
   2. Indicate pump type, capacity, power requirements.
   3. Provide electrical characteristics and connection requirements.

B. Shop Drawings:

C. Operation and Maintenance Data: Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

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

1.03 WARRANTY

A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.

B. HEAT EXCHANGER(S) shall carry a non-prorated (5) year warranty.

C. STORAGE TANK shall carry a non-prorated ten (10) year limited warranty on carbon steel tank with double glass lining

D. ALL OTHER COMPONENTS shall carry a non-prorated one (1) year warranty.

PART 2 PRODUCTS

2.01 CIRCULATING, STORAGE, DOMESTIC WATER HEAT EXCHANGERS

A. Manufacturers:
   1. Diversified Heat Transfer, Inc. (DHT): https://www.dhtnet.com/products/stp-series/
   2. Substitutions: See Section 01 60 00 - Product Requirements.

B. Description: Packaged, large-capacity, hot-water storage tank with Duplex brazed-plate heat-exchanger module; circulators; controls; and specialties for heating domestic water with heating hot water.

C. Flow Pattern: Standard-flow arrangement, with water from bottom of storage tank circulated across heat-exchanger plates and returned to tank. Include hot-water outlet located at top of tank and temperature sensor in tank. Counter flow arrangement through each heat exchanger for efficient heat transfer.

D. Cleaning Connections: Provide factory installed clean in place connections at the supply and return connection to each heat exchanger.

E. Storage-Tank Construction: ASME-code Carbon Steel with 150-psig working-pressure rating. Include nozzle and head for heat-exchanger tube coil.
   1. Configuration: Vertical.
   2. Manhole: 12 by 16 inches in sidewall of vertical storage-tank shell.
   3. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing and labeling.
      a. NPS 3 (DN 80) Threaded ends according to ASME B1.20.1.
   4. Lining: Carbon Steel material tanks must have double glass lining complying with NSF 61 barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.
   5. Insulation: Complying with ASHRAE/IESNA 90.1, unless otherwise indicated, and suitable for operating temperature. Surround entire storage tank and nozzle except connections and controls.
   6. Anode Rods: Factory installed, magnesium.
   7. Dispersion Tubes: installed on both cold and hot water inlet to prevent mixing of hot and cold water inside the tank.

F. Brazed-Plate, Heat-Exchanger: Assembly of heat-exchanger plates, permanently brazed together.
   1. Working-Pressure Rating: Heat-Exchanger plates, permanently brazed together shall be rated for 150 psig minimum at 250°F.
   2. Plate Construction: Double wall.
   3. Plate Material: 316L Stainless steel plates.
   4. Plate Thickness: Not less than 0.024 inch (0.6 mm) combined.
   5. Brazing Filler Metal: Copper.
   6. Heat Exchanger Connections: 2 inches (DN 50) Victaulic.
   7. AHRI 400: Use heat exchanger certified by AHRI Liquid to Liquid Brazed and Fusion Bonded Plate Heat Exchangers (LLBF) certification program, based on AHRI Standard 400.
   8. KIWA certification: Use KIWA certified double wall Brazed-plate heat exchanger.

G. Temperature Control: Include adjustable temperature solid-state control module with touchscreen user interface, mounted externally on unit skid. Control panel temperature set point range shall be from minimum 35°F to maximum 180°F. Unit shall include modulating VFD Pump(s) to maintain hot water supply temperature within +/-4 deg F variation from set point when operated under normal load conditions with maximum load variation up to 25% of heating capacity.

H. Safety Control: Automatic, high-temperature-limit cutoff device or system. Include sound alarm functionality in the safety controls. Red color error message display on screen when hot water temperature reaches alarm setting and alarm shall start sounding. In the next step, controller shall interrupt power supply to the control valve

causing it to close. When unit goes back to normal operating temperature conditions, display screen status changes back to green color and the power to control valve shall restore. Also include manual switch on front of the control panel to silence the alarm.

I. Relief Valves: ASME rated and stamped for combination temperature-and-pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of heat exchanger. Select relief valve with sensing element that extends into storage tank.

J. Circulating Pump: UL/CUL listed, lead-free bronze and/or stainless steel material construction, in-line pump(s). Include mechanical seals, 150-psig maximum working-pressure rating, and 230 deg F continuous-water-temperature rating.
   1. Pump Control: Constant speed pump to circulate water through each heat exchanger to maintain water temperature in tank.

K. Support: Factory mounted on skids.

L. Control Panel shall be provided with the following associated features:
   1. Factory mounted on the skid package. Provide manual disconnect switch for power supply to control panel and refer to electrical drawings/specifications as well as codes for details.
   2. Touchscreen HMI user interface display with easy adjustable set points. Backup LCD display on feedforward PID controller installed inside the control panel enclosure.
   3. Control Panel shall have two level password protections for settings adjustment.
   4. Process indication displayed on the colored touchscreen display on home screen with user configurable through plain English menus.
   5. Solid-state control module shall be provided with a field programmable digital electronic HMI and PID controller allowing the user to set operating and temperature limits on the display screen.
   6. Solid –state control module shall be supplied with dry contact closure outputs to indicate to building management system (BMS) the occurrence of high temperature alarm condition.
   7. Control module shall be supplied with an on-off switch and shall be mounted in a NEMA 4X panel; all limits shall be 24 VAC.

M. Building/Energy Management System Interface: The control panel either shall be capable of remote communications with the building management system to:
   1. Turn the heater on or off through dry contact.
   2. Remotely set the temperature of the heater using 4-20mA input signal.
   3. Remotely monitor the operating temperature.
   4. Remotely monitor high and low temperature alarm.
   5. Remotely monitor inlet and outlet temperature sensor status.
   6. Remotely monitor control valve opening percentage.
   7. Compatibility with Modbus and BACnet /IP standard. For Interface with BACnet MS/TP, LonWorks, Metasys N2 and Modbus RTU protocols; an external Diversified Heat Transfer supplied built-in translation communications gateway shall be utilized.

N. Capacity and Characteristics:

1. Refer to equipment Schedules on the Drawings.

2.02 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect domestic-water heat exchangers specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test domestic-water heat exchangers to minimum of one and one-half times pressure rating before shipment.

C. Domestic-water heat exchangers will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 01 40 00 "Quality Requirements" for retesting and reinspecting requirements and Section 01 70 00 "Execution and Closeout Requirements" for requirements for correcting the Work.

D. Prepare test and inspection reports.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install plumbing equipment in accordance with manufacturer's instructions, as required by code, and complying with conditions of certification, if any.

B. Coordinate with plumbing piping and related electrical work to achieve operating system.

C. Domestic-Water, Heat-Exchanger Mounting: Install domestic-water heat exchangers on concrete base.

D. Install domestic-water heat exchangers level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

E. Install shutoff valves on domestic-water-supply piping to heat exchangers and on domestic-hot-water outlet piping.

F. Install shutoff valves on heating hot-water piping to heat exchangers.

G. Install temperature and pressure relief valves in top portion of storage-tank shells of domestic-water heat exchangers with domestic-water storage. Use relief valves with sensing elements that extend into shells. Extend relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

H. Install combination temperature-and-pressure relief valves in water piping for domestic-water heat exchangers without storage. Extend relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

I. Install heat-exchanger drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for domestic-water heat exchangers that do not have tank drains.

J. Install thermometer on each domestic-water, heat-exchanger, inlet and outlet piping, and install thermometer on each domestic-water, heat-exchanger, heating-fluid [inlet and] outlet piping. Comply with requirements for thermometers specified in Section 22 05 19 "Meters and Gages for Plumbing Piping."

K. Install pressure gages on domestic-water, heat-exchanger, heating-fluid piping. Comply with requirements for pressure gages specified in Section 22 05 19 "Meters and Gages for Plumbing Piping."

L. Fill domestic-water heat exchangers with water.

END OF SECTION 22 30 00

SECTION 23 05 00

HVAC GENERAL PROVISIONS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Bidding Documents, Condition of the Contract and pertinent portions of Sections in Division One of these specifications apply to the work of this section.

B. Before submitting proposal for the work for these specifications and drawings, each bidder shall study the contract documents, examine the site, and become familiar with all existing conditions such as utility service pressure, locations, invert elevations, and materials.

C. No extra compensation will be allowed because of a misunderstanding as to the amount of work involved or lack of knowledge of existing conditions.

D. Consult drawings and specifications of other trades for correlating work with that of the other trades.

E. Where a Specification Section refers to other Sections under the Article on “Related Sections”, this is done for Contractor’s convenience only. It shall in no way relieve the Contractor of responsibilities stated in other Sections of the Specifications, even though these Sections are not specifically referenced. The Contractor is responsible for all information contained in this Division’s Specifications as well as for information contained in all other Divisions.

1.02 REFERENCES

A. Refer to Section – Mechanical References for Titles of all referenced standards or codes. Contractor and/or manufacturer shall be aware of all applicable standards that apply to this work.

1.03 WORK INCLUDED

A. The work under this section of the specifications consists of furnishing all labor, equipment and materials necessary for and reasonably incidental to the complete installation of the mechanical systems as herein described and indicated on the drawings, including such minor details not specifically mentioned or shown as may be necessary to complete the system ready for successful operation, and subject to the terms and conditions of the contract.

B. All work under this section shall be done in accordance with the best modern practice, using new first grade equipment and shall be arranged to avoid interference with other trades and existing conditions.

C. All mechanical systems and portions thereof shall be concealed unless otherwise indicated or specified.

D. Concrete foundations, pits and grouting: The Mechanical Contractor shall provide suitable concrete foundations, pads, pits and necessary anchor bolts, tie plates, openings, curbs, caulk, etc. for his systems unless otherwise noted or specified. Refer to Architectural drawings for pads by the General Contractor. All grouting of Mechanical equipment shall be by the Mechanical Contractor.

E. Electrical Work: See Divisions 26, 27 and 28 for related electrical specifications not included in Division 23.
   1. Control Contractor shall provide controls and control wiring. All electrical wiring required in Division 23 shall follow the NEC & Division 26 requirements for controls wiring installation.
   2. Fire Alarm Contractor (Div 27) shall provide wiring for power and control to the fire and smoke dampers with interconnection to the fire alarm system. Div 23 shall provide dampers and actuators for fire/smoke dampers.

F. All workers involved in the fabrication or installation of any and all mechanical work, both rough in and finish shall carry a journeyman's license in the particular trade involved. General laborers shall not be used for this work

1.04 DRAWINGS & SPECIFICATIONS

A. Furnish all labor, equipment and material for the complete installation of the mechanical systems indicated and specified.
   1. The drawings accompanying the specifications are diagrammatic and are intended to indicate the approximate and relative locations of services and equipment; the drawings shall not be scaled.
   2. Verify building dimensions with dimensions on architectural drawings.
   3. Because the drawings are diagrammatic and on a small scale, all risers, drops, offsets, etc. have not been shown and shall be provided under this contract.

B. Install all systems and individual equipment according to the manufacturer's installation instructions and recommendations.
   1. Where these differ from these Contract Documents, contact the Engineer immediately.

C. All pipes, ducts and equipment shall be coordinated and installed to avoid interference with all other trades.
   1. Except for piping and ductwork in equipment rooms, piping shall be concealed unless specifically indicated otherwise or directed by Engineer.
   2. Field changes necessary or as a result of varying construction conditions shall have the written acceptance of the Architect/Engineer prior to modifications.

D. The Contractor shall maintain an up-to-date record set of drawings and specifications at the job site. Transfer all field changes to one (1) clean set at time of substantial completion and submit to Engineer prior to final acceptance.

E. In specifying particular materials and/or methods, the intent is to indicate the minimum standard of quality acceptable to Owner.

1. If a case occurs where these Contract Documents do not meet the minimum standards of existing federal, state and local codes regulations and requirements, then those governing codes, regulations and requirements shall prevail.

F. The word “provide” shall mean furnish and install. The words “As required” shall mean as needed to provide a complete and satisfactorily operating system complying with all governing codes and the intent of the project contract documents. The word “indicated” shall mean as shown or noted on the Contract Drawings.

G. Manufacturer Selection
1. Where one manufacturer, model or brand name is specified alone, no substitution will be allowed, except if approved by Owner as an alternate.
2. Where more than one manufacturer, model or brand name is specified for the same item, the Contractor may choose between them.
3. When one or more manufacturers, models or brand names are mentioned and followed by the phrase “or approved equal”, it shall be understood that the names mentioned are to set a standard, and another manufacturer, model brand name may be used if fully equal or superior in all aspects. Contractor shall obtain prior approval from Engineer for substitute manufacturer prior to bid.

H. Should equipment furnished be different from the Model Numbers in the specifications, schedules, or drawings, the Contractor initiating such change will be responsible for all extra costs.
1. Acceptance of substitutions shall in no way relieve the Contractor from the responsibility for any deficiency, which may exist in the substitute product, or that may result from performing the required work with the substitute.
2. If the accepted substitutions shall require changes or modifications to the work of any other trades, such changes shall be considered part of the substitution and shall be coordinated and performed by the Contractor at no additional cost to the Owner.
3. Verify and coordinate all dimensions and other pertinent characteristics of the substituted materials with the requirements of all other parts of the building system and project.
4. Contractor shall provide submittals for substitute equipment, per Division 1 & Division 23 requirements.

I. References to Contract Documents refer to a complete set of Drawings and Specifications for the entire Project. Drawings and Specifications are intended to supplement one another. Provide items shown on the Drawings but not mentioned in the Specifications and items mentioned but not shown the same as if they were both mentioned and shown. Bid the most expensive interpretation of a conflict between Drawings and Specifications so the conflict can be resolved with a deduct rather than an add to the contract amount

1.05 SUBMITTALS

A. The equipment manufacturer shall submit an electronic copy submittals to the Contractor. The Contractor will review, stamp, and send to the Engineer for review. The Engineer will retain one (1) reviewed copy for his files, forward one (1) copy to the Architect, forward one (1) copy to Owner of the final submittal and return copy to the Contractor to be incorporated into the Maintenance & Operating Instructions Manuals.

B. If equipment manufacturer or Contractor elects to issue submittals electronically, the equipment manufacturer shall submit one (1) copy of Submittals to the Contractor. The Contractor will review, stamp, and send to the Engineer for review. The Engineer will retain reviewed copies for his files and forward copy to the Architect, Owner of the final submittal, and to the Contractor to be incorporated into the Maintenance & Operating Instructions Manuals.

C. Manufacturer's standard dimension drawings, performance and product data shall be edited to delete reference to equipment, features or information which is not applicable to the equipment being supplied for this project.

D. All shop drawings must be reviewed and accepted by the Engineer prior to fabrication and installation.

E. Provide sufficient copies of approved data with the Engineers approved stamp for inclusion in the Operation and Maintenance Manuals as specified in this Section.

F. Submittals on all equipment shall be submitted for approval with-in one month of Contract award.

G. In addition to the hard paper copy shop drawing, supply one (1) copy of the maintenance shop drawing and maintenance data for the respective equipment on electronic format.

H. Allow a minimum of fourteen (14) calendar days for the Engineer to review the shop drawings. Time is from the receipt of drawings in the Engineers office until they are shipped out of the office.

I. If the Engineer rejects (Make corrections as noted/Submit Specified Item, Rejected/Submit specified item) two (2) times for the same section the Engineer will be compensated for the additional reviews. Compensation will be incorporated by Change Order and deducted from the Contractor's application for payment. Contractor is responsible for delays caused by the re-submittal process.

1.06 ELECTRONIC DRAWING FILE

A. The Mechanical CAD drawing files prepared by Karges-Faulconbridge, Inc. for this project are Instruments of KFI for use solely with respect to this project and will not be made available to the Contractor.

B. Request CAD drawing files of Architectural floor plans, elevations, sections, etc directly from the Architect.

1.07 OPERATION AND MAINTENANCE MANUAL

A. The Division 23 Contractor shall compile O&M manuals for every piece of Division 23 equipment, including owner-provided equipment and building operating system.
   1. Format
      a. 8 ½" x 11" loose leaf binders.

b. Each binder shall be clearly labeled on the spine and cover with printed title "OPERATION AND MAINTENANCE INSTRUCTIONS", title of project and subject matter of binder when multiple binders are required.
c. Use as many binders as required. Do not overload binders.
d. There shall be dividers with permanently marked tabs of card stock separating each section and sub section.
e. Tab labels shall be typed.
f. Project extraneous information needs to be removed or clearly crossed out.
g. There shall be a title page and table of contents in the front of each binder for each binder's contents. In each binder, there shall be a main tab for each specification section.

2. Submittal
   a. Submit 1 draft copy of completed volumes 60 days prior to substantial completion.
   b. This copy will be reviewed and returned with comments. Revise content of all document sets as required prior to final submission.
   c. Submit three (3) (coordinate number with Owner) hard copies of the Operation and Maintenance Manuals for all systems and equipment and also two (2) electronic copies within 15 days of receipt of review comments. The electronic version shall follow the format of the paper version and be in PDF format.
   d. All O&M manuals shall also be submitted in electronic format, submitted on CD-Rom. Scanned-in information is acceptable only if saved to Adobe "PDF" format and extraneous information has been deleted.
   e. The Owner may with-hold the monthly payment if O & M manuals have not been submitted in accordance with the schedule above.
3. Content
   a. Contacts / Equipment Listing
      1) The first page behind the equipment tab shall contain the name, address and telephone number of the manufacturer, installing contractor and subcontractors and the 24-hour number for emergency warranty service for all equipment in the section identified by equipment. It shall also clearly list each equipment item within that section, using assigned equipment numbering from construction documents.
   b. Submittal and Product Data
      1) Approved submittal data, cut sheets and appropriate shop drawings, including Engineer's review and comments. If submittal was not required for approval, descriptive product data shall be included.
   c. System Description: Descriptive summary of function, normal system operating characteristics and limitations. This will be provided by the Engineer for insertion in binders.
   d. Operation and Maintenance Instructions: These shall be the written manufacturer's data with the model and features of this installation clearly marked and edited to omit reference to products or data not applicable to this installation. This section shall include data on the following:
      1) Manufacturer's printed operating procedures to include start-up, break-in, routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and seasonal operating instructions.
      2) O&M and installation instructions that were shipped with the unit.

3) Preventative maintenance and service procedures and schedules.
4) Troubleshooting procedures.
5) A parts list, edited to omit reference to items which do not apply to this installation.
6) A list of any special tools required to service or maintain the equipment.
7) Disassembly, repair, and re-assembly; aligning and adjusting instructions.
8) Servicing instructions and lubrication charts and schedules.
9) Wiring diagrams
10) Warranty, which clearly lists conditions to be maintained to keep warranty in effect and conditions that would affect the validity of the warranty.

B. Control Drawings: Include the control drawings each piece of equipment and its components, including the sequence of operation. This will be prepared and submitted in a separate binder by the Controls Contractor.

1.08 WARRANTY

A. This Contractor shall warranty all materials, equipment, workmanship and the successful operation of all apparatus furnished and installed under this contract for a period of one (1) year from the issuance of the final Certificate of Substantial Completion, except if noted otherwise. This Contractor shall guarantee to repair or replace at his own expense, any part of the apparatus which may show defect, in the opinion of the Architect or Engineer, due to imperfect material, equipment, or workmanship. Individual warranties are as per manufacturer's standard unless extended warranties are specified. Copies of manufacturer's warranty for each piece of equipment shall be given to Owner.

B. Warranty related repairs or replacement shall be scheduled within 14 days of notice by the ARCHITECT/ENGINEER. Schedule and perform repairs immediately if delay interferes with Owner occupancy or will result in damage to the Owner facility.

1.09 COMPLAINTS DUE TO ADJUSTMENT OR REPAIR

A. Any complaints received by the Architect or Engineer due to adjustments, repair of operation, difficulties, or the need for replacement within the construction phase or the guarantee time will be turned over to the Contractor.

B. Upon the receipt of complaint by letter, fax or telephone, the Contractor shall investigate complaint immediately, and complete the necessary work within seventy-two (72) hours, or as directed in writing by the Architect or Engineer.
   1. When any delay in repair or replacement would result in damage to the Owner's facility or affect Owner occupancy and intended use, or to maintain design environmental conditions, the Contractor shall respond within four (4) hours of notice.

1.10 UTILITY PERMITS, FEES LICENSES & SERVICES

A. All plan reviews, permits, licenses, fees and service charges required in connection with the work of this division shall be secured and paid for by this Contractor. This includes water, sewer and other utility hookup charges and meter deposits.

B. Schedule and coordinate all work with government agencies and utility companies. Arrange for all inspections and furnish Owner with certification of final inspection and any other approvals as required by enforcement authorities.

C. Arrange with appropriate utility companies to provide temporary and permanent utility services as required and coordinate their installation with construction progress of this project. Pay all fees and costs charged by utility companies for utility services.

1.11 CODES AND STANDARDS

A. Work shall meet or exceed the requirements of the latest codes, ordinances, and regulations applicable to the project.
   1. All installations shall conform to the following codes and regulations amended to this date:
      a. State and Local Heating, Ventilating, Air Conditioning and Refrigeration Codes
      b. State and Local Plumbing Codes
      c. State and Local Building Codes
      d. State and Local Electrical Codes
      e. State and Local Mechanical Codes
      f. State and Local Elevator Codes
      g. Americans with Disabilities Act
      h. Municipal Water and Sewer Regulations
      i. National Electrical Code
      j. State and Local Board of Health Regulations
      k. Local Applicable Ordinances
      l. State and Local Fire Codes and Regulations
      m. Gas Company Requirements
      n. Occupational Safety and Health Act (OSHA)
      o. State and Local Energy Code
   2. All materials and equipment supplied shall conform to the following standards amended to this date:
      a. American Society of Mechanical Engineers (ASME)
      b. American Gas Association (AGA)
      c. Sheet Metal and Air Conditioning Contractors National Association (SMACNA)
      d. Underwriters Laboratories (UL)
      e. National Electrical Manufacturers Association (NEMA)
      f. Manufacturer’s Standardization of the Valve & Fitting Ind.
      g. American Welding Society (AWS)
      h. American Society for Testing Material (ASTM)
      i. American National Standards Institute (ANSI)
      j. American Water Works Association (AWWA)

k. American Society of Mechanical Engineers Boiler Code
l. Air Moving and Conditioning Association (AMCA)
m. Air Conditioning and Refrigeration Institute (ARI)
n. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
o. Sheet Metal and Air Conditioning Contractors National Association
p. Occupational Safety and Health Act (OSHA)

B. Higher quality of workmanship and materials indicated in the Contract Documents takes precedence over that allowed in referenced codes and standards.

C. Inform the Engineer of any discrepancies between the Contract Documents and the prevailing codes and regulations. Correction of any non-compliant work completed prior to notification of the Engineer will be paid for by this Contractor.

1.12 COORDINATION OF WORK

A. The Mechanical Contractor shall set up and submit coordination drawings for plumbing, hydronic piping, sheet metal, sprinkler, general construction, and electrical. The Mechanical Contractor shall follow Division 1 and Division 23 requirements for the contractor's coordination drawings.

B. Contractor shall proceed to measure, layout, fabricate and install ductwork and piping systems when mechanical equipment is supplied by either the contractor or the owner, even if mechanical equipment is not yet available to the contractor.
1. Obtain and review dimensions and installation requirements for the mechanical equipment prior to equipment arrival.
2. Fabricate and install mock-up units when required to assist with the fabrication and installation of the ductwork and piping systems.

C. Coordinate work with that of other Contractors. Organize work so that it will not interfere with or delay the work of other Contractors.

D. Field verify dimensions on Drawings since actual locations, distances and levels will be governed by actual field conditions. Field verify all conditions before starting work.

E. Consult the Drawings and specifications for work to be provided by other trades for coordinating information including details, dimensions, alignment, elevation, foundations, pits, and other interference's to avoid possible installation or future access for adjustment, operation and maintenance conflicts.
1. Should changes from the original Drawings be required to resolve such conflicts notify the Engineer and secure approval and agreement on necessary adjustments before the installation is started. Make all arrangements for the entry of equipment to the installed locations.

F. Do not install any mechanical systems or portions thereof above electrical panels and within code clearance distances in front of and on sides of electrical panels.

G. Route all mechanical systems or portions thereof around transformer vaults, other electrical spaces, elevators, elevator equipment rooms, or electrical equipment spaces and enclosures.

H. Layout all piping and duct systems in careful coordination with the Drawings and site conditions.
   1. Determine proper location and elevation of all components.
   2. Install the minimum number of bends possible to produce a satisfactorily functioning system.
   3. Layout all pipes and ducts within partitions, walls, roof cavities and ceiling spaces unless furred out spaces or soffits are indicated on the Architectural drawings.

I. Coordinate layout and installation to ensure that clearances are maintained to accommodate future Owner operations, adjustment, maintenance and repair of the equipment.

J. Where coordination or field conditions require considerable deviation from plans, the contractor shall contact the Engineer for approval prior to proceeding.

K. Verify prior to printing, labeling, ordering, or programming that the room names and room numbers utilized match the actual final installed room names and room numbers. Coordinate with Owner and architect for final room numbering to be utilized.

1.13 ELECTRICAL

A. Magnetic starters, disconnects, and power wiring are provided elsewhere, unless otherwise specified.

B. Control and interlock wiring provided elsewhere in Division 23, unless otherwise specified.

1.14 PROTECTION OF EQUIPMENT & MATERIALS

A. Receive and properly protect all equipment and material required for this Contract including any or all Owner furnished equipment.
   1. Damaged equipment shall be placed in original operating condition or returned to source of supply for repair or replacement, as determined by the Architect/Engineer.
   2. Equipment, ducts and piping systems shall be protected against entry of foreign matter during fabrication, storage, and installation and shall be cleaned both inside and outside before operation and painting.
   3. Receive and properly store equipment and materials in approved locations away from damaging traffic and interference. Store equipment and materials indoors to prevent water damage.

B. Protect and take precautions to prevent damage to existing equipment, piping, ductwork, electrical, fireproofing, insulation, structure and other building systems, elements and components.
   1. Protect these existing systems against entry of foreign matter during construction from all trades.
   2. Any building systems, elements and components that are accidentally or purposely disturbed or damaged by this Contractor’s work shall be restored to the original undisturbed condition, including floor, roof, ceiling, wall and other finished surfaces, stored material, hardware, structure disturbed or otherwise damaged.

3. Water damage or other subsequent damages caused by this contractor shall also be restored to the original undisturbed condition at this contractor's expense.

C. The sheet metal Contractor shall protect all interior surfaces of ductwork and HVAC equipment interior surfaces from contamination prior to, during and after installation of ductwork and equipment.
   1. The duct work and air handling equipment system shall be protected from dust and moisture at all times (securely cap ends and openings both in stored position or installed position).
   2. Ducts and air handling units shall be isolated from any source of contamination at all times prior to, during, and after installation.

D. Contractor shall not use any ductwork, air handling units, exhaust fans, chiller or pumps during the construction period.

E. If the contractor needs to exhaust, ventilate, heat, cool, or dehumidify the building, provide and operate temporary units and systems.

F. Install and maintain specified filter in all HVAC equipment.
   1. Confirm that filter and filter rack prevent any direct or indirect air stream bypass of the filter.

G. Existing ductwork and air transfers that may stay in place during construction shall be cleaned, capped, and sealed to assure no contamination prior to, during or after installation of new system.

H. Cutting and Patching:
   1. Perform all cutting and patching necessary to work, unless specifically delegated to other Contractors. Obtain special permission from the Engineer before cutting structural members or finished material. Perform all patching in such a manner as to leave no visible trace and return the area affected to the condition of undisturbed work. Perform all patching by workers experienced, skilled, and licensed for the particular type of work involved. Inferior work will not be accepted.
   2. Patch all holes left as a result of demolition of mechanical equipment and devices.
   3. Drill all holes in masonry with rotary drill. Impact tools are not allowed. Core drill all holes in masonry and concrete for mechanical penetrations. Provide and dispose of all water required for core drilling. Coordinate with other trades to prevent damage from water.
   4. Prevent the spread of dust, debris, and other material into adjacent areas.
   5. Replace all ceiling tiles damaged during installation of work, with new tile.

I. Painting:
   1. Refinish all mechanical equipment damaged during shipping and/or installation to its original condition. Remove all rust; prime, and paint per manufacturer's recommendations for finish equal to original.

1.15 CONNECTIONS

A. Make connections at terminal points of contact.

1. Where connections are made to equipment furnished by others, obtain exact locations of connections from persons furnishing the equipment and make the connections.
2. Provide required connection pieces, including but not limited to, mating flanges, dielectric fittings, fasteners, couplings, supports, insulation and vapor barrier.

1.16 START UP & DEMONSTRATION

A. Confirm that all systems are installed, aligned, adjusted, balanced and operating in accordance with requirements of Contract Documents prior to Architect, Engineer, and Owner Demonstration Tests.

B. Perform repairs required to place all systems in proper operating condition.

C. Provide all lubrication, check, test, and start-up services, supervise the initial operation of all equipment and demonstrate to the Owner's representative that all equipment is properly operating.
   1. Make adjustments and repairs as required for the Owner's complete satisfaction.

D. Mechanical Contractor shall provide a minimum of 4 hours of training on building mechanical systems for personnel selected by the owner. Mechanical contractor shall provide owner 2 weeks' notice when scheduling training, coordinate training with Owner. O&M manuals shall be submitted and approved before training so they are available for reference during training.

1.17 PREPARATION

A. Continuity of Service:
   1. Coordinate/schedule all work with the Owner to minimize any disruptions. Confine all interruptions to the smallest possible area. Provide temporary connections if required to provide continuity of service.
   2. Inspect all areas affected by the interruptions and return all automatically controlled equipment, electrically operated equipment to the same operating condition prior to the interruption.
   3. No fire sprinkler or fire alarm systems are to remain inactive at the end of the work day. Assure that the fire sprinkler or fire alarm system is operational at the end of each work day. Coordinate with Owner.

B. Use of Facility:
   1. Do not disturb normal use of the facility, except within the immediate construction area. Keep walks, driveways, entrances, etc. free and clear of equipment, material and debris.
   2. Store all equipment and material in a place and manner that minimizes congestion and is approved by Owner.

1.18 RENOVATION & DEMOLITION WORK IN EXISTING BUILDING

A. Verify all existing conditions prior to submitting bid.

B. Remove, relocate and/or reroute existing work as required for the installation of construction.

1. Materials and equipment removed shall be shown to and inspected by the Owner. Those materials and equipment not claimed by the Owner shall be removed from the site.
2. Dust, dirt, noise and vibration from the work shall be controlled as required by the Owner to prevent damage to other facility systems or interfere with Owner occupancy.
3. Provide plastic sheet temporary carrier walls around work where not provided by the General Contractor.
4. Piping and ductwork shall be capped behind finished surfaces.
5. Review and coordinate work with the demolition and abatement contractors.

C. Coordinate the installation of pipe and duct sleeves through floors, walls and foundation wall penetrations.
1. All duct and pipe penetrations to be over cut a minimum of ½" clear and a maximum of 1" clear around perimeter of finished pipe or duct system.
2. Provide dust containment and removal in all areas of work.
3. Repair damaged wall with backup wall and finish to match existing.
4. General Contractor shall provide specialty finishes such as terrazzo, tile or brick finishes unless otherwise indicated. For finishes, refer to Architectural room finish schedule.
5. Above ceiling or in mechanical storage and custodial rooms, repair all areas around penetrations with back up wall to match existing. Provide continuous batt insulation with caulking encapsulation around duct and sheet metal sleeves.
6. Provide fire caulking as required in fire rated walls.
7. Provide lintels at mechanical openings per Architectural lintel schedule unless noted otherwise on structural drawings.

D. Coordinate demolition and construction with General Contractor and Owner asbestos abatement Contractor.
1. Provide isolation valves and hose bibs during construction as required to drain equipment and piping for demolition and to isolate and maintain operation of existing system.
2. Water and heating equipment shutdown shall be coordinated with General Contractor and the Owner.
3. Existing air systems shall not be run after Abatement Contractor starts work.

E. When work areas or spaces are classified as an O.S.H.A. Class I confined space. Contractor shall verify and include requirements, training, procedures and equipment for performing work in those environments.

1.19 CLEAN UP

A. Keep the premises free from accumulation of waste material or rubbish, caused by his employees or work, at all times. Remove rubbish, tools, scaffolding, and surplus materials from and about the building, and leave work areas "broom clean" or its equivalent upon completion of the work. Clean mechanical equipment and remove temporary identification.

B. In case of dispute, the Owner will remove the rubbish and charge the cost to the Contractor.

1.20 RECORD DOCUMENTS

A. Prepare record documents in accordance with the requirements in Division 1. In addition to the requirements specified in Division 1, refer to specific sections for additional record documentation.

1.21 DELIVERY, STORAGE & HANDLING

A. General: Follow procedures specified in Division 1 and as outlined below.
   1. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.
   2. Storage of materials and equipment shall not impede the work of other contracts.
   3. Protect all components of the mechanical installation from becoming contaminated or otherwise damaged in delivery or storage.
   4. Handling of equipment and products shall be according to manufacturers instructions and in compliance with the articles of their warranty.
   5. Protect products from weather, unless product is slated for exterior installation. If outdoor storage is necessary, support products off the ground or pavement in watertight enclosures that will not result in corrosion, temperature stress, or other damage to the products.

1.22 SURPLUS SPARE PARTS

A. The contractor shall be responsible for providing all spare parts listed in the contract documents and shall coordinate the delivery of the spare parts furnished through the Owner's procurement package.
   1. Schedule delivery of all spare parts to the site.
   2. Deliver spare parts to the project properly identified with names, model numbers, and types.
   3. Protect and store spare parts to protect contamination or damage.
   4. Obtain signature of approval of delivery by the ARCHITECT/ENGINEER and the Owner Project Manager.

1.23 FIRE SAFETY PRECAUTIONS

A. The Contractors shall exercise extreme care to maintain and exercise adequate fire safety precautions throughout the work. This shall include providing sufficient fire extinguishing devices, watchmen, standby helpers or other precautions during construction, in use of temporary heat, welding, brazing, sweating, testing or other phases of work.

B. At all times, access shall be maintained for fire department equipment and personnel access to the building.

C. All welding, brazing, cutting and sweating operations performed in vicinity of or accessible to combustible materials shall be adequately protected to make certain that sparks or hot slag does not reach the combustible material and start a fire.

D. All glass, glazed materials and other finishes, in the vicinity of welding, brazing and cutting, shall be masked and protected from damage by the Contractor performing the welding work.

E. When necessary to do cutting, welding, brazing, sweating and similar work in vicinity of wood, in shafts, or vicinity of any combustible material (and the combustible material cannot be removed), the materials shall be adequately protected with fire resistant blankets or similar approved coverings. In addition, a helper shall be stationed nearby with proper fire extinguishers (provided by the Contractor performing the work) to guard against sparks and fire.

F. Whenever combustible materials have been exposed to sparks, molten metal, hot slag or splatter, a person shall be kept at the place of work to make sure the smoldering fires have not been started.
   1. Whenever cutting or welding operations are carried on in a vertical pipe shaft, a person to act as a fireguard shall be employed to examine all areas in the area of work and below the point of cutting or welding.
   2. This fireguard shall be kept on duty after completion of work to guard against fires and shall examine each level after this time, prior to leaving.
   3. There shall be no exceptions to this requirement and failure to comply will be construed as negligence.

1.24 SALVAGEABLE MATERIALS

A. Owner may salvage some equipment and materials from the building that are part of system scheduled for mechanical demolition.

B. Owner shall have the opportunity to access and perform the salvage work prior to the contractor's demolition or during demolition work. Owner will coordinate the salvage work with Contractor.

1.25 CONTRACTOR WORK

A. If work does not proceed in a timely manner in the opinion of the Owner and Engineer, the Owner reserves the right to bring in other Contractors to complete specific areas of work. The cost for this work will be deducted from this contract.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION – NOT USED

END OF SECTION 23 05 00

SECTION 23 05 19

METERS AND GAGES FOR HVAC PIPING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:
   1. Liquid-in-glass thermometers.
   2. Thermowells.
   3. Dial-type pressure gages.
   4. Gage attachments.
   5. Test plugs.
   6. Test-plug kits.

B. Related Sections:
   1. Division 23, Section "Instrumentation and Control Devices" for Flow Meters.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Wiring Diagrams: For power, signal, and control wiring.

1.04 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of meter and gage, from manufacturer.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 PRODUCTS

2.01 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Trerice, H. O. Co.
      b. Weiss Instruments, Inc.
      c. Winters Instruments - U.S.
   2. Standard: ASME B40.200.
   3. Case: Cast aluminum; 7-inch nominal size unless otherwise indicated.

4. Case Form: Adjustable angle unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue organic liquid.
6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
7. Window: Glass.
8. Stem: Aluminum and of length to suit installation.
   a. Design for Air-Duct Installation: With ventilated shroud.
   b. Design for Thermowell Installation: Bare stem.
9. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.02 THERMOWELLS

A. Thermowells:
   1. Standard: ASME B40.200.
   2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
   3. Material for Use with Copper Tubing: CNR or CUNI.
   4. Material for Use with Steel Piping: CRES.
   5. Type: Stepped shank unless straight or tapered shank is indicated.
   6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
   7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
   8. Bore: Diameter required to match thermometer bulb or stem.
   9. Insertion Length: Length required to match thermometer bulb or stem.
   10. Lagging Extension: Include on thermowells for insulated piping and tubing.
   11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.03 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Trerice, H. O. Co.
      b. Weiss Instruments, Inc.
      c. WIKA Instrument Corporation - USA.
   2. Standard: ASME B40.100.
   3. Case: Liquid-filled type(s); cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
   4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
   5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
   6. Movement: Mechanical, with link to pressure element and connection to pointer.
   7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
   8. Pointer: Dark-colored metal.
   9. Window: Glass.

10. Ring: Brass.
11. Accuracy: Grade B, plus or minus 2 percent of middle half of scale range.

2.04 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.

B. Siphons: Loop-shaped section of brass pipe with NPS 1/4 or NPS 1/2 pipe threads.

C. Valves: Brass ball, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

2.05 TEST PLUGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Trerice, H. O. Co.
   2. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
   3. Weiss Instruments, Inc.

B. Description: Test-station fitting made for insertion into piping tee fitting.

C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

D. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.

E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

F. Core Inserts: Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber.

2.06 TEST-PLUG KITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Trerice, H. O. Co.
   2. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
   3. Weiss Instruments, Inc.

B. Furnish one test-plug kit(s) containing one thermometer(s), one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.

C. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch-diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 deg F.

D. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch-diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F.

E. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch-diameter dial and probe. Dial range shall be at least 0 to 200 psig.

F. Carrying Case: Metal or plastic, with formed instrument padding.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.

G. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

H. Install remote-mounted pressure gages on panel.

I. Install valve and snubber in piping for each pressure gage for fluids (except steam). Extend nipples to allow clearance from insulation.

J. Install valve and siphon fitting in piping for each pressure gage for steam. Extend nipples to allow clearance from insulation.

K. Install test plugs in piping tees.

L. Install thermometers, pressure gages, and test plugs in locations indicated on drawings.

M. Adjust gages and thermometers to final angle, clean windows and lenses, and calibrate.

3.02 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

3.03 ADJUSTING

A. Adjust faces of meters and gages to proper angle for best visibility.

3.04 THERMOMETER SCHEDULE

A. Thermometers in hydronic systems shall be the following:
   1. Industrial-style, liquid-in-glass type.

B. Thermometer stems shall be of length to match thermowell insertion length.

3.05 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Heating Hot-Water Piping: 30 to 240 deg F.

3.06 PRESSURE-GAGE SCHEDULE

A. Pressure gages in hydronic systems shall be the following:
   1. Liquid-filled, direct-mounted, metal case.

3.07 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Heating, Hot-Water Piping: 0 to 100 psi.

END OF SECTION 23 05 19

SECTION 23 05 29

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:
   1. Metal pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Metal framing systems.
   4. Thermal-hanger shield inserts.
   5. Fastener systems.
   6. Pipe stands.
   7. Equipment supports.

B. Related Sections:
   1. Division 23 Section(s) "Metal Ducts" for duct hangers and supports.

1.03 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.05 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.06 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

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

PART 2 PRODUCTS

2.01 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.

2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Copper Pipe Hangers:
1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.02 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.03 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Carpenter & Paterson, Inc.
2. Clement Support Services.
3. ERICO International Corporation.
4. National Pipe Hanger Corporation.
5. PHS Industries, Inc.
6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
7. Piping Technology & Products, Inc.
8. Rilco Manufacturing Co., Inc.
9. Value Engineered Products, Inc.

B. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, 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 degrees of pipe.

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

2.04 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: Insert-wedge-type, [zinc-coated] [stainless-] steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.05 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.

C. High-Type, Single-Pipe Stand:
   1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
   2. Base: Stainless steel.
   3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
   4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

D. High-Type, Multiple-Pipe Stand:
   1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
   2. Bases: One or more; plastic.
   3. Vertical Members: Two or more protective-coated-steel channels.
   4. Horizontal Member: Protective-coated-steel channel.
   5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

E. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.06 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.07 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, 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.

PART 3 EXECUTION

3.01 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
   2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

D. Fastener System Installation:
   1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

E. Pipe Stand Installation:
   1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
   2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Division 07 Section "Roof Accessories" for curbs.

F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

H. Install hangers and supports to allow controlled thermal and seismic 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.

I. Install lateral bracing with pipe hangers and supports to prevent swaying.

J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

K. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

L. 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.

M. Insulated Piping:
   1. Attach clamps and spacers to piping.

a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
3. Shield Dimensions for Pipe: Not less than the following:
   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
   b. NPS 4: 12 inches long and 0.06 inch thick.
   c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
   d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
4. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.02 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.03 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.04 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-thread hanger and support rods to 1-1/2 inches.

3.05 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. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.06 CONCRETE HOUSEKEEPING PADS

A. Provide concrete housekeeping pads required for mechanical equipment, except where otherwise indicated. Post install bolts in concrete pads for attachment of equipment and/or isolators. Refer to section on Post Installed Anchors for additional information.

B. All concrete work shall conform to the latest editions of the following standards:
   1. ACI 301 – “Specifications For Structural Concrete”.
   2. ACI MCP – “Manual Of Concrete Practice”.
   3. ACI 318 – “Building Code Requirements For Reinforced Concrete”.
   4. ACI 318.1 – “Building Code Requirements For Structural Plain Concrete”.
   5. ACI 304 – “Guide For Measuring, Mixing, Transporting, And Placeing Concrete".
   6. ACI 305 – “Specification For Hot Weather Concreting”.
   7. ACI 306 – “Specification For Cold Weather Concreting”.

C. Housekeeping pads shall be constructed of a normal weight concrete with a minimum 28-day ultimate compressive strength f’c as follows when testing in accordance with ASTM C39:
   1. Exterior Exposed Concrete: 4500 PSI
   2. All Other Concrete: 4000 PSI

D. All concrete exposed to weather shall be air entrained with 4.5%-7% air entrainment.

E. Aggregate sizes shall be in accordance to ASTM C33 “Standard Specification For Concrete Aggregation”. The coarse aggregate shall be well graded stone with a maximum aggregate size of 3/4".

F. Maximum flyash content shall not exceed 15% of the cementitious material by weight.

G. Maximum water cement ratio:
   1. Air entrained concrete: 0.45
   2. Non-air entrained concrete: 0.5

H. Housekeeping pads shall be minimum of 4” thickness with minimum plan dimensions extending at least 4” beyond the edge of the equipment unless noted otherwise on the drawings.

I. Housekeeping pads shall be reinforced with #4 bars (Grade 60) at 12” on centers each way centered on the pad. Provide 2” clear distance to edge of concrete.

J. Housekeeping pads surfaces shall be finished sufficiently smooth to receive painting. Provide ¾” chamfers on all exposed edges.

K. Existing concrete surfaces to receive housekeeping pad shall be roughen to ¼” amplitude and shall receive bonding agent prior to placing new concrete.

L. Contractor to submit concrete design mix to engineer for review.

3.07 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

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

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

E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers, and metal framing systems and attachments for general service applications.

F. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

G. Use padded hangers for piping that is subject to scratching.

H. Use thermal-hanger shield inserts for insulated piping and tubing.

I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
   2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
   3. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.

4. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
5. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
6. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
7. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
8. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
9. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
10. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
11. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
12. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
13. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
14. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
15. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
16. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
17. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
18. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
19. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
   2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.
13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
   2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
   3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
   4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
   5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
   6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
   7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
   8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
      a. Horizontal (MSS Type 54): Mounted horizontally.
      b. Vertical (MSS Type 55): Mounted vertically.
      c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

O. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

P. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

Q. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 23 05 29

SECTION 23 05 53

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:
   1. Equipment labels.
   2. Warning signs and labels.
   3. Pipe labels.
   4. Valve tags.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve numbering scheme.

E. Valve Schedules: For each piping system to include in maintenance manuals.

1.04 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 PRODUCTS

2.01 EQUIPMENT LABELS

A. Metal Labels for Equipment:
   1. Material and Thickness: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.

2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
4. Fasteners: Stainless-steel rivets or self-tapping screws.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.02 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
1. 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.
2. Lettering Size: At least 1-1/4 inches high.

2.03 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire-link or beaded chain; or S-hook.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch 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), and

variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.
    a. Verify prior to printing, labeling, ordering, or programming that the room names and room numbers utilized match the actual final installed room names and room numbers. Coordinate with Owner and architect for final room numbering to be utilized.

PART 3 EXECUTION

3.01 PREPARATION

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.

3.02 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.03 PIPE LABEL INSTALLATION

A. Piping Color-Coding: Conform to ASME A13.1.

B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine 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 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. Concealed piping in accessible ceilings and soffits:
        a. Labels shall be located at each change in direction of pipe runs and at intervals not to exceed 20 feet.
    7. Exposed piping in mechanical and equipment rooms:
        a. Labels shall be located at each change in direction of pipe runs and at intervals not to exceed 20 feet.
    8. Exposed piping outside of mechanical and equipment rooms:
        a. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.

C. Pipe Label Color Schedule:
    1. Heating Water Piping:
        a. Background Color: Green.
        b. Letter Color: White.
    2. Fuel Oil Piping:

a. Background Color: Yellow.
b. Letter Color: Black.

3.04 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
   1. Valve-Tag Size and Shape:
      a. Hot Water: 1-1/2 inches, round.
      b. Fuel Oil: 1-1/2 inches, round.
   2. Valve-Tag Color:
      a. Hot Water: Green.
      b. Fuel Oil: Yellow.
   3. Letter Color:
      a. Hot Water: White.
      b. Fuel Oil: Black.

END OF SECTION 23 05 53

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:
   1. Balancing Hydronic Piping Systems:

1.03 DEFINITIONS

A. NEBB: National Environmental Balancing Bureau.

B. TAB: Testing, adjusting, and balancing.

C. TABB: Testing, Adjusting, and Balancing Bureau.

D. TAB Specialist: An entity engaged to perform TAB Work.

1.04 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.

C. Strategies and Procedures Plan: Within 30 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

D. Certified TAB reports.

E. Sample report forms.

F. Instrument calibration reports, to include the following:
   1. Instrument type and make.
   2. Serial number.
   3. Application.
   4. Dates of use.
   5. Dates of calibration.

1.05 QUALITY ASSURANCE

A. TAB Contractor Qualifications: Engage a TAB entity certified by NEBB or AABC.
   1. TAB Field Supervisor: Employee of the TAB contractor and certified by NEBB or AABC.
   2. TAB Technician: Employee of the TAB contractor and who is certified by NEBB or AABC as a TAB technician.

B. TAB Conference: Meet with Architect, Owner, and Construction Manager on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven days' advance notice of scheduled meeting time and location.
   1. Agenda Items:
      a. The Contract Documents examination report.
      b. The TAB plan.
      c. Coordination and cooperation of trades and subcontractors.
      d. Coordination of documentation and communication flow.

C. Certify TAB field data reports and perform the following:
   1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
   2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

D. TAB Report Forms: Use standard TAB contractor's forms approved by Commissioning Authority.

E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

F. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

G. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.06 PROJECT CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.07 COORDINATION

A. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.01 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 systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices 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 fan and 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.
   2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

F. Examine system and equipment installations and verify that field quality-control 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 filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

I. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.

J. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

K. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

L. Examine system pumps to ensure absence of entrained air in the suction piping.

M. Examine operating safety interlocks and controls on HVAC equipment.

N. 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.

3.02 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system-readiness checks and prepare reports. Verify the following:
   1. Permanent electrical-power wiring is complete.
   2. Hydronic systems are filled, clean, and free of air.
   3. Automatic temperature-control systems are operational.
   4. Isolating and balancing valves are open and control valves are operational.

3.03 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.
   1. Comply with requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

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. After testing and balancing, install test ports and duct access doors that comply with requirements in Division 23 Section "Air Duct Accessories."
   3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "HVAC Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.04 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.
2. Check liquid level in expansion tank.
3. Check makeup water-station pressure gage for adequate pressure for highest vent.
4. Check flow-control valves for specified sequence of operation, and set at indicated flow.
5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
6. Set system controls so automatic valves are wide open to heat exchangers.
7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.05 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.06 PROCEDURES FOR PRIMARY-SECONDARY HYDRONIC SYSTEMS

A. Balance the primary circuit flow first and then balance the secondary circuits.

3.07 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
   1. Manufacturer's name, model number, and serial number.
   2. Motor horsepower rating.
   3. Motor rpm.
   4. Efficiency rating.
   5. Nameplate and measured voltage, each phase.
   6. Nameplate and measured amperage, each phase.
   7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.08 PROCEDURES FOR BOILERS

A. Hydronic Boilers: Measure and record entering- and leaving-water temperatures and water flow.

3.09 PROCEDURES FOR HEAT EXCHANGERS

A. Measure, adjust, and record the following data for each water coil:
   1. Entering- and leaving-water temperature.

2. Water flow rate.
3. Water pressure drop.

3.10 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:
   1. Bearings and other parts are properly lubricated.

B. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.

3.11 TOLERANCES

A. Set HVAC system's flow rates and water flow rates within the following tolerances:
   1. Heating-Water Flow Rate: Plus or minus 10 percent.

3.12 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

3.13 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 proof of calibration.

B. Final Report Contents: In addition to certified field-report data, include the following:
   1. Pump curves.
   2. Manufacturers' test data.
   3. Field test reports prepared by system and equipment installers.
   4. Other information relative to equipment performance; do not include Shop Drawings and 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. Architect's name and address.
   6. Engineer's name and address.
   7. Contractor's name and address.
   8. Report date.

9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:
    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.
12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
    1. Water and steam flow rates.
    2. Pipe and valve sizes and locations.
    3. Terminal units.
    4. Balancing stations.
    5. Position of balancing devices.

E. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:
    1. Unit Data:
        a. System identification.
        b. Location.
        c. Make and type.
        d. Model number and unit size.
        e. Manufacturer's serial number.
        f. Fuel type in input data.
        g. Output capacity in Btu/h (kW).
        h. Ignition type.
        i. Burner-control types.
        j. Motor horsepower and rpm.
        k. Motor volts, phase, and hertz.
        l. Motor full-load amperage and service factor.
        m. Sheave make, size in inches and bore.
        n. Center-to-center dimensions of sheave, and amount of adjustments in inches.
    2. Test Data (Indicated and Actual Values):
        a. Low-fire fuel input in Btu/h (kW).
        b. High-fire fuel input in Btu/h (kW).
        c. Manifold pressure in psig.
        d. High-temperature-limit setting in deg F.
        e. Operating set point in Btu/h (kW).
        f. Motor voltage at each connection.
        g. Motor amperage for each phase.
        h. Heating value of fuel in Btu/h (kW).

F. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:
   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 feet of head or psig.
      h. Required net positive suction head in feet of head or psig.
      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.
      p. Seal type.
   2. Test Data (Indicated and Actual Values):
      a. Static head in feet of head or psig.
      b. Pump shutoff pressure in feet of head or psig.
      c. Actual impeller size in inches.
      d. Full-open flow rate in gpm.
      e. Full-open pressure in feet of head or psig.
      f. Final discharge pressure in feet of head or psig.
      g. Final suction pressure in feet of head or psig.
      h. Final total pressure in feet of head or psig.
      i. Final water flow rate in gpm.
      j. Voltage at each connection.
      k. Amperage for each phase.

G. Instrument Calibration Reports:
   1. Report Data:
      a. Instrument type and make.
      b. Serial number.
      c. Application.
      d. Dates of use.
      e. Dates of calibration.

3.14 ADDITIONAL TESTS

A. Within 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 winter conditions, perform additional TAB during winter conditions.

END OF SECTION 23 05 93

SECTION 23 07 19

HVAC PIPING INSULATION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 RELATED REQUIREMENTS

A. Section 22 10 05 - Plumbing Piping: Placement of hangers and hanger inserts.

B. Section 23 21 13 - Hydronic Piping: Placement of hangers and hanger inserts.

1.03 REFERENCE STANDARDS

A. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2015.

B. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2014.

C. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric]; 2014.

D. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus; 2013.

E. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement; 2007 (Reapproved 2013).

F. ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement; 2007 (Reapproved 2013).

G. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2010.

H. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation; 2013.

I. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2014.

J. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation; 2015.

K. ASTM C552 - Standard Specification for Cellular Glass Thermal Insulation; 2015.

L. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation; 2015a.

M. ASTM C585 - Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing; 2010.

N. ASTM C591 - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation; 2015.

O. ASTM C610 - Standard Specification for Molded Expanded Perlite Block and Pipe Thermal Insulation; 2011.

P. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel; 2008 (Reapproved 2013).

Q. ASTM D1056 - Standard Specification for Flexible Cellular Materials--Sponge or Expanded Rubber; 2014.

R. ASTM D2842 - Standard Test Method for Water Absorption of Rigid Cellular Plastics; 2012.

S. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.

T. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials; 2014.

U. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.04 SUMMARY

A. Section includes insulating the following HVAC piping systems:
   1. Heating hot-water piping.

1.05 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied, if any).

1.06 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

1.07 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

C. Comply with the following applicable standards and other requirements specified for miscellaneous components:
   1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.09 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.10 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 PRODUCTS

2.01 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Mineral-Fiber, Preformed Pipe Insulation:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Fibrex Insulations Inc.; Coreplus 1200.
      b. Johns Manville; Micro-Lok.
      c. Knauf Insulation; 1000-Degree Pipe Insulation.
      d. Manson Insulation Inc.; Alley-K.
      e. Owens Corning; Fiberglas Pipe Insulation.
   2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ or with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   3. Type II, 1200 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type II, Grade A, with factory-applied ASJ or with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   4. Insulation: ASTM C547; rigid molded, noncombustible
      a. ‘K’ Value: ASTM C177, 0.24 at 75° F
      b. Maximum moisture absorption: 0.2% by volume
   5. Vapor Barrier Jacket: ASTM C921
      a. All service jacket (ASJ): White Kraft paper with glass fiber yarn, bonded to aluminized film.
      b. Moisture vapor transmission: ASTM E96; 0.02 perm-inches.
   6. Tie Wire: 0.048” stainless steel with twisted ends on maximum
      a. 12” centers.
   7. Vapor Barrier Lap Adhesive:
      a. Compatible with insulation.

2.02 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

1. Products: Subject to compliance with requirements, provide the following:
   a. Ramco Insulation, Inc.; Super-Stik.

B. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.
   1. Products: Subject to compliance with requirements, provide the following:
      a. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.

2.03 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
      b. Eagle Bridges - Marathon Industries; 225.
      c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
      d. Mon-Eco Industries, Inc.; 22-25.
   2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. ASJ Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
      b. Eagle Bridges - Marathon Industries; 225.
      c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
      d. Mon-Eco Industries, Inc.; 22-25.
   2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. PVC Jacket Adhesive: Compatible with PVC jacket.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Dow Corning Corporation; 739, Dow Silicone.
      b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
      c. P.I.C. Plastics, Inc.; Welding Adhesive.
      d. Speedline Corporation; Polyco VP Adhesive.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.04 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
   1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
      b. Eagle Bridges - Marathon Industries; 550.
      c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
      d. Mon-Eco Industries, Inc.; 55-50.
      e. Vimasco Corporation; WC-1/WC-5.
   2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
   3. Service Temperature Range: Minus 20 to plus 180 deg F.
   4. Solids Content: 60 percent by volume and 66 percent by weight.
   5. Color: White.

2.05 SEALANTS

A. Joint Sealants:

B. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:
   1. Products: Subject to compliance with requirements, provide the following:
      a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
   2. Materials shall be compatible with insulation materials, jackets, and substrates.
   3. Fire- and water-resistant, flexible, elastomeric sealant.
   4. Service Temperature Range: Minus 40 to plus 250 deg F.
   5. Color: White.
   6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.06 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
   2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

2.07 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Johns Manville; Zeston.
      b. P.I.C. Plastics, Inc.; FG Series.
      c. Proto Corporation; LoSmoke.
      d. Speedline Corporation; SmokeSafe.
   2. Adhesive: As recommended by jacket material manufacturer.
   3. Color: White, Color-code jackets based on system, or Color as selected by Architect.
   4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
      a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

2.08 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. ABI, Ideal Tape Division; 428 AWF ASJ.
      b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
      c. Compac Corporation; 104 and 105.
      d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
   2. Width: 3 inches.
   3. Thickness: 11.5 mils.
   4. Adhesion: 90 ounces force/inch in width.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lbf/inch in width.
   7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. ABI, Ideal Tape Division; 370 White PVC tape.
   b. Compac Corporation; 130.
   c. Venture Tape; 1506 CW NS.
2. Width: 2 inches.
3. Thickness: 6 mils.
4. Adhesion: 64 ounces force/inch in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

2.09 SECUREMENTS

A. Bands:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. ITW Insulation Systems; Gerrard Strapping and Seals.
      b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.
   2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing seal or closed seal.
   3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.
   4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

C. Wire: 0.062-inch soft-annealed, stainless steel.
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. C & F Wire.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
   1. Verify that systems to be insulated have been tested and are free of defects.
   2. Verify that surfaces to be insulated are clean and dry.
   3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
   1. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for

appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.03 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
      a. For below-ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:
   1. Vibration-control devices.
   2. Testing agency labels and stamps.
   3. Nameplates and data plates.
   4. Manholes.
   5. Handholes.
   6. Cleanouts.

3.04 PENETRATIONS

A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

B. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
   1. Comply with requirements in Division 07 Section "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

3.05 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. 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.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

E. Pre insulated pipe supports: Butt the pipe insulation to each end of the pre-insulated pipe support devices. Care shall be taken in making the butt joint so that the thermal and vapor barrier integrity of the joint is assured. Use extra care on the joints for all cold piping systems.

F. Saddles, Inserts and Shields:
1. Application: Piping 2” diameter or larger
2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
3. Saddles: Carbon steel, designed to support pipe between shield and pipe, notched to minimize heat loss.
4. Insert location: Between support shield and piping and under the finish jacket.
5. Insert configuration: Minimum 6” long, of same thickness and contour as adjoining insulation; may be factory fabricated.

G. Insert material (Above Ambient Temperatures): Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.

3.06 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
   4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
   3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   4. Install insulation to flanges as specified for flange insulation application.

3.07 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
   1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
   2. Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.
   3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.
   1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.08 FINISHES

A. Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
   a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Do not field paint aluminum or stainless-steel jackets.

3.09 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
   1. Drainage piping located in crawl spaces.
   2. Underground piping.
   3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.10 INDOOR PIPING INSULATION SCHEDULE

PIPE LABEL	PIPING DESCRIPTION	PIPE SIZE	INSULATION CODE	INSULATION THICKNESS	NOTES
HWS/ HWR	HEATING WATER SUPPLY/RETURN	0 – 1¼" 1 ½" +	2.1.H	1½" 2"	1, 2, 3

NOTES:

1. For outdoor installations, apply aluminum jacket (Code C, Aluminum) over specified insulation.

2. PVC jacket (Code B. PVC) required below 10' – 0" A.F.F in exposed areas. For occupied spaces, all exposed pipe insulation shall have PVC jacket, including Gymnasiums.

3. PVC jacket (Code B.PVC) required for all piping in exposed finished areas.

GENERAL NOTES:

No PVC jacket allowed in air plenum ceiling.

PIPING INSULATION CODES:

2.1. H. Mineral Fiber

PIPING JACKET CODES:

2.9. B. PVC

END OF SECTION 23 07 19

SECTION 23 09 00

INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

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

B. Related Sections:
   1. Section 230923 "Direct Digital Control (DDC) System for HVAC"

1.03 SUBMITTALS

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

1.04 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace products that fail in materials or workmanship within specified warranty period.
   1. Failures shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner.
   2. Include updates or upgrades to software and firmware if necessary to resolve deficiencies.

3. Warranty service shall occur during normal business hours and commence within four hours of Owner's warranty service request.
4. Warranty Period: two (2) years from date of Substantial Completion.

PART 2 PRODUCTS (INPUT AND OUTPUT CONTROL DEVICES)

2.01 ELECTRONIC SENSORS

A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required. Selected range of sensor must fit range of measured variable and of the measuring range of the controller input. The measured value on the controller must be accurate and repeatable within the ranges listed below.

B. Thermistor or RTD Temperature Sensors and Transmitters:
   1. Manufacturers:
      a. DDC Control System Manufacturer’s Brand
      b. Kele
      c. ACI
      d. BAPI
      e. MAMAC
   2. Accuracy: Plus or minus 0.5 deg F at calibration point.
   3. Drift: Less than 0.25 deg F over 5 years.
   4. Insertion Elements in Ducts: Single point, of sufficient length to measure near center of duct to a maximum of 18 inches long.
   5. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches.
   6. Room Sensor: Color and style to match architecture with insulated back.
   7. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.

C. Pressure Transmitters/Transducers:
   1. Manufacturers:
      a. Honeywell, Inc.
      b. Dwyer
      c. Setra
      d. ACI
      e. BAPI
      f. MAMAC
      g. Vaisala
   2. Static-Pressure Transmitter: sensor with suitable range for expected input, and temperature compensated.
      a. Accuracy: 1 percent of full scale with repeatability of 0.5 percent.
      b. Output: linear
      c. Building or Zone Static-Pressure Range: plus or minus 0.10 inch wg.
      d. Duct Static-Pressure Range: 0- to 5 inch wg.
   3. Water Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure; linear output.
   4. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure and tested to 300-psig; linear output.

5. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.
6. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; linear output.

D. Current Sensors/Transducers
   1. Manufacturers:
      a. ACI
      b. Hawkeye
      c. Functional Devices, Inc.
   2. Range Selection: The maximum expected current draw of the measured equipment must be no less than 50% and no more than 100% of the maximum measurable scale of the transducer as configured. Transducer must be capable of reliably detecting the equipment operating at a minimum speed.
   3. Accuracy: +/- 2%

2.02 STATUS SENSORS

A. Current Switches: Self-powered, solid-state, selected to match current and system output requirements.

B. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2-10 VDC feedback signal.

2.03 FLOW MEASURING DEVICES

A. Water Flow Sensor:
   1. Manufacturers
      a. Onicon, Inc.
   2. Technology
      a. Ultrasonic sensor with as accuracy of plus or minus 1 percent.
      b. Electromagnetic sensor with an accuracy of plus or minus 1 percent from 2 to 20 ft/sec.
      c. Dual turbine sensor with an accuracy of plus or minus 1 percent from 3 to 30 ft/sec.
   3. Sensor must be located such that there are appropriate numbers of pipe diameters up and down stream of sensor to ensure laminar flow. Follow manufacturer recommendation.
   4. Sensor shall be sized and scaled appropriately for specific application.

2.04 ACTUATORS

A. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
   1. Manufacturers:
      a. Belimo Aircontrols, Inc.
      b. Honeywell, Inc.
      c. Johnson Controls, Inc.
      d. Siemens USA
      e. Schneider Electric

2. Valves: Size for torque required for valve close off at maximum pump differential pressure.
3. Dampers: Size for running torque of 7 in.lbs/sq.ft at 1 in.wc. If operating conditions exceed 3 in.wc, multiply torque by 2.
4. Coupling: V-bolt and V-shaped, toothed cradle.
5. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
6. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on non-spring-return actuators.
7. Power Requirements: All actuators to be powered by 24 VAC.
8. Proportional Signal: 0(2) to 10 VDC or 4 to 20 mA, and 0(2) to 10 VDC position feedback signal (if required).
9. Temperature Rating: -22 to plus 122 deg F Temperature Rating.
10. Run Time: Maximum of 100 Seconds

2.05 CONTROL VALVES

A. Manufacturers:
1. Belimo Aircontrols, Inc.
2. Honeywell, Inc.
3. Johnson Controls, Inc.
4. Siemens USA

B. Usage with Actuator:
1. Provide electronic actuators on all control valves unless noted otherwise.
2. Whenever possible, provide a valve and actuator assembly from factory.
3. Fail-Safe operation, spring return mechanism. Provide for these:
   a. AHU/RTU with heating water, glycol, or steam coil.
   b. Cabinet unit heaters and unit heaters.

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

D. Terminal Units - Ball Valves (Water): Equal percentage ball valves with characterized disc.
1. Construction: Brass body, brass or stainless steel trim, EPDM o-rings.
2. Rating: 200 psig body rating, 200 deg F operating conditions, 200 psid close-off pressure.
3. Sizing: 5 psig maximum pressure drop at design flow rate.
4. Connection: 2” and smaller shall be threaded, 2-1/2” and larger shall be flanged.

2.06 RELAYS

A. General-Purpose Relays
1. Relays shall be heavy duty and rated for at least 10 A at 240-VAC and 60 Hz.
2. Relays shall be either double pole double throw (DPDT) or three-pole double throw, depending on the control application.
3. Use a plug-in-style relay with industry-standard, 35-mm DIN rail socket.
4. Relay socket shall have screw terminals. Mold into the socket the coincident screw terminal numbers and associated pin numbers.

5. Construct the contacts of either silver cadmium oxide or gold.
6. Enclose the relay in a clear transparent polycarbonate dust-tight cover.
7. Relays shall have LED indication.
8. Performance:
    a. Mechanical Life: At least 10 million cycles.
    b. Electrical Life: At least 100,000 cycles at rated load.
    c. Pickup Time: 30 ms or less.
    d. Dropout Time: 310 ms or less.
    e. Pull-in Voltage: 85 percent of rated voltage.
    f. Dropout Voltage: 50 percent of nominal rated voltage.
    g. Power Consumption: 2 VA or less.
    h. Ambient Operating Temperatures: Minus 40 to 115 deg F

2.07 PUSH BUTTONS (SHUTOFF)

A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.
    1. Provide with clear cover that is ADA compliant (<4" deep).
    2. Provide with custom labels to indicate device purpose "BOILER SHUTOFF", "EPO", etc…
    3. Push to activate, turn to reset.
    4. Provide with horn where it is critical that it is only used in an emergency.
    5. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
        a. Safety Technology International (STI) SS-2341.
        b. Approved Equal

PART 3 EXECUTION

3.01 INSTALLATION

A. Modify the existing pneumatic control system as needed to assure an operable system.

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

C. Verify location of temperature sensors, thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install all devices with manual adjustment at 48 inches above the floor to comply with ADA. Install all devices without manual adjustments, sensors at 48 inches above the floor.

D. Use flat plate zone sensors in all locations.

E. Where temperature sensors are installed on exterior walls, use the following installation practice to minimize the influence of outside conditions on sensor reading.
    1. Provide 2-inch deep wall box, filled with insulation, so that sensor is mounted 2-inches off the surface of wall.
    2. Provide ¼" thick, closed-cell foam insulation between sensor and wall box with a small slit to allow only wiring to pass through. Foam insulation shall provide a tight seal to prevent infiltration air from spilling over sensing element.

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

G. Install labels and nameplates to identify control components according to Section 230553 "Identification for HVAC Piping and Equipment."

H. Install hydronic instrument wells, valves, and other accessories according to Section 232116 Hydronic Piping Specialties."

I. Install steam and condensate instrument wells, valves, and other accessories according to Section 232216 Steam and Condensate Piping Specialties."

J. Install refrigerant instrument wells, valves, and other accessories according to Section 232300 "Refrigerant Piping."
   1. Location that is easily accessible by operators.
   2. Top of controller shall be within 84 inches of finished floor.

END OF SECTION 23 09 00

SECTION 23 09 23

DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This section includes control equipment for HVAC systems using the Automated Logic WebCTRL platform. WebCTRL supervisor software and network controllers are required for the supervisor and network levels of the BAS. Communication at these levels shall be BACnet IP. Communication at the field level shall be BACnet MS/TP.

B. Related Sections:
   1. Section 230900 "Instrumentation and Control for HVAC."

1.03 QUALITY ASSURANCE

A. DDC System Manufacturer Qualifications:
   1. Automated Logic Company
   2. Having complete published catalog literature, installation, operation and maintenance manuals for all products intended for use.
   3. Having full-time in-house employees for the following:
      a. Product research and development.
      b. Product and application engineering.
      c. Product manufacturing, testing and quality control.
      d. Technical support for DDC system installation training, commissioning, and troubleshooting of installations.
      e. Owner operator training.

B. DDC System Provider Qualifications:
   1. Authorized representative of, and trained by, DDC system manufacturer
      a. Minimum of 5 network level software certified individuals on staff.
      b. Minimum of 2 field level controller product certified individuals on staff.
   2. Each person assigned to Project shall have a minimum of 5 years past experience.
   3. In-place facility located within 75 miles of Project.
   4. Demonstrated past experience with over 20 BAS system installations, including individual systems comprised of more than 10 network level controllers.
   5. Staffing resources of competent and experienced full-time employees that are assigned to execute work according to schedule.
   6. Service and maintenance staff assigned to support project during warranty period.
   7. Product parts inventory to support on-going DDC system operation for a period of not less than five years after substantial completion.

8. DDC system manufacturer's backing to take over execution of work if necessary to comply with requirements indicated. Include project-specific written letter, signed by manufacturer's corporate officer, if requested.

1.04 DEFINITIONS

A. BACnet: An open communications protocol for building automation and ASHRAE 135 control networks. It is an ASHRAE, ANSI, and ISO standard protocol developed under the auspices of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).

B. LonTalk: An open communications protocol for building automation and LonWorks control networks. It is a LonMark International, ANSI, and ISO standard protocol originally developed by Echelon Corporation.

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

D. Modbus: An open communications protocol for building automation and Modbus control networks. It is a standard protocol supported by the Modbus Organization, Inc.

E. TCP/IP: Short for Transmission Control Protocol/Internet Protocol. A protocol for communication between computers, used as a standard for transmitting data over networks and as the basis for standard Internet protocols.

1.05 SUBMITTALS

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

B. Shop Drawings:
   1. General Requirements:
      a. Include cover drawing with Project name, location, Owner, Architect, Contractor, and issue date with each Shop Drawings submission.

b. Include a drawing index sheet listing each drawing number and title that matches information in each title block.

2. Schematic drawings for each controlled HVAC system indicating the following:
   a. I/O points labeled with point names shown. Indicate instrument range, normal operating set points, and alarm set points. Indicate fail position of each damper and valve, if included in Project.
   b. I/O listed in table format showing point name, type of device, manufacturer, model number, and cross-reference to product data sheet number.
   c. A graphic showing location of control I/O in proper relationship to HVAC system.
   d. Wiring diagram with each I/O point having a unique identification and indicating labels for all wiring terminals.
   e. Unique identification of each I/O that shall be consistently used between different drawings showing same point.
   f. Elementary wiring diagrams of controls for HVAC equipment motor circuits including interlocks, switches, relays, and interface to DDC controllers.
   g. Narrative sequence of operation.
3. Control panel drawings indicating the following:
   a. Panel dimensions, materials, size, and location of field cable, raceways, and tubing connections.
   b. Interior subpanel layout, drawn to scale and showing all internal components, cabling and wiring raceways, nameplates, and allocated spare space.
   c. Front, rear, and side elevations and nameplate legend.
   d. Unique drawing for each panel.
   e. Point of connection to field power with requirements (volts/power) listed for each.
4. DDC system network riser diagram indicating the following:
   a. Each device connected to network with unique identification for each.
   b. Interconnection of each different network in DDC system.
   c. For each network, indicate communication protocol, speed, and physical means of interconnecting network devices, such as copper cable type, or fiber-optic cable type. Indicate raceway type and size for each.
   d. Each network port for connection of an operator workstation or other type of operator interface with unique identification for each.
5. Monitoring and control signal diagrams indicating the following:
   a. Control signal cable and wiring between controllers and I/O.
   b. Point-to-point schematic wiring diagrams for each product.
   c. Control signal tubing to sensors, switches and transmitters.
   d. Process signal tubing to sensors, switches and transmitters.
   e. Pneumatic main air and control signal tubing to pneumatic damper and valve actuators, pilot-positioners if applicable, and associated transducers.
6. Color graphics indicating the following:
   a. Itemized list of color graphic displays to be provided.
   b. For each display screen to be provided, a true color copy showing layout of pictures, graphics and data displayed.
   c. Intended operator access between related hierarchical display screens.

C. System Description:

1. Full description of DDC system architecture, network configuration, operator interfaces and peripherals, servers, controller types and applications, gateways, routers and other network devices, and power supplies.
2. Complete listing and description of each report, log and trend for format and timing and events which initiate generation.
3. System and product operation under potential power failure condition.
4. Description of testing plans and procedures.
5. Description of Owner training.

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

E. Schedule and design calculations for control valves, control dampers and actuators.
   1. Flow at Project design and minimum flow conditions.
   2. Pressure drop across valve at Project design flow condition.
   3. Minimum system pressure drop (pump close-off pressure) across valve at Project minimum flow condition.
   4. Maximum close-off pressure.
   5. Actuator selection indicating torque provided.
   6. Actuator signal to control damper (on, close, or modulate).
   7. Actuator position on loss of power.

F. Schedule and design calculations for selecting flow instruments.
   1. Instrument flow range.
   2. Project design and minimum flow conditions with corresponding accuracy, control signal to transmitter and output signal for remote control.
   3. Extreme points of extended flow range with corresponding accuracy, control signal to transmitter and output signal for remote control.
   4. Pressure-differential loss across instrument at Project design flow conditions.
   5. Where flow sensors are mated with pressure transmitters, provide information for each instrument separately and as an operating pair.

G. Coordination drawings
   1. Include details and descriptions on schematic control drawings as required to coordinate work with other trades.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For DDC system to include in emergency, operation and maintenance manuals.
   1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
      a. Project Record Drawings of as-built versions of submittal Shop Drawings provided in electronic PDF format. These PDF files shall also be inserted into BAS with an on-screen hyperlink to access from graphic screen.
      b. Testing and commissioning reports and checklists of completed final versions of reports, checklists, and trend logs.
      c. As-built versions of submittal Product Data.

d. Names, addresses, e-mail addresses, and 24-hour telephone numbers of Installer and service representatives for DDC system and products.
e. All Programming, Operator's manuals, and other BAS reference materials shall be made available as on-line help files accessible from an on-screen hyperlink to access from graphic screen.
f. Backup copy of graphic files, programs, and database on electronic media such as a flash drive.
g. List of recommended spare parts with part numbers and suppliers.
h. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
i. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
j. Licenses, guarantees, and warranty documents.
k. Any other pertinent Owner training materials.

1.07 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace products that fail in materials or workmanship within specified warranty period.
   1. Failures shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner.
   2. Include updates or upgrades to software and firmware if necessary to resolve deficiencies.
   3. Warranty service shall occur during normal business hours and commence within four hours of Owner's warranty service request.
   4. Warranty Period: two (2) years from date of Substantial Completion.

PART 2 PRODUCTS (DDC CONTROL SYSTEM HARDWARE AND SOFTWARE)

2.01 DDC SYSTEM MANUFACTURER AND PROVIDER ARE LISTED IN THE QUALITY ASSURANCE SECTION NEAR THE TOP OF THIS SPECIFICATION.

2.02 WEB ACCESS

A. DDC system shall be web-based Automated LogicWebCTRL.
   1. Web-Based Access to DDC System:
      a. DDC system software shall be based on server thin-client architecture, designed around open standards of Web technology. DDC system server shall be accessed using a Web browser over DDC system network, using Client's LAN, and remotely over Internet through Client's LAN.
      b. Intent of thin-client architecture is to provide operators complete access to DDC system via a Web browser. No special software other than a Web browser shall be required to access graphics, point displays, and trends; to configure trends, points, and controllers; and to edit programming.
      c. Web access shall be password protected.

B. DDC System Speed:
   1. Response and display update Time of Connected I/O:

a. All point values connected to DDC system shall be updated at least every two seconds for use by DDC controllers. Points used globally shall also comply with this requirement.
b. Graphic display refresh shall update within five seconds.
c. Point change of values and alarms displayed from workstation to workstation when multiple operators are viewing from multiple workstations shall not exceed graphic refresh rate.

C. Environmental Conditions for Controllers, Gateways, Instruments and Actuators:
1. Products shall operate without performance degradation under ambient environmental temperature, pressure and humidity conditions encountered for installed location.
a. If product alone cannot comply with requirement, install product in a protective enclosure that is isolated and protected from conditions impacting performance. Enclosure shall be internally insulated, electrically heated, cooled and ventilated as required by product and application.
2. Products shall be protected with enclosures satisfying the minimum requirements specified later in this section unless more stringent requirements are indicated.

D. DDC System Reliability and Redundancy:
1. Design, install, and configure DDC control system, to match mechanical/electrical systems and equipment reliability and redundancy design.
a. For example; if two chillers are installed, one being a back-up, it is expected that the back-up chiller will automatically start when the primary chiller fails. Two chillers were installed to ensure cooling remains active if a single device fails. The DDC control system must match this design intent, where the single failure of one DDC controller or DDC component does not prevent cooling of the building.

E. Electric Power Quality:
1. When building is equipped with UPS or emergency power, these sources, in respective order should be used to power all DDC system products if capacity is available.
2. Power Conditioning:
a. When building UPS power is used to power DDC system products, no additional power conditioning is required.
b. When building UPS power is not used to power DDC system products, protect all DDC system products connected to ac power circuits from surges, irregularities, brownouts, and noise using power-line conditioner units. Basis of design: Tripp-Lite model LS604WM. Application intent as follows:
1) Must be provided for all level one, enterprise level devices and level two, middle level devices.
2) Provide as applicable for level three, field level devices.
(a) Must be provided to feed central transformer banks whenever low voltage power is pulled to groups of terminal unit controllers such as VAV controllers powered from a central location.
(b) Not required where terminal unit controllers are powered directly from served equipment such as fan coil units, heat pumps, fan-powered VAVs, etc.

3. Ground Fault: Protect products from ground fault by providing suitable grounding. Products shall not fail due to ground fault condition. Install grounding wires as shown in manufacturer's instructions.

F. Backup Power Source:
   1. Design, install and configure DDC control system, to match mechanical/electrical systems and equipment reliability and redundancy design.
      a. For example; if two chillers are installed, one being a back-up, and each powered from separate power panels, it is expected that one chiller will run when power is cut to one power panel. Two power panels were utilized to ensure cooling remains active if a single device fails. Power to the DDC control system must match this design intent, where the single failure of one power source does not prevent cooling to the building.
   2. Mechanical/electrical systems and equipment served by a backup power source shall have associated DDC system products that control such systems and equipment also served from the same or equivalent backup power source.

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

2.03 SYSTEM ARCHITECTURE

A. System architecture shall consist of no more than three levels of LAN and/or communication busses.
   1. Level one - Enterprise level - Consists of network level controllers acting as gateway devices to share data between buildings and supervisor. Server, where supervisor software resides, is overseen by Client. All modifications must be pre-approved and coordinated. Client staff access supervisor using Client provided workstations, connected to the Client LAN/WAN using preferred web browser software. Network level controllers to be installed throughout Client buildings connected to Client LAN/WAN for communication between supervisor server and the specific building controls. The communication protocol between supervisor and network level controllers shall be a TCP/IP-based protocol.
   2. Level two - Middle level - Consists of network level controllers, utilizing the included control engine capability and connected input/output devices located near network level to provide stand-alone control of larger, central systems that serve other subordinate systems within a building. Examples of larger, central systems include; cooling plants, heating plants, VAV air handling units serving terminal units, etc. It is required to provide one network level controller per central system to maintain stand-alone capability. It is not acceptable to scatter input/output devices throughout building to control multiple central systems from a single network level controller; this is not considered stand-alone control. It is encouraged to locate any network level controller acting as a gateway controller near a central system so it can be additionally used as a middle level controller for that central system. Middle level network level controllers connect to Client

LAN/WAN using TCP/IP-based protocol identical to enterprise level network level controller connections.

3. Level three - Field level - consists of general purpose programmable controllers to provide stand-alone control of terminal units. Examples of terminal units include VAV boxes, fan coil units, heat pumps, induction units, unit heaters, smaller rooftop units serving a single zone, etc. Field level controllers to be configured or programmed using the programmable controller tool made available by the manufacturer. Programmable controller tool shall be capable of connection to field controllers via Client LAN/WAN routed through the network level controllers. Communication at the field level shall be open protocol, BACnet MS/TP. These field level networks shall be installed and maintained by controls contractor.

2.04 SUPERVISOR SERVER OR DESKTOP OPERATOR WORKSTATIONS

A. Supervisor server exists and is located at Client office. All BAS control projects must be added to this server. Supervisor server, including versions, and patches, is maintained by Client. Server version upgrades and patches are not required as part of project.

B. A copy of the programmable controller tool required to program the field level controllers shall be provided and installed on the supervisor server if tool does not already exist. Programmable controller tool shall not require the use of any hardware key such as a dongle or USB key to operate. Programmable controller tool shall not require any software generated key or applied license to operate.

C. Personal Computers, or Laptop workstations are not required as part of project. Client staff access supervisor using Client provided workstations, connected to the Client LAN/WAN using preferred web browser software

2.05 USER INTERFACE

A. Graphic Interface Software:
   1. Utilize graphic package included within head-end software system to create a complete graphical interface.

B. Project-Specific Graphics: Shall include, but not limited to, the following:
   1. All configurations including added graphics, navigation, trending, alarming, etc. must match existing Client standards described here. Requirement is that all graphics provided with each project are very similar to all other graphics provided with other projects such that all graphics on supervisor flow seamlessly.
   2. Site plan showing each building, and additional site elements, which are being controlled or monitored by DDC system.
   3. Plan for each building floor, including interstitial floors, and each roof level of each building, showing the following:
      a. Room layouts with room identification and name.
         1) Verify prior to printing, labeling, ordering, or programming that the room names and room numbers utilized match the actual final installed room names and room numbers. Coordinate with Owner and architect for final room numbering to be utilized.
      b. Locations and identification of all monitored and controlled HVAC equipment and other equipment being monitored and controlled by DDC system.

c. Location and identification of each hardware point being controlled or monitored by DDC system.

4. Graphic display for each piece of equipment connected to DDC system. Include dynamic indication of all points associated with equipment. Include accurate schematic diagram with flow directions and labels. Include point identification, set points, customizable note, and sequence of operation.
5. PDF files of control O&M manuals and all other pertinent documentation to be inserted into BAS with an on-screen hyperlink to access from graphic screen.

C. Standard Reports: Standard DDC system reports shall be provided and operator shall be able to customize reports later.
1. All I/O: With current status and values.
2. All I/O in a manual override state: With current status and values.
3. Alarm: All current alarms.
4. Disabled I/O: All I/O points that are disabled.
5. Logs:
a. Alarm history.
b. Audit history, displaying all operator initiated events.
c. System messages.
d. System events.
e. Trends.

D. Custom Reports: Operator shall be able to easily define any system data into a daily, weekly, monthly, or annual report. Reports shall be time and date stamped and shall contain a report title.

E. Custom Trends: Operator shall be able to define a custom trend log for any I/O point in DDC system.
1. Each trend shall include interval, start time, and stop time.
2. Data shall be sampled and stored on DDC controller, within storage limits of DDC controller, and then uploaded to archive on server hard drives.
3. Data shall be retrievable for use in spreadsheets and standard database programs.

2.06 DDC CONTROLLERS

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

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

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

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

E. Environment Requirements:
1. Controller hardware shall be suitable for the anticipated ambient conditions.

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

G. DDC Controller Spare Processing Capacity:
   1. Include spare processing memory for each controller. RAM, PROM, or EEPROM will implement requirements indicated with the following spare memory:
      a. Network Controllers: 15 percent spare. Average operating CPU% shall not be greater than 85 percent and “heap used” value shall not exceed 85 percent of “heap total”.
      b. Programmable Application Controllers: 15 percent spare.
      c. Application-Specific Controllers: 15 percent spare.
   2. Memory shall support network controller's operating system and database and shall include the following:
      a. Monitoring and control.
      b. Energy management, operation, and optimization applications.
      c. Alarm management.
      d. Historical trend data of all connected I/O points.
      e. Maintenance applications.
      f. Operator interfaces.
      g. Monitoring of manual overrides.

H. DDC Controller Spare I/O Point Capacity: Include spare I/O point capacity for each controller as follows:
   1. Network Controllers:
      a. Room in panel shall be allocated to allow for additional I/O devices and associated wiring needed to achieve 25 percent added point capacity in the future. Anticipated point mixture shall be planned at approximately 6-1/2 percent of each point type, AI, AO, BI and BO.
   2. Programmable Application Controllers:
      a. When applied to equipment other than a zone terminal unit, spare capacity requirements shall follow that of network controller.
      b. When applied to a zone terminal unit, no spare capacity is required.
   3. Application-Specific Controllers:
      a. Spare capacity requirements shall be identical to programmable application controllers.

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

J. Input and Output Point Interface:

1. Hardwired input and output points shall connect to network controller I/O devices, programmable application and application-specific controllers.
2. Input and output points shall be protected so shorting of point to itself, to another point, or to ground will not damage controller.
3. Input and output points shall be protected from voltage up to 24 V of any duration so that contact will not damage controller.

2.07 NETWORK CONTROLLERS

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

B. Communication:
   1. Network controllers shall communicate with other devices on DDC system level one and/or level two networks.
   2. Network controller also shall perform routing if connected to a level three network of programmable application, application-specific controllers or integrated equipment. Level three network shall be open protocol; BACnet MS/TP. The use of other open protocols including, Lonworks or Modbus is acceptable when integrating third party devices.
   3. A separate level three network is required for each unique device manufacturer type. For example; a single level three network connecting several different size BACnet VAV controllers and FCU controllers from a common manufacturer would be acceptable, but it would not be acceptable to add a BACnet chiller to this same network. A separate level three network would be required to connect the BACnet chiller or chillers. The only exception to this requirement would be for level three networks connecting less than (10) devices with Client approval.

C. Serviceability:
   1. Controller shall be equipped with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
   2. Wiring and cable connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.

3. Controller shall maintain BIOS and programming information in event of a power loss for at least 96 hours.

2.08 PROGRAMMABLE APPLICATION CONTROLLERS

A. General Programmable Application Controller Requirements:
   1. Include adequate number of controllers to achieve performance indicated.
   2. Controller shall have enough memory to support its operating system, database, and programming requirements.
   3. Data shall be shared between networked controllers and other network devices.
   4. Operating system of controller shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
   5. Controllers that perform internal scheduling shall have a real-time clock.
   6. Controller shall continually check status of its processor and memory circuits. If an abnormal operation is detected, controller shall assume a predetermined failure mode and generate an alarm notification.
   7. Controllers shall be fully programmable with configuration software tool connected via the attached network controller or with embedded tools within the network controller.

B. Communication:
   1. Programmable application controllers shall communicate with other devices on level three network.
   2. Communication at this third level shall be open protocol; BACnet or Lonworks

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

2.09 APPLICATION-SPECIFIC CONTROLLERS

A. Description: Microprocessor-based controllers, which through hardware or firmware design are dedicated to control a specific piece of equipment. Controllers are not fully user-programmable but are configurable and customizable for operation of equipment they are designed to control.
   1. Capable of standalone operation and shall continue to include control functions without being connected to network.
   2. Data shall be shared between networked controllers and other network devices.
   3. Controllers shall be configured or programmed using the configuration software tool connected via the attached network controller or with embedded tools within the network controller.

B. Communication: Application-specific controllers shall communicate with other application-specific controller and devices on level three network, and to programmable application and network controllers. Communication at this third level shall be open protocol; BACnet or Lonworks.

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

2.10 POINT NAMING - TYPICAL

A. It is required that a logical and consistent point naming strategy be used. The point naming strategy described here may be used or alternative strategy may be submitted for engineer's approval prior to implementation. The naming abbreviations listed here show common abbreviations, it is expected that additional abbreviations be added when applicable.

B. Actual point names of Boolean, Numeric, Enumerated and String points shall be simple short names that are repeated as much as possible throughout system to take advantage of batch commands. For example, there should be many points throughout the system with the name "Zn_Temp" The key is that these repeat points are all in different, uniquely named folders. The full point name shall be derived from folder structure naming and extracted as needed automatically by the BAS. For example, when a point alarms and is issued to the alarm log, the full point name, extracted from the folder structure shall be included in the alarm message so it is known exactly which Zn_Temp of all the Zn_Temps throughout the system is in alarm.

C. Title case is used in this naming strategy to efficiently group abbreviations without the need to use several separator characters. When it is prudent to use a separator character, the use of the underscore character is preferred. Total character count in point naming is limited.

D. Order of text within the point name from left to right is important. Often alphabetical sorting techniques are inherent within BAS systems. This point naming strategy takes advantage of this by starting with broad location in the left-most characters and narrowing to fine detail in the right-most characters, all the while attempting to group like items.

E. <Prefix> = <Building Name>_<System Name>_< Equipment Name>
   1. This prefix to be included in all full point names. Prefix shall be derived from folder structure and shall automatically change with folder renaming.

F. <Point Name> = <Component Name>_<Feature Name>
   1. At least first feature name must be included. Additional feature names to be included as appropriate

G. <Full Point Name> = <Prefix>_<Point Name>
   1. Example Full Point Names:
      a. NorthBldg_Ahu01_SaFan_Cmd
      b. NorthBldg_Ahu01_ClgChws_Temp
      c. NorthBldg_Ahu01_Oa_Flow

d. Science_Vav05_Zn_Temp
e. Science_Vav05_Zn_ClgUnocTempSpt
f. Science_Vav05_PriAirDmpr_Sig
g. GB1_ClgPlnt_SecChwP2_Cmd
h. GB1_ClgPlnt_ClgTwr1_FanA_Sts
i. MplsBank_Energy_Hvac_kW
j. MplsBank_Energy_HVAC_Flr01_BTUH
k. MplsBank_Energy_Lights_kWh
l. MainStPark_Lights_ExtLights_Cmd

2. <Building>_<System>_<Equipment>_<Component>_<Feature>

This folder name to be derived from building name shown on drawing set, examples might include:			
NorthBldg	North Building	MplsBank	Minneapolis Bank Building
GB1	1st - General Building	MainStPark	Main Street Park
Science	Science Building		

3. <Building>_<System>_<Equipment>_<Component>_<Feature>

This folder name (optional) is used when prudent to describe the larger system the point will be associated with. Often this will allow the logical grouping of equipment such as in central plants or helping to distinguish lighting control from HVAC control. Some examples include:			
ClgPlnt	Central Chiller Plant	HwPlant	Central Heating Plant
Energy	Energy Monitoring	Hvac	HVAC systems
Lighting	Lighting Systems		

4. <Building>_<System>_<Equipment>_<Component>_<Feature>

This is the folder name when not part of a system. This is part of the actual point name when part of a system. It is used to describe the specific piece of equipment the point is associated with. It can be derived from the designated equipment name shown on drawing set. Combine with multiple component names as appropriate to further clarify the piece of equipment, examples might include:			
Ahu1	Air Handling Unit #1 (folder)	Vav01	VAV #2 (folder)
SecChwp2	Secondary Chilled Pump #2 (point)	PriHwp7	Primary Heating Pump #7 (point)

5. <Building>_<System>_<Equipment>_<Component>_<Feature>

This part of the actual point name (optional) can be used to describe a component of a piece of equipment. Combine with multiple component names as appropriate to further clarify the component. Examples might include: Ahu01_**SaFan**_Cmd, ClgPlnt_ClgTwr1_**FanA**_Sts

Dmpr	Control damper	Filt	Filter
Safety	Safety device value	Oa	Outside air section
EmgStop	Emergency stop button	Ma	Mixed air section
Fan	Fan	Da	Discharge air section
Zn	Controlled zone, room or space	Sa	Supply air section
Pri	Primary water loop	Ra	Return air section
Sec	Secondary water loop	Rlf	Relief air section
Chw	Chilled water	PreHt	Pre-heating coil and valve
Chws	Chilled water supply	Rht	Re-heating coil and valve
Chwr	Chilled water return	Htg	Heating coil and valve
Hw	Heating water	Clg	Cooling coil and valve
Hws	Heating water supply	DxCmp	Direct exp clg compressor
Hwr	Heating water return	Vlv	Control valve
Sump	Sump tank	RevVlv	Reversing Valve
Rad	Radiation	Vfd	Variable frequency drive
Humid	Humidifier	PriAir	Primary air section
Light	Lighting	Pump	Circulating pump
FrzStat	Freezestat	Iso	Isolation, as in Isolation valve
Set	Part of a set, such as a pump set	Sys	Indicate part of a specific system

6. <Building>_<System>_<Equipment>_<Component>_<Feature>

This last part of the actual point name is used to describe the feature of the equipment/component. The action, reading, calculated value, associated setpoint, etc. Combine with multiple feature or component names as appropriate to further clarify the feature. Examples might include: Vav05_Zn_**ClgUnocTempSpt,** Vav05_Zn_**SptAdj,** Ahu01_SaFan_**Cmd,** Ahu01_Ra_**MaxCo2**

Cmd	Command; on/off	Occ	Occupied value
Sig	Modulating signal; controller to device	Unoc	Unoccupied value
Sts	Status: on/off device to controller	StndBy	Stand-by value
FdBk	Feedback signal from device to cntrl	Co2	Carbon dioxide
Alm	Alarm status from device	Co	Carbon monoxide
Flow	Air or water flow	No2	Nitrogen dioxide
Temp	Temperature	Mode	Operating control mode
Rh	Relative humidity	Vel	Velocity
Enth	Enthalpy	Area	Area
Dew	Dewpoint temperature	Level	Level measurement
Press	Gauge pressure	Kfactor	Balancing constant
Dp	Differential pressure	Config	Configuration value

Sched	Schedule value	Pct	Percentage
Calc	Calculated value in software	Cap	Capacity
Spt	Setpoint value in software	Eff	Effective or resulting
Offset	Offset value	Select	Selected value
Hi	Highest value	OptStart	Optimum start value
Lo	Lowest value	Mwu	Morning warm-up
Min	Minimum value	Mcd	Morning cool-down
Max	Maximum value	Btuh	Power
Spec	Red/Blue floor plan color spectrum	Btu	Energy
Adj	Adjustment slider, button, knob, etc.	Int	Interior
Btn	Button, user initiated	Ext	Exterior
kW	Power - electrical	Lux	Lighting level - illuminance
kWh	Energy - electrical	PctRla	Percent run load amps
			Any name from the component list

2.11 ALARMING - TYPICAL

A. It is required that a logical and consistent alarm strategy be used. The alarm strategy described here may be used or alternative strategy may be submitted for engineer's approval prior to implementation. The typical alarms listed here show common situations, it is expected that additional alarms be added when applicable.

B. Additional, non-typical alarm extensions shall be added for specific situations described within the control sequences in drawing set.

C. Include alarm handling software to report all alarm conditions monitored and transmitted through DDC controllers, gateways and other network devices.

D. Include first in, first out handling of alarms according to alarm priority ranking.

E. Alarm handling shall be active at all times to ensure that alarms are processed even if an operator is not currently signed on to DDC system

F. Full point name shall be included in every alarm message, refer to "Point Naming" this specification section.

G. These steps must be taken to prevent nuisance alarming. False alarms can quickly fill alarms logs causing real alarms to get overlooked.

H. All indicated alarm threshold, limit, and time delay values to be user adjustable.

I. End-users shall be able to define additional alarms for any point in the system.

J. Example alarms:

Full Point Name (Source)	Class	Message
NorthBldg_Ahu1_SaFan_Cmd	Medium	SUP_Fan Problem
NorthBldg_Ahu1_Filter_Sts	Low	ABS_Filter Dirty
NorthBldg_Ahu1_FrzStat_Alm	High	ABS_Freeze Condition
NorthBldg_Ahu1_Clg_Alm	Medium	SUP_Cooling Valve Problem
NorthBldg_Ahu1_Dmpr_Alm	Medium	SUP_Cooling Damper Problem
Science_VAV_05_Zn_Temp	Medium	SUP_Zone Temp Away From Spt, 79°F
Science_VAV_20_Zn_Temp	High	ABS_Zone Temp Extremely Cold, 38°F
Science_VAV_38	Medium	COM_Controller Offline, Comm Problem
Science_VAV_64_Zn_Temp	Medium	RNG_Sensor Problem, -20°F
Science_Oa_Temp	High	RNG_Sensor Problem, 150°F

K. Classes, at least three alarm classes as described here shall be programmed. The class assignments for each point are defined in control sequences in drawing set.
   1. Low - Class for maintenance type notifications. Log is checked weekly.
   2. Medium - Class for most alarms. Log is checked throughout the day.
   3. High - Class for a few of the most urgent alarms. Emails are sent immediately.

L. Types, at least four alarm types as described here shall be programmed. Examples are shown here to set the level of expectation to apply these types of alarms to each of these typical situations.
   1. Supervisory Alarms, where the BAS system monitors itself. Programming to issue an alarm when a predicted result is not achieved as the result of a programmed control action, typically applies to outputs. All supervisory alarms shall have the prefix “SUP” in the alarm message to immediately provide more insight into how and why this alarm appeared on the alarm log.
      a. Command fail alarm shall be sent to the BAS any time the fan start/stop and status don't match for 60 seconds (adj).
      b. Cooling alarm shall be sent to the BAS anytime a cooling valve is full open or cooing stage is active for 5 minutes (adj) and there is not a temperature drop across coil of at least 5 Deg F (adj).
      c. Cooling alarm shall be sent to the BAS anytime an outside air damper is full open while economizer is active for 5 minutes (adj) and there is not a temperature drop from return air to mixed air of at least 5 Deg F (adj).
      d. Heating alarm shall be sent to the BAS anytime a heating valve is full open or heating stage is active for 5 minutes (adj) and there is not a temperature rise across coil of at least 5 Deg F (adj).
      e. Setpoint alarms, only active when control is active. For example, RmTemp alarms shall only alarm when area is occupied, and has been occupied long enough for the temperatures to be normal. Setpoint alarms shall be sent to

the BAS anytime a sensed value is not within tolerance of setpoint value within 15 minutes (adj).

2. Range Alarms, where an input sensor is outside of its operating range. Indicates when a sensor has failed, power to the sensor has failed, wiring has be shorted or opened, etc. It is required to determine how every controller reads both an open and short for every input and program a specific range alarm for each. All range alarms shall have the prefix “RNG” in the alarm message to immediately provide more insight into how and why this alarm appeared on the alarm log.
   a. High limit alarm shall be sent to the BAS anytime an input sensor reads near the top of its range, and this value is above its normal control range. For example, outside air temperature reading of 150 Deg F.
   b. Low limit alarm shall be sent to the BAS anytime an input sensor reads near the bottom of its range, and this value is below its normal control range. For example, outside air temperature reading of -60 Deg F.
3. Absolute Alarms, where an input sensor is above or below a fixed threshold. Or where an alarm contact closes. All absolute alarms shall have the prefix “ABS” in the alarm message to immediately provide more insight into how and why this alarm appeared on the alarm log.
   a. High limit alarm shall be sent to the BAS anytime an input sensor reads above the high limit threshold. For example, when kitchen freezer temperature is greater than 0°F (adj) for a minimum of 10 minutes (adj). Or when kitchen cooler temperature is greater than 37°F (adj) for a minimum of 10 minutes (adj).
   b. Low limit alarm shall be sent to the BAS anytime an input sensor reads below the low limit threshold. For example, any room temperature less than 40 Deg F.
   c. Discrete alarms shall be sent to the BAS anytime a monitored contact changes to an alarm state. For example, freezestat device trips or inhibitor chemical running low contact remains closed for 10 minutes (adj).
4. Communication Alarms, where a controller is offline. All communication alarms shall have the prefix “COM” in the alarm message to immediately provide more insight into how and why this alarm appeared on the alarm log.
   a. Any controller communication alarm shall be sent to the BAS anytime communication is lost to a controller for 10 minutes (adj).

2.12 HISTORY TRENDING - TYPICAL

A. It is required that a logical and consistent history trend strategy be used. The history trend strategy described here may be used or alternative strategy may be submitted for engineer’s approval prior to implementation. The typical history trends listed here show common situations, it is expected that additional history trends be added when applicable.

B. History trend extensions shall be added and configured for all typical situations described here. This includes every hardware point and every calculated software point that changes automatically by way of program logic.

C. Full point name shall be included in every trend name, refer to “Point Naming” this specification section.

D. All indicated trend configuration parameter values to be user adjustable.

E. All history trends shall store at minimum (3) years' worth of data before rolling to overwrite data. It is understood that change of value (COV) type trend sizes will have to be estimated, configure at least 10,000 records for these.

F. History trend data shall be stored on the central supervisor server.

G. End-users shall be able to define additional trends for any point in the system.

H. Change of Value (COV) trends are where a sample is logged whenever the value changes by a specified amount.
   1. Boolean and Enumerated point COV trends shall log a sample every change of state. Examples of Boolean or Enumerated points are; fan command, fan status and current mode.
   2. For Numeric points, COV trends are not recommended, use Interval trends instead.

I. Interval trends are where a sample is logged according to a preset regular time interval.
   1. Numeric point Interval trends log interval times shall be set as:
      a. 15 minute intervals for slower variables such as; outside temp, room temp, return temp, etc.
      b. 2 minute intervals for faster variables such as; discharge air temp, heating valve signal, building static pressure, etc.
   2. For Boolean and Enumerated points, Interval trends are not recommended, use COV trends instead.

2.13 CONTROL FUNCTIONALITY

A. Sequencing: Include application software based on sequences of operation indicated to properly sequence chillers, boilers, and other applicable HVAC equipment.

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

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

D. Anti-Short Cycling:
   1. BO points shall be protected from short cycling.

2. Feature shall allow minimum on-time and off-time to be selected.

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

F. Run-Time Totalization:
1. Include software with the capability to totalize run-times for BI points.

2.14 ENCLOSURES

A. General Enclosure Requirements:
1. Include enclosure door with secure latching mechanism.
2. All enclosures containing a DDC controller applied to equipment other than a zone terminal unit shall have hinged door.
3. All enclosures associated with DDC control system shall be alike color/style with a visible label identifying its tag/controlled equipment.
4. Individual enclosures shall not exceed 36 inches wide and 48 inches tall high.
5. Supply each enclosure with a complete set of as-built schematics, wiring diagrams, and product literature located in a pocket on inside of door.
6. Enclosure shall be NRTL listed according to UL 508 A.
7. Constructed of steel with factory applied galvanized coating or paint.
8. Internal panel mounting hardware, grounding hardware and sealing washers.
9. Grounding stud on enclosure body.

B. Internal Arrangement:
1. Internal layout of enclosure shall group and protect pneumatic, electric, and electronic components associated with a controller, but not an integral part of controller.
2. Arrange layout to group similar products together.
3. Include a barrier between line-voltage and low-voltage electrical and electronic products.
4. Factory or shop install products, tubing, cabling and wiring complying with requirements and standards indicated.
5. Terminate field cable and wire using heavy-duty terminal blocks.
6. Install a maximum of two wires on each side of a terminal.
7. Include enclosure field power supply with a toggle-type switch located at entrance inside enclosure to disconnect power.
8. Include enclosure with a line-voltage nominal 20-A GFCI duplex receptacle for service and testing tools. Wire receptacle on hot side of enclosure disconnect switch.
9. Mount products within enclosure on removable internal panel/backplane.
10. All internal panel components to be labeled.
11. Route tubing cable and wire located inside enclosure within a raceway with a continuous removable cover.
12. Label controller end of cable, wire and tubing in enclosure following an approved identification system that extends from field I/O connection and all intermediate connections throughout length to controller connection.

13. Size enclosure internal panel to include at least 25 percent spare area on backplane of panel.

C. Environmental Requirements:
   1. Evaluate temperature and humidity requirements of each product to be installed within each enclosure and locate panel accordingly.
   2. Outdoors, Type 4X. Additional panel heater is required when components are not rated for design outdoor temperature and humidity levels.
   3. Indoors, Dry Areas: Type 1.
   4. Indoors, Wet Areas or Areas Exposed to Condensation or Washdown: Type 4X

2.15 ELECTRICAL POWER DEVICES

A. Transformers:
   1. Transformer shall be sized for the total connected load, plus an additional 25 percent of connected load.
   2. Transformer shall be UL Listed.
   3. Transformer shall be at least 40 VA.
   4. Transformer shall have secondary resettable breaker.

B. DC Power Supply:
   1. Output voltage nominally 24-VDC or other voltage within 5 percent.
   2. Output power minimum of 14W.
   3. Input voltage nominally 120-VAC, 60 Hz. Lower voltage input is not acceptable.
   4. Load regulation within 0.5 percent from zero- to 100-mA load.
   5. Line regulation within 0.5 percent at a 100-mA load for a 10 percent line change.
   6. Stability within 0.1 percent of rated volts for 24 hours after a 20-minute warmup.

2.16 PIPING AND TUBING

A. Pneumatic, and Pressure Instrument Signal Air, Tubing and Piping:
   1. Products in this paragraph are intended for use with the following:
      a. Main air and signal air to pneumatically controlled instruments, actuators and other control devices and accessories.
      b. Signal air between pressure instruments, such as sensors, switches, transmitters, controllers and accessories.
   2. Copper Tubing:
      a. Seamless phosphor deoxidized copper, soft annealed or drawn tempered, with chemical and physical properties according to ASTM B 75.
      b. Performance, dimensions, weight and tolerance according to ASTM B 280.
      c. Diameter, as required by application, not less than nominal 0.25 inch
      d. Wall thickness, as required by the application, but not less than 0.030 inch.
   3. Copper Tubing Connectors and Fittings:
      a. Brass, compression type.
      b. Brass, solder-joint type.
   4. Galvanized-Steel Piping:
      a. Galvanized pipe shall be ASTM A 53/A 53M, Schedule 40.
      b. Fittings, galvanized malleable iron, ASME B16.3, Class 150.
   5. Polyethylene Tubing:

a. Fire-resistant black virgin polyethylene according to ASTM D 1248, Type 1, Class C and Grade 5.
b. Tubing shall comply with stress crack test according to ASTM D 1693.
c. Diameter, as required by application, of not less than nominal 0.25 inch.

6. Polyethylene Tubing Connectors and Fittings:
   a. Brass, barbed fittings.
   b. Brass, compression type.

2.17 CONTROL WIRE AND CABLE

A. Low Voltage Power Wiring
   1. Wiring runs less than 150 feet
      a. Wire size shall be minimum 18 AWG.
   2. Wiring runs greater than 150 feet
      a. Wire size shall be minimum 16 AWG. Power/voltage drop calculation must be completed for all longer runs to determine if even larger wire is required.
   3. Conductors shall be twisted soft annealed copper strand.
   4. Conductor insulation shall have a nominal 15-mil thickness, constructed from flame-retardant PVC.
   5. Outer jacket insulation shall have a 300-V, 105-deg C rating and shall be Type PLTC cable.
   6. Power cabling to have a unique jacket color or striping color.

B. Low Voltage Input/Output wiring - Must be shielded.
   1. Wire size shall be minimum 18 AWG.
   2. Conductors shall be twisted soft annealed copper strand.
   3. Conductor insulation shall have a nominal 15-mil thickness, constructed from flame-retardant PVC.
   4. Outer jacket insulation shall have a 300-V, 105-deg C rating and shall be Type PLTC cable.
   5. Shielding shall be 100 percent type, 1.35-mil aluminum/polymer tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
   6. Input cabling to have a unique jacket color or striping color.
   7. Output cabling to have a unique jacket color or striping color.

C. LAN and Communication Cable: Comply with DDC system manufacturer requirements for network being installed.
   1. Cable shall be plenum rated.
   2. Cable shall comply with NFPA 70.
   3. Cable shall have a unique color that is different from other cables used on Project.
   4. Copper Cable for Ethernet Network:
      a. 100BASE-TX.
      b. TIA/EIA 586, Category 6.
      c. Minimum No. 24 AWG solid.
      d. Unshielded Twisted Pair (UTP).
      e. Thermoplastic insulated conductors, enclosed in a thermoplastic outer jacket, Class CMP as plenum rated.

2.18 RACEWAYS FOR CONTROL WIRING, CABLING, AND TUBING

A. Metal Conduits, Tubing, and Fittings:
   1. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. GRC: Comply with NEMA ANSI C80.1 and UL 6.
   3. ARC: Comply with NEMA ANSI C80.5 and UL 6A.
   4. IMC: Comply with NEMA ANSI C80.6 and UL 1242.
   5. PVC-Coated Steel Conduit: PVC-coated IMC.
      a. Comply with NEMA RN 1.
      b. Coating Thickness: 0.040 inch minimum.
   6. EMT: Comply with NEMA ANSI C80.3 and UL 797.
   7. FMC: Comply with UL 1; zinc-coated steel or aluminum.
   8. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
   9. Fittings for Metal Conduit: Comply with NEMA ANSI FB 1 and UL 514B.
      a. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
      b. Fittings for EMT:
         1) Material: Steel or Die Cast
         2) Type: Setscrew or Compression.
      c. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
      d. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.
   10. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

B. Nonmetallic Conduits, Tubing, and Fittings:
   1. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. ENT: Comply with NEMA TC 13 and UL 1653.
   3. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
   4. LFNC: Comply with UL 1660.
   5. Rigid HDPE: Comply with UL 651A.
   6. Continuous HDPE: Comply with UL 651A.
   7. Coilable HDPE: Preassembled with conductors or cables, and complying with ASTM D 3485.
   8. RTRC: Comply with UL 2515A and NEMA TC 14.
   9. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
   10. Fittings for LFNC: Comply with UL 514B.
   11. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less.

12. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Public Health's (formerly, the California Department of Health Services') "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. Metal Wireways and Auxiliary Gutters:
   1. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.
      a. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
   3. Wireway Covers: Hinged or Screw-cover type unless otherwise indicated.
   4. Finish: Manufacturer's standard enamel finish.

D. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5.

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

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

PART 3 EXECUTION

3.01 DDC SYSTEM INTERFACE WITH OTHER SYSTEMS AND EQUIPMENT

A. Communication Interface to Equipment with Integral Controls and Other Building Systems:
   1. DDC system shall have communication interface with equipment and building systems having integral controls and having a communication interface for remote monitoring or control.
   2. Perform all steps necessary for integration. These steps may include:
      a. Research and gathering effort to identify how to integrate each particular piece of equipment and identify the significance of each integrated point.
      b. Trial and error troubleshooting time as required. May require time to contact equipment manufacturer’s technical support.
      c. Testing of interface. Disconnect communication bus and confirm that points do indeed display as “down”. Confirm values are accurate by comparing with onboard equipment display screen. Test writable points and confirm written values are accepted by comparing with onboard equipment display screen and equipment operation.
      d. Create a meaningful graphic screen displaying integrated points in a logical fashion with accompanying system schematic diagram.
      e. Add trending and alarming as appropriate and/or as shown on point lists.

B. Integration with Existing Enterprise System, Supervisor Server:

1. When expanding an existing DDC system and it is necessary to interface with an existing enterprise system, Supervisor server, it is required to adhere to Owner standards already in-place and to achieve integration.
2. Expand existing Supervisor Server by adding all new controls matching the process utilized to integrate previous installations. Expanded system shall very much resemble existing DDC system, both in appearance and functionality. This includes; graphic layout, navigation, point override and setpoint capabilities, alarming, reporting and trending.
3. Prepare on-site demonstration mockup of integration of DDC system to be installed with existing system before installing DDC system. Obtain approval from Owner's control system representative before proceeding with installation.

3.02 CONTROL DEVICES FOR INSTALLATION BY OTHER INSTALLERS

A. Deliver selected control devices, specified in indicated HVAC instrumentation and control device Section 230900, to identified equipment and systems manufacturers for factory installation and to identified installers for field installation.

B. Deliver the following to duct fabricator and Installer for installation in ductwork. Include installation instructions to Installer and supervise installation for compliance with requirements.
   1. Automatic control dampers
   2. Airflow sensors and switches
   3. Pressure sensors

C. Deliver the following control devices specified in indicated HVAC instrumentation and control device Section 230900, to plumbing and HVAC piping installers for installation in piping. Include installation instructions to Installer and supervise installation for compliance with requirements.
   1. Automatic control valves
   2. Pipe-mounted flow meters
   3. Pipe-mounted sensors, switches and transmitters.
   4. Tank-mounted sensors, switches and transmitters.

3.03 GENERAL INSTALLATION REQUIREMENTS

A. Install room sensors such that they are centered at 60 inches above finished floor A.F.F. unless mounting height is specifically called out on drawings.

B. Install products to satisfy more stringent of all requirements indicated.

C. Install products level, plumb, parallel, and perpendicular with building construction.

D. Support products, tubing, piping wiring and raceways. Brace products to prevent lateral movement and sway or a break in attachment.

E. If codes and referenced standards are more stringent than requirements indicated, comply with requirements in codes and referenced standards.

F. Fabricate openings and install sleeves in ceilings, floors, roof, and walls required by installation of products. Before proceeding with drilling, punching, and cutting, check

for concealed work to avoid damage. Patch, flash, grout, seal, and refinish openings to match adjacent condition.

G. Firestop penetrations made in fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

H. Seal penetrations made in acoustically rated assemblies. Comply with requirements in Section 079200 "Joint Sealants."

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

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

3.04 SUPERVISOR SERVER CONFIGURATION

A. Perform all steps necessary to provide a fully functional supervisor server as specified earlier in this document. Steps to include, but not limited to: operating system configuration, supervisor software installation and licensing, site specific supervisor server software configuration, graphics, schedules, trends, alarms, scheduling, operator setup, etc.

3.05 LAN, ROUTER AND GATEWAY INSTALLATION

A. All LAN/WAN network equipment; including LAN drops near network level controllers to be furnished and installed by Client.

B. Install level two LAN network and network equipment if required for DDC system communication interface requirements indicated.

C. Test LAN and LAN equipment to verify that communication interface functions properly.

D. Provide a separate line item in proposal showing how many LAN drops are planned for project and the total price for this included in proposal. The price for each LAN drop is $250.

E. Locations of all requested LAN drops must be communicated in writing with locations clearly identified on floor plans. Allow at least two-weeks from time of request for LAN drops to be installed.

F. Provide a temporary LAN if required to keep pace with construction schedule. Permanent Client LAN drops may be delayed and it is not acceptable to delay any control work as a result of these delays. Temporary construction LAN may be abandoned and permanent Client LAN connected when available. Any necessary reconfiguration of network level controllers must be included.

3.06 CONTROLLER INSTALLATION

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

B. Connect controllers to field power supply.

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

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

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

F. Installation of Programmable Application Controllers:
   1. Quantity and location of programmable application controllers shall be determined by DDC system manufacturer to satisfy requirements indicated.
   2. Install controllers in a protected location that is easily accessible by operators.
   3. Top of controller shall be within 84 inches of finished floor.

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

3.07 ENCLOSURES INSTALLATION

A. Attach wall-mounted enclosures to wall using galvanized steel struts in dry areas and stainless-steel struts in wet areas:

B. Align top of adjacent enclosures.

3.08 ELECTRIC POWER CONNECTIONS

A. Provide electrical power to DDC system products requiring electrical power connections. Source power from available circuits on the nearest electrical panelboard.

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

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

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

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

3.09 IDENTIFICATION

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

B. Where product is installed above ceiling, also install location identification on ceiling grid directly below. This includes all terminal units such as VAV boxes, fan coil units, heat pumps, etc.

C. Include identification on all DDC devices including; room sensors, duct sensors, pipe sensors, relays, power supplies, controllers, control dampers and controls valves.

D. Verify prior to printing, labeling, ordering, or programming that the room names and room numbers utilized match the actual final installed room names and room numbers. Coordinate with Owner and architect for final room numbering to be utilized.

3.10 NETWORK NAMING AND NUMBERING

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

3.11 CONTROL WIRE, CABLE AND RACEWAYS INSTALLATION

A. Comply with NECA 1.

B. Comply with TIA 568-C.1.

C. Wiring Method: Install cables in raceways and cable trays. Conceal raceway and cables except in unfinished spaces.
   1. Install plenum cable in environmental air spaces, including plenum ceilings.
   2. Comply with requirements for cable trays specified in Section 260536 "Cable Trays for Electrical Systems."
   3. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

D. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

E. Field Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

F. Conduit Installation:
   1. Install conduit expansion joints where conduit runs exceed 200 feet and where conduit crosses building expansion joints.
   2. Coordinate conduit routing with other trades to avoid conflicts with ducts, pipes and equipment and service clearance.

3. Maintain at least 3-inch separation where conduits run axially above or below ducts and pipes.
4. Limit above-grade conduit runs to 100 feet without pull or junction box.
5. Do not install raceways or electrical items on any "explosion-relief" walls, or rotating equipment.
6. Do not fasten conduits onto the bottom side of a metal deck roof.
7. Flexible conduit is permitted only where flexibility and vibration control is required.
8. Limit flexible conduit to 3 feet long.
9. Conduit shall be continuous from outlet to outlet, from outlet to enclosures, pull and junction boxes, and shall be secured to boxes in such manner that each system shall be electrically continuous throughout.
10. Direct bury conduits underground or install in concrete-encased duct bank where indicated.
    a. Use rigid, nonmetallic, Schedule 80 PVC.
    b. Provide a burial depth according to NFPA 70, but not less than 24 inches.
11. Secure threaded conduit entering an instrument enclosure, cabinet, box, and trough, with a locknut on outside and inside, such that conduit system is electrically continuous throughout. Provide a metal bushing on inside with insulated throats. Locknuts shall be the type designed to bite into the metal or, on inside of enclosure, shall have a grounding wedge lug under locknut.
12. Conduit box-type connectors for conduit entering enclosures shall have an insulated throat.
13. Connect conduit entering enclosures in wet locations with box-type connectors or with watertight sealing locknuts or other fittings.
14. Offset conduits where entering surface-mounted equipment.
15. Seal conduit runs by sealing fittings to prevent the circulation of air for the following:
    a. Conduit extending from interior to exterior of building.
    b. Conduit extending into pressurized duct and equipment.
    c. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.

G. Wire and Cable Installation:
1. Cables serving a common system may be grouped in a common raceway. Install control wiring and cable in separate raceway from power wiring. Do not group conductors from different systems or different voltages.
2. Install cables with protective sheathing that is waterproof and capable of withstanding continuous temperatures of 194 deg F with no measurable effect on physical and electrical properties of cable.
    a. Provide shielding to prevent interference and distortion from adjacent cables and equipment.
3. Installation of Cable Routed Exposed under Raised Floors:
    a. Install plenum-rated cable only.
    b. Install cabling after the flooring system has been installed in raised floor areas.
    c. Coil cable 6 feet long not less than 12 inches in diameter below each feed point.
4. Identify each wire on each end and at each terminal with a number-coded identification tag. Each wire shall have a unique tag.
5. Provide strain relief.

6. Terminate wiring in a junction box.
   a. Clamp cable over jacket in junction box.
   b. Individual conductors in the stripped section of the cable shall be slack between the clamping point and terminal block.
7. Terminate field wiring and cable not directly connected to instruments and control devices having integral wiring terminals using terminal blocks.
8. Install signal transmission components according to IEEE C2, REA Form 511a, NFPA 70, and as indicated.
9. Keep runs short. Allow extra length for connecting to terminal boards. Do not bend flexible coaxial cables in a radius less than 10 times the cable OD. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.
10. Ground wire shall be copper and grounding methods shall comply with IEEE C2. Demonstrate ground resistance.
11. Wire and cable shall be continuous from terminal to terminal without splices.
12. Do not install bruised, kinked, scored, deformed, or abraded wire and cable. Remove and discard wire and cable if damaged during installation, and replace it with new cable.
13. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

3.12 DDC SYSTEM I/O CHECKOUT PROCEDURES

A. Check instruments for proper location and accessibility.

B. Check instruments for proper installation on direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.

C. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material and support.

D. For pneumatic products, verify that air supply for each product is properly installed.

E. Control Damper Checkout:
   1. For pneumatic dampers, verify that pressure gages are provided in each air line to damper actuator and positioner.
   2. Verify that control dampers are installed correctly for flow direction.
   3. Verify that proper blade alignment, either parallel or opposed, has been provided.
   4. Verify that damper frame attachment is properly secured and sealed.
   5. Verify that damper actuator and linkage attachment is secure.
   6. Verify that actuator wiring is complete, enclosed and connected to correct power source.
   7. Verify that damper blade travel is unobstructed.
   8. Verify that any configurable switches on device are set properly.

F. Control Valve Checkout:
   1. For pneumatic valves, verify that pressure gages are provided in each air line to valve actuator and positioner.
   2. Verify that control valves are installed correctly for flow direction.
   3. Verify that valve body attachment is properly secured and sealed.

4. Verify that valve actuator and linkage attachment is secure.
5. Verify that actuator wiring is complete, enclosed and connected to correct power source.
6. Verify that valve ball, disc or plug travel is unobstructed.
7. After piping systems have been tested and put into service, but before insulating and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks. Replace the valve if leaks persist.
8. Verify that any configurable switches on device are set properly.

G. Instrument Checkout:
1. Verify that instrument is correctly installed for location, orientation, direction and operating clearances.
2. Verify that attachment is properly secured and sealed.
3. Verify that conduit connections are properly secured and sealed.
4. Verify that wiring is properly labeled with unique identification, correct type and size and is securely attached to proper terminals.
5. Inspect instrument tag against approved submittal.
6. For instruments with tubing connections, verify that tubing attachment is secure and isolation valves have been provided.
7. For flow instruments, verify that recommended upstream and downstream distances have been maintained.
8. For temperature instruments:
   a. Verify sensing element type and proper material.
   b. Verify length and insertion.
9. Verify that any configurable switches on device are set properly

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

A. Calibrate each instrument installed that is not factory calibrated and/or provided with calibration documentation. Calibrate according to instrument instruction manual supplied by manufacturer.

B. Provide NIST traceable diagnostic and test equipment for calibration and adjustment.

C. Comply with field testing requirements and procedures indicated by ASHRAE's Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements, and to supplement requirements indicated.

D. Control Dampers:
1. Stroke and adjust control dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.
2. For control dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

E. Control Valves:
1. Stroke and adjust control valves following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.
2. For control valves equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

F. Switches: Calibrate switches to make or break contact at set points indicated.

3.14 DDC SYSTEM CONTROLLER CHECKOUT

A. Verify power supply.
   1. Verify voltage, polarity, and protection.
   2. Verify that ground fault protection is installed.
   3. If applicable, verify that power conditioning units are installed.

B. Verify that wire and cabling is properly secured to terminals and labeled with unique identification.

3.15 DDC CONTROLLER I/O CONTROL LOOP TESTS

A. Fine-Tune and Test every control loop to verify operation is stable and accurate.

3.16 DDC SYSTEM VALIDATION TESTS

A. Perform validation tests before requesting final review of system with Client.

B. After validation testing is complete, submit completed validation test checklist.

C. Validation Test:
   1. Verify operation of every I/O point and connected device in DDC system.
   2. Make adjustments to out-of-tolerance I/O points.
      a. Identify I/O points not ready and need future verification.
      b. Simulate abnormal conditions to verify proper function of safety devices.
      c. Replace instruments and controllers that cannot maintain performance indicated after adjustments.
   3. Simulate conditions to verifying proper sequence of control.
   4. Readjust settings to design values and observe ability of DDC system to establish desired conditions.
   5. After 24 Hours following Initial Validation Test:
      a. Re-check I/O points that required corrections during initial test.
      b. Identify I/O points that still require additional correction and make corrections necessary to achieve desired results.
   6. After validation testing is complete, prepare and submit a report showing status of all I/O points. Identify adjustments or corrections made and indicate instruments that were replaced.
   7. Submit completed validation test checklist and schedule final review date(s).

3.17 FINAL REVIEW AND COMMISSIONING WITH CLIENT

A. DDC system final review with Client Staff and/or commissioning agent shall include an on-site demonstration to all parties participating in final review.

B. Should more than two final review sessions be required, DDC system manufacturer and Installer shall compensate entity performing review for total costs, labor and expenses, associated with third and subsequent reviews.

C. Commissioning shall include, but not be limited to, the following:
   1. Briefly review validation report submitted prior and discuss.
   2. Accuracy and calibration of 20 percent of I/O points randomly selected by reviewers. If review finds that some I/O points are not properly calibrated and not satisfying performance requirements indicated, additional I/O points may be selected by reviewers.
   3. HVAC equipment and system hardwired and software safeties and life-safety functions are operating according to sequence of operation. Up to 20 percent of I/O points shall be randomly selected by reviewers. Additional I/O points may be selected by reviewers to discover problems with operation.
   4. Correct sequence of operation after electrical power interruption and resumption after electrical power is restored for randomly selected HVAC systems.
   5. Operation of randomly selected dampers and valves in normal-on, normal-off and failed positions.
   6. Reporting of alarm conditions for randomly selected alarms, including different classes of alarms, to ensure that alarms are properly received by operators and operator workstations.
   7. Trends, summaries, logs and reports set-up for Project.
   8. For up to 20 percent of HVAC systems randomly selected by reviewers, use graph trends to show that sequence of operation is executed in correct manner and that HVAC systems operate properly through complete sequence of operation including different modes of operations indicated. Show that control loops are stable and operating at set points and respond to changes in set point of 20 percent or more.
   9. Software's ability to communicate with controllers, operator workstations, uploading and downloading of control programs.
   10. Software's ability to edit control programs.
   11. Data entry to show Project-specific customizing capability including parameter changes.
   12. Step through penetration tree, display all graphics, demonstrate dynamic update, and direct access to graphics.
   13. Execution of digital and analog commands in graphic mode.
   14. Online user guide and help functions.
   15. System speed of response compared to requirements indicated.
   16. For Each Network and programmable Controller:
      a. Memory: Programmed data, parameters, trend and alarm history collected during normal operation is not lost during power failure.
      b. Standalone Ability: Demonstrate that controllers provide stable and reliable standalone operation using default values or other method for values normally read over network.
      c. Electric Power: Ability to disconnect any controller safely from its power source.
      d. Wiring Labels: Match control drawings.
      e. Network Communication: Ability to locate a controller's location on network and communication architecture matches Shop Drawings.
      f. Nameplates and Tags: Accurate and permanently attached to control panel doors, instrument, actuators and devices.
      g. Communications and Interoperability: Demonstrate proper interoperability of data sharing, alarm and event management, trending, scheduling, and device

and network management. Requirements must be met even if only one manufacturer's equipment is installed.

1) Data Presentation: On operator workstation, demonstrate graphic display capabilities.
2) Reading of Any Property: Demonstrate ability to read and display any used readable object property of any device on network.
3) Set Point and Parameter Modifications: Show ability to modify set points and tuning parameters indicated.
4) Peer-to-Peer Data Exchange: Network devices are installed and configured to perform without need for operator intervention to implement Project sequence of operation and to share global data.
5) Alarm and Event Management: Alarms and events are installed and prioritized according to Owner. Demonstrate that time delays and other logic are set up to avoid nuisance tripping. Show that operators with sufficient privileges are permitted.
6) Schedule Lists: Schedules are configured for start and stop, mode change, occupant overrides, and night setback as defined in sequence of operations.
7) Schedule Display and Modification: Ability to display any schedule with start and stop times for calendar year. Show that all calendar entries and schedules are modifiable from any connected operator workstation by an operator with sufficient privilege.
8) Archival Storage of Data: Data archiving is handled by operator workstation and server and local trend archiving and display is accomplished.
9) Modification of Trend Log Object Parameters: Operator with sufficient privilege can change logged data points, sampling rate, and trend duration.
10) Device and Network Management:
    (a) Display of network device status.
    (b) Time synchronization.
    (c) Backup and restore network device programming and master database(s).

3.18 CUSTOMER TRAINING

A. Controls contractor representative with complete knowledge of Project-specific system installed to train Owner's maintenance personnel to adjust, operate, and maintain DDC system.

B. Customer Training:
   1. Base extent of training on scope and complexity of DDC system indicated and training requirements indicated. Provide extent of training required to satisfy requirements indicated even if more than minimum training requirements are indicated.
   2. Minimum Training Requirements:
      a. Provide not less than 4 hours of training total. Two, 2 hour sessions.
      b. First training session just prior to substantial completion and second training session during first week of occupancy.

c. Training shall occur within normal business hours at a mutually agreed on time, arranged at least 10 business days in advance.
d. Plan in advance of training for five attendees
e. Training Outline:
    1) Submit training outline for Owner review while arranging training date.
    2) Outline shall include a detailed agenda, training objectives and synopses for each lesson planned.
f. Provide a preprinted sign-in sheet for each training session and circulate sign-in sheet at beginning of each session and solicit attendees to sign or initial in applicable location.
g. At end of each training day, send Owner an e-mail with an attachment of scanned copy (PDF) of circulated sign-in sheet for each session.
h. Provide each attendee with a color hard copy of all training materials and visual presentations. Email a PDF copy of all training materials to attendees.
i. Minimum Training Content Shall Include:
    1) Basic operation of system.
    2) Understanding DDC system architecture and configuration.
    3) Understanding each unique product type installed including performance and service requirements for each.
    4) Understanding operation of each system and piece of equipment controlled by DDC system including sequences of operation, each unique control algorithm, and each unique optimization routine.
    5) Logging on and off system.
    6) Accessing graphics, reports, and alarms.
    7) Adjusting and changing set points and time schedules.
    8) Recognizing DDC system malfunctions.
    9) Understanding content of operation and maintenance manuals including control drawings.
    10) Understanding physical location and placement of DDC controllers and I/O hardware.
    11) Accessing data from DDC controllers.
    12) Stepping through graphics penetration tree, displaying all graphics, demonstrating dynamic updating, and direct access to graphics.
    13) Demonstrating DDC system performance through trend logs and command tracing.
    14) Demonstrating spreadsheet and curve plot software, and its integration with database.
    15) Demonstrating the HVAC systems and equipment controlled by DDC system:
    16) Using graphed trends, show that sequence of operation is executed in correct manner, and HVAC systems operate properly through complete sequence of operation including seasonal change, occupied and unoccupied modes, warm-up and cool-down cycles and other modes of operation indicated.
    17) Hardware interlocks and safeties function properly and DDC system performs correct sequence of operation after electrical power interruption and resumption after power is restored.
    18) Reporting of alarm conditions for each alarm, and confirm that alarms are received at assigned locations, including operator workstations.

19) Control loops responds to set point adjustment and stabilizes within time period indicated.
20) Sharing of previously graphed trends of all control loops to demonstrate that each control loop is stable and set points are being maintained.
21) Modifying alarms including annunciation and routing.
22) Modifying point trend logs including graphing and printing on an ad-hoc basis and operator-defined time intervals.
23) Adding new operators and making modifications to existing operators.
24) Operator password assignments and modification.
25) Operator authority assignment and modification.

END OF SECTION 23 09 23

SECTION 23 11 13

FACILITY FUEL-OIL PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Piping and fittings.

B. Flanges and piping components.

C. Pipe hangers and supports.

D. Valves.

E. Strainers.

F. Flexible connectors.

1.02 REFERENCE STANDARDS

A. API Spec 5L - Line Pipe; 2018, with Errata.

B. API RP 1615 - Installation of Underground Petroleum Storage Systems; 2011.

C. ASME B1.1 - Unified Inch Screw Threads (UN, UNR, and UNJ Thread Forms); 2019.

D. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2016.

E. ASME B16.5 - Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard; 2013.

F. ASME B16.9 - Factory-Made Wrought Buttwelding Fittings; 2018.

G. ASME B16.11 - Forged Fittings, Socket-welding and Threaded; 2016 (Errata 2017).

H. ASME B16.12 - Cast Iron Threaded Drainage Fittings; 2009 (Reaffirmed 2014).

I. ASME B18.2.1 - Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series); 2012, Including July 2013 Errata.

J. ASME B18.2.2 - Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series); 2015.

K. ASME B31.3 - Process Piping; 2020.

L. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2012.

M. ASTM A105/A105M - Standard Specification for Carbon Steel Forgings for Piping Applications; 2021.

N. ASTM A182/A182M - Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service; 2021.

O. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2016.

P. ASTM D229 - Standard Test Methods for Rigid Sheet and Plate Materials Used for Electrical Insulation; 2019, with Editorial Revision.

Q. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2009.

R. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.

PART 2 PRODUCTS

2.01 PIPING AND FITTINGS

A. Regulatory Requirements:
   1. Comply with the material, fabrication, and operating requirements of ASME B31.3, except as modified herein.

B. Comply with the material, fabrication, and operating requirements of ASME B31.3, except as modified herein.

C. Carbon Steel Pipe:
   1. Comply with One of the Following:
      a. ASTM A53/A53M, Type E or S, Grade B, seamless or electric welded, Schedule 80 for pipe less than 2-1/2 inches in diameter or Schedule 40 for pipe 2-1/2 inches in diameter and larger.
      b. API Spec 5L, Product Specification Level (PSL) 1, Grade B, submerged-arc welded or gas metal-arc welded.
   2. End Connections:
      a. Forged, socket weld type, complying with ASTM A182/A182M and ASME B16.11 for pipe or fittings less than 2-1/2 inches.
      b. Buttweld type complying with ASTM A234/A234M, Grade WPB and ASME B16.9 for pipe or fittings 2-1/2 inches and larger of the same wall thickness as the adjoining pipe.
      c. Threaded type complying with ASME B16.3, Class 150 or ASME B16.11.

2.02 FLANGES, COUPLINGS, AND PIPING COMPONENTS

A. Flanges:
   1. Provide flanged end connections on equipment, fittings, piping, piping components, adapters, couplings, and valves complying with ASME B16.5, Class 150.
   2. Carbon Steel: Comply with ASTM A105/A105M.
   3. Gaskets, Non-Isolating:
      a. 1/8 inch thick.
      b. Comply with ASME B16.12, raised-faced type.
      c. Material: Buna-N.
   4. Gaskets, Electrically Isolating:
      a. Comply with ASTM D229.
      b. Electrical Insulating Material: 1000 ohms resistance.
      c. Chemically compatible with fuel handled.
      d. Full face type.
      e. Provide full surface, spiral-wound, mylar, insulating sleeves between bolts and holes of flanges.
      f. Furnish bolt shank diameter not less than diameter at root of threads.
      g. Provide high-strength 1/8 inch thick, phenolic, insulating washers next to flanges with flat, circular, stainless steel washers over the insulating and under bolt heads and nuts.
      h. Supply adequate bolt length to accommodate insulating gaskets and stainless steel washers.
   5. Bolts, Nuts, and Washers:
      a. Comply with ASME B18.2.1 and ASME B18.2.2.
      b. Bolts:
         1) Regular hexagonal type.
         2) Threaded in accordance with ASME B1.1, Class 2A fit, Coarse Thread Series, for sizes 1 inch and smaller and Eight-Pitch Thread Series for sizes larger than 1 inch.
         3) Provide sufficient length to obtain full bearing on nuts, projecting no more than two full threads beyond nuts with bolts tightened to required torque.
      c. Nuts:
         1) Hexagonal, heavy series type.
         2) Threaded in accordance with ASME B1.1, Class 2B fit, Coarse Thread Series for sizes 1 inch and smaller and Eight-Pitch Thread Series for sizes larger than 1 inch.

B. Piping Components:
   1. Provide components that meet the material, fabrication, and operating requirements of ASME B31.3, except as modified herein.
   2. Pressure Design Class: Class 150, as defined in ASME B16.5.

2.03 PIPE HANGERS AND SUPPORTS

A. Provide hangers and supports that comply with MSS SP-58.

1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.

B. Hangers for Pipe Sizes 1/2 to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.

C. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.

D. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

2.04 BALL VALVES

A. MSS SP-110, Class 150, 400 psi CWP, bronze, two piece body, chrome plated brass ball, regular port, teflon seats and stuffing box ring, blow-out proof stem, lever handle with balancing stops, solder.

2.05 STRAINERS

A. Threaded brass body for 175 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen.

2.06 FLEXIBLE CONNECTORS

A. Bronze inner hose and braided exterior sleeve, suitable for minimum 200 psi CWP and 250 degrees F.

PART 3 EXECUTION

3.01 PIPING INSTALLATION

A. Install in accordance with manufacturer's instructions and API RP 1615.

B. Route piping in orderly manner and maintain gradient.

C. Group piping whenever practical at common elevations.

D. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

E. Provide clearance for installation of insulation and access to valves and fittings.

F. Label piping with "FOS" and "FOR" including directional arrows.

END OF SECTION 23 11 13

SECTION 23 21 13

HYDRONIC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Hydronic system requirements.

B. Heating water and glycol piping, above grade.

C. Equipment drains and overflows.

D. Unions, flanges, mechanical couplings, and dielectric connections.

E. Valves:
   1. Ball valves.
   2. Butterfly valves.
   3. Check valves.

1.02 RELATED REQUIREMENTS

A. Section 07 84 00 - Firestopping.

B. Section 23 07 19 - HVAC Piping Insulation.

C. Section 23 25 00 - HVAC Water Treatment: Pipe cleaning.

1.03 REFERENCE STANDARDS

A. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Welding, Brazing, and Fusing Qualifications; 2015.

B. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2012.

C. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2013.

D. ASME B31.9 - Building Services Piping; 2014.

E. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2012.

F. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2016.

G. ASTM B32 - Standard Specification for Solder Metal; 2008 (Reapproved 2014).

H. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2016.

I. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2016.

J. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2011-AMD 1.

K. AWS A5.8/A5.8M - Specification for Filler Metals for Brazing and Braze Welding; 2011 and errata.

L. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2015 (with March 2016 Errata).

M. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2009.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate the installation of all piping and valves with size, location and installation of service utilities.

1.05 SUBMITTALS

A. Welders Certificate: Include welders certification of compliance with ASME BPVC-IX.

B. Product Data:
   1. Include data on pipe materials, pipe fittings, valves, and accessories.
   2. Provide manufacturers catalogue information.
   3. Indicate valve data and ratings.
   4. Show fittings, valves, and specialties on drawings and product submittals, specifically identified with the manufacturer's style or series designation.

C. Project Record Documents: Record actual locations of valves.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing work of the type specified in this section.

B. Provide all fittings, valves, specialties, and grooving tools from a single manufacturer.

C. Welder Qualifications: Certify in accordance with AWS D1.1/D1.1M.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary protective coating on cast iron and steel valves.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.08 FIELD CONDITIONS

A. Do not install underground piping when bedding is wet or frozen.

PART 2 PRODUCTS

2.01 HYDRONIC SYSTEM REQUIREMENTS

A. Comply with ASME B31.9 and applicable federal, state, and local regulations.

B. Piping: Provide piping, fittings, hangers and supports as required, as indicated, and as follows:
   1. Where more than one piping system material is specified, provide joining fittings that are compatible with piping materials and ensure that the integrity of the system is not jeopardized.
   2. Use non-conducting dielectric connections whenever jointing dissimilar metals.
   3. Grooved mechanical joints are not permitted in any location.
   4. Provide pipe hangers and supports in accordance with Section 23 05 29 unless indicated otherwise.

C. Pipe-to-Valve and Pipe-to-Equipment Connections: Use unions (or flanges) to allow disconnection of components for servicing; do not use direct welded, soldered, or threaded connections.

D. Valves: Provide valves where indicated and as follows:
   1. Provide drain valves at main shut-off, low points of piping, bases of vertical risers, and at equipment. Use 3/4 inch ball valves with cap; pipe to nearest floor drain.

E. Welding Materials and Procedures: Conform to ASME BPVC-IX.

2.02 HEATING WATER PIPING, ABOVE GRADE

A. 4" and Larger: Steel Pipe: ASTM A53/A53M, Schedule 40, black, using one of the following joint types:
   1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D1.1/D1.1M welded.

B. 3" and Smaller: Copper Tube: ASTM B88 (ASTM B88M), Type L (B), drawn, using one of the following joint types:
   1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings.
      a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
      b. Braze: AWS A5.8M/A5.8 BCuP copper/silver alloy.
      c. Braze: AWS A5.8/A5.8M BCuP copper/silver alloy.

2.03 EQUIPMENT DRAINS AND OVERFLOWS

A. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), drawn; using one of the following joint types:

1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings; ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.

2.04 UNIONS, FLANGES, MECHANICAL COUPLINGS, AND DIELECTRIC CONNECTIONS

A. Unions for Pipe 2 Inches and Less:
   1. Ferrous Piping: 150 psig malleable iron, threaded.
   2. Copper Pipe: Bronze, soldered joints.

B. Flanges for Pipe 2 Inches and Greater:
   1. Ferrous Piping: 150 psig forged steel, slip-on.
   2. Copper Piping: Bronze.
   3. Gaskets: 1/16 inch thick preformed neoprene.

2.05 BALL VALVES

A. Manufacturers:
   1. Conbraco Industries.
   2. Grinnell Products, a Tyco Business.
   3. Shurjoint Piping Products, Inc., a Tyco Business.
   4. Milwaukee Valve Company.
   5. Nibco, Inc.
   6. Victaulic Company.
   7. Substitutions: See Section 01 60 00 - Product Requirements.

B. Up To and Including 2 Inches:
   1. Bronze two piece body, stainless steel ball, teflon seats and stuffing box ring, lever handle, solder ends.

C. Over 2 Inches:
   1. Cast steel body, chrome plated stainless steel ball, Virgin TFE seat and stuffing box seals, lever handle, flanged ends, rated to 800 psi.

2.06 BUTTERFLY VALVES

A. Manufacturers:
   1. Crane Co.
   2. Grinnell Products, a Tyco Business.
   3. Shurjoint Piping Products, Inc., a Tyco Business.
   4. Hammond Valve.
   5. Milwaukee Valve Company.
   6. Victaulic Company.
   7. Substitutions: See Section 01 60 00 - Product Requirements.

B. Body: Cast or ductile iron with resilient replaceable EPDM seat, flanged ends, extended neck.

C. Disc: Construct of stainless steel.

D. Stem: Stainless steel with stem offset from the centerline to provide full 360 degree circumferential setting.

2.07 SWING CHECK VALVES

A. Manufacturers:
   1. Grinnell Products, a Tyco Business.
   2. Shurjoint Piping Products, Inc., a Tyco Business.
   3. Hammond Valve.
   4. Milwaukee Valve Company.
   5. Nibco, Inc.
   6. Victaulic Company.
   7. Substitutions: See Section 01 60 00 - Product Requirements.

B. Up To and Including 2 Inches:
   1. Bronze body, bronze trim, bronze rotating swing disc, with composition disc, threaded ends.

C. Over 2 Inches:
   1. Iron body, bronze trim, stainless steel, bronze, or bronze faced rotating swing disc, renewable disc and seat, flanged ends.

2.08 CHEMICAL TREATMENT

A. Contractor to utilize Innovational Water Systems for all chemical treatment.

B. Propylene Glycol: Industrial grade with corrosion inhibitors and environmental-stabilizer additives for mixing with water in systems indicated to contain antifreeze or glycol solutions.

PART 3 EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment using jointing system specified.

D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

E. After completion, fill, clean, and treat systems. Refer to Section 23 25 00 for additional requirements.

3.02 PIPE JOINT CONSTRUCTION

A. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

B. 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.

C. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

D. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. 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.

C. Install piping to conserve building space and to avoid interference with use of space.

D. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

E. Sleeve pipe passing through partitions, walls and floors.

F. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such 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 Coordination Drawings.

G. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

H. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

I. Install piping to permit valve servicing.

J. Install piping at indicated slopes.

K. Install piping free of sags and bends.

L. Install fittings for changes in direction and branch connections.

M. Install piping to allow application of insulation.

N. Select system components with pressure rating equal to or greater than system operating pressure.

O. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

P. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

S. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

T. Identify piping as specified in Division 23 Section "Identification for HVAC Piping and Equipment."

U. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."

V. Install tees and bypass piping for flushing ground each piece of equipment that have coils and heat exchangers that may become plugged during flushing process.

W. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.

X. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

Y. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Manual vents at heat-transfer coils and elsewhere as required for air venting.

Z. Pipe Hangers and Supports:
   1. Install in accordance with MSS SP-58.
   2. Support horizontal piping as scheduled.
   3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
   4. Place hangers within 12 inches of each horizontal elbow.
   5. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.

6. Support vertical piping at every floor and at 10' intervals between floors. Support riser piping independently of connected horizontal piping.
7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
8. Provide copper plated hangers and supports for copper piping.
9. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
10. On PP-R piping, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.

AA. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 23 07 19.

AB. Provide access where valves and fittings are not exposed.

AC. Use eccentric reducers to maintain top of pipe level.

AD. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.

AE. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting.

AF. Install valves with stems upright or horizontal, not inverted.

3.04 SCHEDULES

A. Hanger Spacing for Copper Tubing.
   1. 1/2 inch and 3/4 inch: Maximum span, 5 feet; minimum rod size, 1/4 inch.
   2. 1 inch: Maximum span, 6 feet; minimum rod size, 1/4 inch.
   3. 1-1/2 inch and 2 inch: Maximum span, 8 feet; minimum rod size, 3/8 inch.
   4. 2-1/2 inch: Maximum span, 9 feet; minimum rod size, 3/8 inch.
   5. 3 inch: Maximum span, 10 feet; minimum rod size, 3/8 inch.
   6. 4 inch: Maximum span, 12 feet; minimum rod size, 1/2 inch.
   7. 6 inch: Maximum span, 14 feet; minimum rod size, 1/2 inch.
   8. 8 inch: Maximum span, 16 feet; minimum rod size, 5/8 inch.
   9. 10 inch: Maximum span, 18 feet; minimum rod size, 3/4 inch.
   10. 12 inch: Maximum span, 19 feet; minimum rod size, 7/8 inch.

B. Hanger Spacing for Steel Piping.
   1. 1/2 inch, 3/4 inch, and 1 inch: Maximum span, 7 feet; minimum rod size, 1/4 inch.
   2. 1-1/4 inches: Maximum span, 8 feet; minimum rod size, 3/8 inch.
   3. 1-1/2 inches: Maximum span, 9 feet; minimum rod size, 3/8 inch.
   4. 2 inches: Maximum span, 10 feet; minimum rod size, 3/8 inch.
   5. 2-1/2 inches: Maximum span, 11 feet; minimum rod size, 3/8 inch.
   6. 3 inches: Maximum span, 12 feet; minimum rod size, 3/8 inch.
   7. 4 inches: Maximum span, 14 feet; minimum rod size, 1/2 inch.
   8. 6 inches: Maximum span, 17 feet; minimum rod size, 1/2 inch.
   9. 8 inches: Maximum span, 19 feet; minimum rod size, 5/8 inch.
   10. 10 inches: Maximum span, 20 feet; minimum rod size, 3/4 inch.
   11. 12 inches: Maximum span, 23 feet; minimum rod size, 7/8 inch.

12. 14 inches: Maximum span, 25 feet; minimum rod size, 1 inch.
13. 16 inches: Maximum span, 27 feet; minimum rod size, 1 inch.
14. 18 inches: Maximum span, 28 feet; minimum rod size, 1-1/4 inch.
15. 20 inches: Maximum span, 30 feet; minimum rod size, 1-1/4 inch.

3.05 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:
   1. Leave joints, including welds, uninsulated and exposed for examination during test.
   2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
   3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
   4. 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.
   5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:
   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 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's 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 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
   5. After hydrostatic test pressure has been applied for at least 15 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 written report of testing.

C. Perform the following before operating the system:
   1. Open manual valves fully.
   2. Inspect pumps for proper rotation.
   3. Set makeup 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, chillers, cooling towers, to specified values.

7. Verify lubrication of motors and bearings.

3.06 CHEMICAL TREATMENT

A. Owner will contract with Innovational Water Systems (IWS) for all chemical treatment. Contractor shall purchase additional propolyne glycol as required from IWS.

B. Fill systems indicated to have antifreeze or glycol solutions with the following concentrations:
   1. Hot-Water Heating Piping: Minimum 35 percent propylene glycol.

END OF SECTION 23 21 13

SECTION 23 21 14

HYDRONIC SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Air vents.

B. Strainers.

C. Magnetic Filters

D. Pressure-temperature test plugs.

E. Balancing valves.

F. Relief valves.

1.02 RELATED REQUIREMENTS

A. Section 22 10 06 - Plumbing Piping Specialties: Backflow preventers.

B. Section 23 21 13 - Hydronic Piping.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description and model.

C. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.

D. Project Record Documents: Record actual locations of flow controls.

E. Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.01 AIR VENTS

A. Manual Type: Short vertical sections of 2 inch diameter pipe to form air chamber, with 1/8 inch brass needle valve at top of chamber.

B. Maximum Fluid Pressure: 150 psi.

C. Maximum Fluid Temperature: 250 degrees F.

2.02 STRAINERS

A. Size 2 inch and Under:
   1. Screwed brass or iron body for 175 psi working pressure, Y pattern with 1/32 inch stainless steel perforated screen.

B. Size 2-1/2 inch to 4 inch:
   1. Provide flanged or welded iron body for 175 psi working pressure, Y pattern with 3/64 inch stainless steel perforated screen.

C. Size 5 inch and Larger:
   1. Provide flanged or welded iron body for 175 psi working pressure, basket pattern with 1/8 inch stainless steel perforated screen.

2.03 PRESSURE-TEMPERATURE TEST PLUGS

A. Construction: Brass body designed to receive temperature or pressure probe with removable protective cap, and Neoprene rated for minimum 200 degrees F.

B. Application: Use extended length plugs to clear insulated piping.

2.04 RELIEF VALVES

A. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labelled.

2.05 MAGNETIC FILTER:

A. Subject to compliance with these specifications, the following manufacturers shall be acceptable:
   1. Magnetic Filter.
      a. ADEY Magna Clean

B. The Magnetic Filter shall be rated for 145 psi maximum working pressure.

C. The Magnetic Filter shall have a maximum temperature rating of 212°F.

D. The Magnetic Filter body shall be made of 304 stainless steel.

E. The Magnetic Filter tube cartridge shall be made of aerospace quality 316 stainless steel.

F. The Magnetic Filter body shall be four times the nominal inlet/outlet pipe diameter.

G. The Magnetic Filter shall include threaded blow down connection to allow for sediment to be regularly cleaned out of the unit.

H. The Magnetic Filter shall include a threaded air removal connection on top of the unit with an integral automatic air vent, allowing collected air to be removed from the unit.

I. The Magnetic Filter shall include permanent rare earth neodymium iron boron magnets with 9,000 gauss high strength. Magnet grade shall be N42SH and inspected by hystergraph prior to use.

J. Flange end connections should be designed according to ANSI Standards.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install specialties in accordance with manufacturer's instructions.

B. Where large air quantities can accumulate, provide enlarged air collection standpipes.

C. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.

D. Provide valved drain and hose connection on strainer blow down connection.

E. Provide pump suction fitting on suction side of base mounted centrifugal pumps where indicated. Remove temporary strainers after cleaning systems.

F. Support pump fittings with floor mounted pipe and flange supports.

G. Provide radiator valves on water inlet to terminal heating units such as radiation, unit heaters, and fan coil units.

H. Provide radiator balancing valves on water outlet from terminal heating units such as radiation, unit heaters, and fan coil units.

I. Provide relief valves on pressure tanks, low pressure side of reducing valves, heat exchangers, and expansion tanks.

J. Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.

K. Pipe relief valve outlet to nearest floor drain.

L. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.

M. Feed glycol solution to system through make-up line with pressure regulator, venting system high points.

N. Feed glycol solution to system through make-up line with pressure regulator, venting system high points. Set to fill at 12 psi.

O. Perform tests determining strength of glycol and water solution and submit written test results.

3.02 MAINTENANCE

A. Provide service and maintenance of glycol system for one year from date of Substantial Completion at no extra charge to Owner.

B. Perform monthly visit to make glycol fluid concentration analysis on site with refractive index measurement instrument. Report findings in detail in writing, including analysis and amounts of glycol or water added.

C. Explain corrective actions to Owner's maintenance personnel in person.

END OF SECTION 23 21 14

SECTION 23 21 23

HYDRONIC PUMPS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Vertical in-line pumps. Owner Furnished, Contractor Installed.

1.02 RELATED REQUIREMENTS

A. Section 23 21 13 - Hydronic Piping.

B. Section 23 21 14 - Hydronic Specialties.

1.03 REFERENCE STANDARDS

A. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

B. UL 778 - Standard for Motor-Operated Water Pumps; Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. Product Data: For each type of pump. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.06 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Mechanical Seals: One mechanical seal(s) for each pump.

1.07 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacture, assembly, and field performance of pumps, with minimum three years of documented experience.

PART 2 PRODUCTS

2.01 PUMPS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Grundfos TPE3

B. The pumps shall be wet rotor, inline design with suction and discharge port flanges of identical diameter, fan-cooled permanent-pagnet synchronous motor with integrated frequecy converter and PI controller in motor terminal box. Pump shall be fitted with a cobined temperature and differential pressure sensor.

C. The head-capacity curve shall have a steady rise in head from maximum to minimum flow within the preferred operating region.

D. The pumps shall have the following features:
   1. The pump housing shall have a stainless steel/teflon neck ring to minimize recirculation and increase pump efficiency.
   2. The impellers shall be laser welded stainless to obtain maximum efficiency. Cast impellers and composite material shall not be acceptable. The impellers shall be secured to the shaft with a split cone and a nut.
   3. The pump shall have unbalanced mechanical seal. The mechanical seal shall be manufactured by the same manufacturer. The seal faces shall be tungsten carbide/carbon with EPDM rubber bellows. (For glycol applications reduced face o-ring seal with tungsten carbide vs. tungsten carbide faces shall be used)
   4. Pump Construction.
      a. Pump housing and motor stool — Cast iron EN-JL-1040 (A 48 Cl 30B)
      b. Impellers, rotor can, rotor cladding — 304 Stainless Steel
      c. Shaft — 431 Stainless Steel
      d. Coupling: — Cast iron, 2 piece rigid coupling
      e. Coupling guard — 304 stainless steel
      f. Vent screw — Brass
      g. For open loop applications pump housing and motor adapter shall be bronze.
   5. All pumps shall be tested per ISO 9906 Annex A. Test certificates are not required.
   6. Pump housing and pump adapter shall be electro coated high corrosion resistance and paint shall be cured at minimum 200°C.

2.02 MOTORS

A. Each motor shall be of the asynchronous squirrel cage design and tested with the pump as one unit by the same manufacturer.

B. The motor enclosure shall be TEFC.

C. The motor insulation shall be Class F with temperature rise of Class B.

2.03 INTEGRATED VARIABLE SPEED DRIVE

A. The VSD shall be designed and manufactured by the same manufacturer. The VSD shall be factory installed on the motor.

B. The VSD enclosure class shall be IP44.

C. The VSD shall have the human interface options of;
   1. Control panel on the VSD face
   2. Infrared remote control
   3. Building Automation Systems via LonWorks (with optional converter unit)

D. The VSD shall have a firmware that recognizes the pump motor VFD combination and maps the pump performance. Via this firmware the VSD should allow following control modes

E. Proportional differential pressure control: The set point shall be entered to the VSD via control panel or infrared remote control and the pump should slow down and reduce the head as the flow demand decreases to provide maximum energy savings.

F. Constant Differential pressure Control: The set point shall be entered to the VSD via control panel or infrared remote control and the pump should slow down to keep the set point constant as the flow demand decreases to provide energy savings. This mode shall be used where losses are not from friction losses in the piping system.

G. The VSD shall allow one digital input and one set point input.

2.04 PACKAGING

A. The unit shall have sturdy packaging to protect the capillary tubing and VSD during transportation.

B. Unit shall be delivered freight paid by the manufacturer, FOB destination. Coordinate delivery with installing contractor.

2.05 INSTALLATION

A. The pump shaft shall be installed per manufacturer's recommendations. The face of the VSD shall be not be covered in order to allow infrared control signal control. The system shall be vented out from a higher location from the pump. The required inlet pressure by the pump shall be available at the pump inlet as recommended by the pump manufacturer.

2.06 TESTING (BY MANUFACTURER)

A. The pumps shall be factory performance and hydrostatic tested as a complete unit prior to shipment. The testing shall be done in accordance with ISO 9906 Annex A. No test certificate is required.

2.07 WARRANTY

A. The warranty period shall be a non-prorated period of 24 months from date of start up, not to exceed 30 months from date of manufacture. Warranty shall cover pump, motor and VSD.

PART 3 EXECUTION

3.01 PREPARATION

A. Verify that electric power is available and of the correct characteristics.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide access space around pumps for service. Provide no less than minimum space recommended by manufacturer.

C. Provide air cock and drain connection on horizontal pump casings.

D. Provide drains for bases and seals, piped to and discharging into floor drains.

E. Lubricate pumps before start-up.

3.03 STARTUP SERVICE (BY MANUFACTURER)

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.
   2. Check piping connections for tightness.
   3. Clean strainers on suction piping.
   4. Perform the following startup 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.

END OF SECTION 23 21 23

SECTION 23 25 00

HVAC WATER TREATMENT

PART 1 GENERAL

1.01 GENERA REQUIREMENTS

A. Innovational Water Solutions (IWS) shall provide the required chemicals, propylene glycol and testing for proper flushing, cleaning, filling and testing of the hydronic system as part of a separate contract with the County. Contractor is responsible for draining, cleaning and filling the hydronic system in accordance with sequence described below. Coordinate with IWS.

1.02 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide chemical treatment materials, chemicals, and equipment including electrical characteristics and connection requirements.

C. Operation and Maintenance Data: Include data on chemical feed pumps, agitators, and other equipment including spare parts lists, procedures, and treatment programs. Include step by step instructions on test procedures including target concentrations.

D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Product Requirements, for additional provisions.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 PREPARATION

A. Systems shall be drained and refilled with clean water. Ensure system is operational, started, and vented prior to cleaning. Use water meter to record capacity in each system.

B. Place terminal control valves in open position during cleaning.

C. Verify that electric power is available and of the correct characteristics.

3.02 CLEANING SEQUENCE

A. Concentration:
   1. As recommended by manufacturer.

B. Hot Water Heating Systems:
   1. Apply heat while circulating, slowly raising temperature to 160 degrees F and maintain for 12 hours minimum.

2. Remove heat and circulate to 100 degrees F or less; drain systems as quickly as possible and refill with clean water.
3. Circulate for 6 hours at design temperatures, then drain.
4. Refill with clean water and repeat until system cleaner is removed.

C. Use neutralizer agents on recommendation of system cleaner supplier and approval of Engineer.

D. Flush open systems and glycol filled closed systems with clean water for one hour minimum. Drain completely and refill.

E. Remove, clean, and replace strainer screens.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions.

3.04 CLOSEOUT ACTIVITIES

A. Training: Train Owner's personnel on operation and maintenance of chemical treatment system.
1. Provide minimum of two hours of instruction for two people.
2. Have operation and maintenance data prepared and available for review during training.
3. Conduct training using actual equipment after treated system has been put into full operation.

END OF SECTION 23 25 00

SECTION 23 51 00

BREECHINGS, CHIMNEYS, AND STACKS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Manufactured breechings.

B. Type B double wall gas vents.

1.02 REFERENCE STANDARDS

A. ASME B16.5 - Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard; 2013.

B. ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges; 2011.

C. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2015.

D. NFPA 31 - Standard for the Installation of Oil Burning Equipment; 2016.

E. NFPA 54 - National Fuel Gas Code; 2015.

F. NFPA 211 - Guide for Smoke and Heat Venting; 2016.

1.03 DEFINITIONS

A. Breeching: Vent Connector.

B. Chimney: Primarily vertical shaft enclosing at least one vent for conducting flue gases outdoors.

C. Smoke Pipe: Round, single wall vent connector.

D. Vent: That portion of a venting system designed to convey flue gases directly outdoors from a vent connector or from an appliance when a vent connector is not used.

E. Vent Connector: That part of a venting system that conducts the flue gases from the flue collar of an appliance to a chimney or vent, and may include a draft control device.

1.04 DESIGN REQUIREMENTS

A. Factory built vents and chimneys used for venting natural draft appliances shall comply with NFPA 211 and be UL listed and labeled.

1.05 SUBMITTALS

A. Shop Drawings: Indicate general construction, dimensions, weights, support and layout of breechings. Submit layout drawings indicating plan view and elevations where factory built units are used.

B. Product Data: Provide data indicating factory built chimneys, including dimensional details of components and flue caps, dimensions and weights, electrical characteristics and connection requirements.

C. Section 01 33 00 Submittals: Submittal Procedures.

D. Submit manufacturer's installation instructions: Indicate assembly, support details, and connection requirements.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum 5 years documented experience.

B. Installer Qualifications: Company specializing in performing the type of work specified in this section with minimum 5 years experience.

PART 2 PRODUCTS

2.01 INSULATED DOUBLE WALL METAL STACKS

A. Manufacturers:
   1. Metal-Fab Model IPIC
   2. Other acceptable manufacturers offering equivalent products.
      a. Van Packer
      b. Metalbestos
      c. Z-Vent
      d. Security Chimneys Int'l

B. Provide double wall metal stacks, tested to UL 103 and UL listed, for use with building heating equipment, in compliance with NFPA 211.

C. Fabricate with 1-inch minimum air space between walls. Construct inner jacket of 20-gage ASTM A167 Type 304 stainless steel. Construct outer jacket of aluminum coated steel 24-gage for sizes 6-inches to 24-inches and 20-gage for sizes 26-inches to 36-inches. Provide (1) inch (6 lb. per cubic foot) insulation between inner and outer jackets.

D. Accessories, UL labels, as required by equipment layout.
   1. Tees, elbows, laterals, reducers, wyes
   2. Supports, guides, and flanges
   3. Expansion joints, adjustable length pieces

2.02 BREECHINGS, CHIMNEYS, AND STACKS - GENERAL REQUIREMENTS

A. Regulatory Requirements:
   1. Conform to applicable code for installation of natural gas burning appliances and equipment.
   2. Conform to NFPA 31 for installation of oil burning appliances and equipment.
   3. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

PART 3 EXECUTION

3.01 PREPARATION

A. Inspect existing conditions and review contract documents.

B. Plan and coordinate work with the work of other trades.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in accordance with NFPA 54 and NFPA 31.

C. Install breechings with minimum of joints. Align accurately at connections, with internal surfaces smooth.

D. Support breechings from building structure, rigidly with suitable ties, braces, hangers and anchors to hold to shape and prevent buckling. Support vertical breechings, chimneys, and stacks at 12 foot spacing, to adjacent structural surfaces, or at floor penetrations. Refer to SMACNA (DCS) for equivalent duct support configuration and size.

E. Install concrete inserts for support of breechings, chimneys, and stacks in coordination with formwork.

F. Pitch breechings with positive slope up from fuel fired equipment to chimney or stack.

G. Install vent dampers, locating close to draft hood collar, and secured to breeching.

H. Assemble and install stack sections in accordance with NFPA 82, industry practices, and in compliance with UL listing. Join sections with acid resistant joint cement to ASTM C105. Connect base section to foundation using anchor lugs.

I. Level and plumb chimney and stacks.

J. Clean breechings, chimneys, and stacks during installation, removing dust and debris.

K. At appliances, provide slip joints permitting removal of appliances without removal or dismantling of breechings, breeching insulation, chimneys, or stacks.

3.03 SCHEDULES

EQUIPMENT	STACK
Boilers	Insulated Double Wall

END OF SECTION 23 51 00

SECTION 23 52 16

CONDENSING BOILERS

PART 1 GENERAL

1.01 SUMMARY

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

B. This Section includes packaged, factory-fabricated and assembled, gas-fired, condensing boilers, trim, and accessories for generating hot water.

C. The work to be performed includes all new equipment, labor and materials required to furnish and install ultra-high efficiency Condensing Hydronic Boilers as described in this product guide specification.

1.02 ACTION SUBMITTALS

A. Product Data: Submit manufacturer's technical product data, including rated capacities of selected model, weights (shipping, installed and operating), installation and start-up instructions, and furnished accessory information.

B. Shop Drawings: Submit manufacturer's end assembly drawings indicating dimensions, connection locations, and clearance requirements.

C. Wiring Diagrams: Submit manufacturer's electrical requirements for the boiler including ladder type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory installed and portions to be field installed.

1.03 INFORMATIONAL SUBMITTALS

A. Source quality-control test reports.

B. Field quality-control test reports.

C. Warranty: Special warranty specified in this Section.

D. Other Informational Submittals:
   1. ASME Stamp Certification and Report: Submit "A," "S," or "PP" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.

1.04 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For boilers to include in emergency, installation, operation, and maintenance manuals.

1.05 QUALITY ASSURANCE

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

B. Manufacturer's Qualifications: Firms regularly engaged in the manufacture of condensing hydronic boilers with steel pressure vessels, whose products have been in satisfactory use in service for not less than ten (10) years. The specifying engineer, contractor and end customer must have the option to visit the factory during the manufacture of the boilers and be able to witness test fire and other relevant procedures.

C. The boiler will be rated for a maximum allowable working pressure of 160 PSIG and a maximum allowable working temperature of 210° F.

D. The flame safeguard control on the boiler shall be the Siemens LMV series for full linkageless operation with servo motors to control the supply of fuel and air to the boiler for combustion.

E. The entire boiler system and its installation shall conform to the manufacturer's instructions, applicable codes and associated National Board requirements.

F. The equipment shall be in strict compliance with the requirements of this specification and shall be the manufacturer's standard commercial product unless specified otherwise. Additional equipment features, details, accessories, etc. which are not specifically identified but which are a part of the manufacturer's standard commercial product, shall be included in the equipment being furnished.

G. The equipment shall be of the type, design, and size that the manufacturer currently offers for sale and appears in the manufacturer's current catalog.

H. The equipment shall fit within the allocated space, leaving ample allowance for maintenance and inspection.

I. The equipment shall be new and fabricated from new materials. The equipment shall be free from defects in materials and workmanship.

J. All units of the same classification shall be identical to the extent necessary to ensure interchangeability of parts, assemblies, accessories, and space parts wherever possible.

K. In order to provide unit responsibility for the specified capacities, efficiencies, and performance, the boiler manufacturer shall certify in writing that the equipment being submitted shall perform as specified.

L. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.

M. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."

N. DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N, "Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers."

O. UL Compliance: Test boilers for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

1.06 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement and formwork requirements are specified in Division 03, by installing Contractor.

1.07 WARRANTY

A. The pressure vessel/heat exchanger shall carry a 15-year from shipment, non-prorated, limited warranty against any failure due to condensate corrosion, thermal stress, mechanical defects or workmanship.

B. The burner shall be conditionally guaranteed against any failure for (5) five years from shipment.

C. Manufacturer labeled control panels are conditionally warranted against failure for (3) three years from shipment.

D. All other components, with the exception of the igniter, flame detector and sensor, are conditionally guaranteed against any failure for (2) two years from shipment.

PART 2 PRODUCTS

2.01 MANUFACTURERS

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

B. Basis-of-Design Product: Subject to compliance with requirements, provide ALDRICH A3C-6000 series.
   1. Approved equals: Riello or Parker

2.02 HORIZONTAL THREE PASS FIRETUBE CONDENSING BOILER

A. The boiler must be manufactured by a company having at least ten (10) years documented boiler manufacturing experience in accordance to ASME Section IV Boiler and Pressure Vessel Code.

B. Description: Factory packaged and firetested firetube condensing boiler complete with gas burner, gas train, and controls mounted and wired, skid mounted requiring only supply, return, fuel, drain, electrical and vent connections.

C. Fabricate base and attachment to pressure vessel with reinforcement strong enough to resist boiler movement during a seismic event when boiler base is anchored to building structure.

D. Design: Horizontal three pass firetube design. The boilers combustion chamber shall be water jacketed including a water surrounded furnace. All fireside surfaces are to be constructed using duplex 2205 stainless steel. Boilers constructed of carbon steel, aluminum, 300 series stainless steel or 400 series stainless steel materials for fireside surfaces are not allowed. Boilers constructed of two passes are not allowed. Boiler to have a minimum efficiency of 95% when return water temperatures are <80°F.

E. Maximum allowable working pressure shall be 160 PSIG.

F. Maximum allowable temperature rating shall be 250°F. Boilers not meeting this temperature are not allowed.

G. U-Type Flex Joint: The furnace must incorporate a “U-Type” flex joint. The “U-Type” flex joint burner port to furnace minimizes the effects of differential stress as the boiler furnace expands at a greater rate than the firetubes during operation. Boilers with other types of furnace to tube sheets construction are not allowed.

H. Front Access Door: Door to include swing joint with hinges for easy fireside access to combustion chamber without removal of the door.

I. Rear Access Door: Door to include swing joint with hinges for easy access to fireside of boiler without removal of the door.

J. Boiler Casing: The external surfaces shall be covered with a minimum of 2” mineral fiber insulation encased within an 18 gauge steel jacket.

K. Water Capacity: The boiler must be of a high mass, large volume design

L. Include the following:
   1. Handholes or inspection tappings for water-side inspection.
   2. Lifting lug on to of boiler.
   3. Minimum 1” boiler drain valve.
   4. Minimum 1” condensate drain connection.
   5. Tappings or flanges for supply and return connections
   6. Condensate Neutralizer: Each boiler to include a factory supplied condensate neutralizer appropriately sized based on rated input of the boiler. Each condensate neutralizer is to be field installed by installing contractor.

2.03 WATER BOILER TRIM

A. Boiler to include the following factory mounted/wired:
   1. Theraltimeter gauge
   2. ASME relief valve
   3. Operating control
   4. High limit control (Manual Reset)
   5. Modulation control

6. Probe type low water cut-off (Manual Reset)

2.04 BURNER

A. The burner shall be a Riello RLS series. No substitutions.

B. The burner shall be capable of operation on natural gas and No.2 oil.

C. Burner firing control shall be full modulation on gas and full modulation on #2 oil. 2 Stage Oil firing is not acceptable.

D. The burner shall operate with a minimum off 5:1 Turndown on Natural Gas for all temperature ranges.

E. The burner shall not produce more than 0.04% of Carbon monoxide (CO) at all firing rates.

F. The burner shall have an integral control panel complete with electronic flame safeguard, air pressure switch, UV scanner, alarm horn with silencing switch, local/remote switch and the following indicating lights: Power On, Ignition On, Alarm & Call for Heat.

G. The burner control panel shall also have a color touch screen display.

H. The flame safeguard shall be a Siemens LMV 3 or 5 system with a QRA flame detector.

I. The burner shall feature fully independent air and fuel actuators for regulation (linkage less). The use of linkage type or CAM type modulation is not acceptable.

J. The burner shall be a packaged design including the combustion air fan and TEFC motor.

K. The burner shall have a remote oil pump with its own motor, oil pressure switches and gauges and shall be mounted on the burner. Integral Oil pumps driven by the blower motor are not acceptable. Remote oil pump shipped loose or mounted anywhere else but on the burner.

L. The burner shall include an on board RWF55 water temperature modulating control with Modbus port

M. The burner fan housing and manifold shall be constructed from aluminum alloy.

N. The burner head shall be a stainless steel flame retention type with diffusor and sleeve that are adjustable while burner is running.

O. The burner shall be equipped with service slide bars or hinges that allow for full access to the burner drawer assembly without removing the burner from the boiler.

P. Quick Connect Wiring of Burner & Gas Train: Burner to include factory wired burner quick connect wiring. This provides quick and easy removal of the burner and gas train for application when the burner may need to be shipped loose or removed for

rigging purposes. The quick connect system greatly reduces the time required for the installing contractor to remount and make wiring connections.

Q. Gas Piping
1. The main gas train shall consist a low gas pressure switch (manual reset) and a high gas pressure switch (manual reset) as required by code.
2. The gas train shall consist of two Siemens VGG valves bodies with SKP15 and SKP25 actuators.
3. The pilot train shall consist of an ASCO solenoid, Maxitrol regulator, and manual shut off valve.
4. Each boiler shall have a manual gas shutoff valve and a test fire valve.
5. The gas train can meet or exceed CSD-1, UL & FM requirements.

R. Oil Piping
1. The oil train shall incorporate U.L. approved components as supplied by the burner manufacturer.
2. The oil pump set shall be mounted to the burner housing and shall be directly driven by a motor independent from the combustion air motor
3. Oil pump must have an integral regulator to adjust the flow of oil to burner nozzles.
4. There shall be three safety shut off valves. Main safety, nozzle supply and nozzle return line
5. All piping on burner valve train must be factory installed.
6. Field connections must be NPT.
7. Two wired braided flexible hoses shall be supplied, one supplying the oil input to the oil pump and the second returning the oil return to the steel piping.
8. All wiring of oil train valves and switches must be factory wired.

2.05 SOURCE QUALITY CONTROL

A. Test and inspect factory-assembled boilers, before shipping according to ASME Boiler and Pressure Vessel Code.

2.06 OPTIONAL ITEMS

A. Boiler Sequencing Control Panel - A sequencing control panel shall be supplied by the boiler manufacturer to control the boilers and motorized isolation valves and shall include the following:
1. Color touch screen not less than 15”
2. Logic to control Motorized Isolation Valves or Boiler Pumps
3. Lead Lag Control to stage boilers
4. Rotate boilers for equal run time
5. Accept enable/disable signal from BAS
6. Accept remote temperature setpoint from BAS
7. Ability for local outdoor air reset
8. BAS Communication Card – BacNet
9. Failure of any component within the Master Panel will not result in loss of boiler operation. Operation will revert to local PID controller (RWF10/RWF55/LMV5), utilizing an adjustable local setpoint.

B. Manually Adjustable Stack Damper

PART 3 EXECUTION

3.01 EXAMINATION

A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.
   1. Boiler locations on drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections and consult mechanical engineering Project Manager for approval prior to proceeding.

B. Examine mechanical spaces for suitable conditions where boilers will be installed.

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

3.02 BOILER INSTALLATION

A. Installation shall be performed by the contractor in accordance with the requirements of the applicable codes and manufacturer's instructions. Contractor shall review the boiler and installation for compliance with requirements and/or issues that may affect boiler performance. Installation should not proceed until unsatisfactory conditions have been corrected.

B. Install gas-fired boilers according to NFPA 54 and ANSI Z223.1

C. Install boilers level on concrete base at a height above the floor as required by boiler manufacturer's recommendation for proper condensate drainage and boiler operation. Concrete base is specified in Division 23 Section "Common Work Results for HVAC". Bases shall be a minimum of 4" high and extend base not less than 6" in all directions beyond the maximum dimensions of boiler unless otherwise indicated.

D. Assemble and install boiler trim and electrical devices furnished with boiler but not specified to be factory mounted.

E. Connections
   1. Piping
      a. Each boiler shall be provided with all necessary inlet and outlet connections. Refer to specific Boiler's specification sheet for connection sizes. Piping installation requirements are specified in other Division 23 Sections such as Section 23 20 00 "HVAC Piping and Pumps". Drawings indicate general arrangement of piping, fittings, and specialties.
      b. Check manufacturer's installation manual for clearance dimensions and install piping adjacent to boiler to allow service and maintenance.
      c. Install piping from condensate drain connection through condensate neutralization kit to nearest floor drain. Piping shall be at least full size of connection and adhere to proper codes for neutralization. Provide an isolation valve if required. Use PVC, CPVC, stainless steel, aluminum or

polypropylene for condensate drain piping. DO NOT use carbon or copper components.

d. Connect gas piping to boiler gas train inlet with unions. Piping shall be at least full size of gas train connection. Provide gas pressure regulator if necessary.

2. Venting & Combustion Air Intake
   a. Install air intake and exhaust venting system per manufacturer's recommendations and state/provincial codes.
   b. Components shall comply with requirements in Section 23 51 00 "Breechings, Chimneys and Stacks".
   c. Use Heatfab exhaust venting adapter designed specifically for boiler.
3. Electrical
   a. Voltage shall be as shown on drawings.
   b. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems".
   c. Connect wiring according to Division 26 Section "Low Voltage Electrical Power Conductors and Cables".
   d. Connect control wiring to field-mounted electrical devices.

F. Flush & clean boiler upon completion of installation in accordance with manufacturer's instructions. Boiler must be isolated when any cleaning or testing of the system piping is being performed.

G. Fill boiler system with water and required glycol and chemical treatment in order to satisfy manufacturer's water quality requirements.

H. Bleed air from boiler water lines and gas lines.

I. Perform hydrostatic test and fix leaks as necessary.

J. Check for proper water flow direction.

K. After all installation requirements have been accomplished, contractor shall fill out and return manufacturer's pre-startup form and return to boiler representative to schedule startup.

3.03 START-UP SERVICE

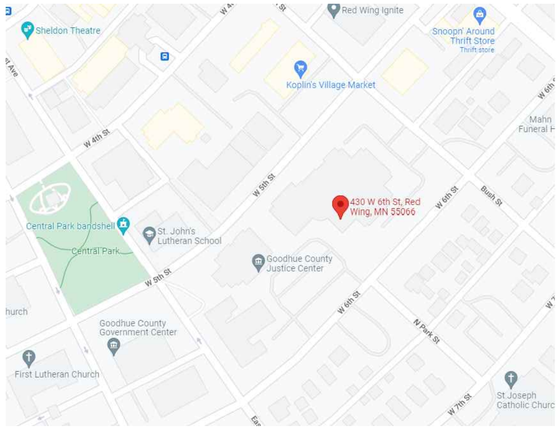
A. Engage a factory authorized service representative to perform the boiler startup.
   1. Confirm boilers are installed properly per manufacturer's requirements.
   2. Perform combustion analysis multiple firing rates from low to high fire and adjust boiler settings as required for proper operation.

B. Engage a factory authorized service representative to train Owner's maintenance personnel as specified below:
   1. Operate boiler, including accessories and controls, to demonstrate compliance with requirements.
   2. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
   3. Review data in the maintenance manuals. Refer to Division 1 Section "Contract Closeout" AND "Operation and Maintenance Data".

4. Schedule training with Owner with at least 7 days advance notice.

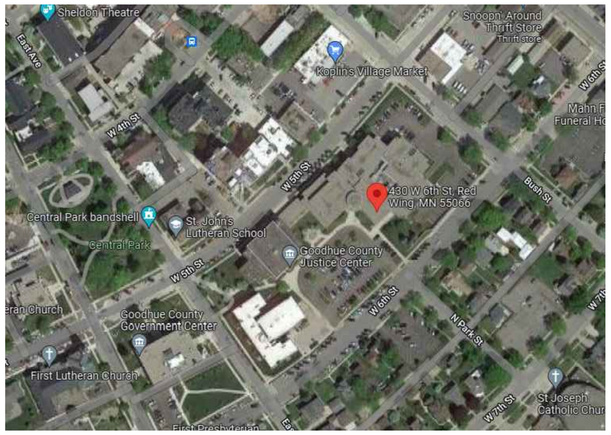
END OF SECTION 23 52 16

GOODHUE COUNTY
LAW ENFORCEMENT CENTER
BOILER REPLACEMENT
430 WEST 6TH STREET
REDWING, MN 55066



1 M000 MAP OF SITE

NORTH



2 M000 GOOGLE MAP OF SITE

NORTH

GENERAL MECHANICAL PLAN NOTES

1. IN GENERAL, ALL PIPING AND DUCTWORK SHALL BE RUN CONCEALED IN SUSPENDED CEILING SPACES AND IN SHAFTS PROVIDED, UNLESS NOTED OR INDICATED OTHERWISE. CERTAIN ROOMS HAVE NO SUSPENDED CEILINGS. PIPING AND DUCTWORK ABOVE THESE ROOMS SHALL BE EXPOSED & INSTALLED AS HIGH AS POSSIBLE.
2. NOT ALL ACCESS PANELS ARE SHOWN ON THESE DRAWINGS. ACCESS IS REQUIRED OF ALL VALVES, FIRE DAMPERS, MANUAL AND MOTORIZED DAMPERS LOCATED IN CONCEALED SPACES (CEILINGS, WALLS, CHASES AND SOFFITS). ALL ACCESS PANELS SHALL BE PROVIDED BY THIS CONTRACTOR.
3. PROVIDE COORDINATION DRAWINGS FOR FABRICATION OF PIPING AND DUCTWORK. DRAWINGS ARE REQUIRED WITH ELEVATIONS FOR ALL AREAS CONGESTED WITH WET AND DRY SIDE EQUIPMENT, SPRINKLER PIPING, DUCTWORK, PLUMBING AND HVAC PIPING. AREAS SHALL INCLUDE EQUIPMENT ROOMS AND CORRIDORS. INCLUDE SPACE ALLOCATION FOR LIGHTING AND CEILING HEIGHTS. USE APPROVED EQUIPMENT SUBMITTALS FOR FINALIZING GENERAL ARRANGEMENTS PRIOR TO SETTING HOUSE KEEPING PADS.
4. COOPERATE WITH THE OTHER TRADES TO ELIMINATE ANY CONFLICTS BETWEEN PIPING, DUCTWORK, ELECTRICAL WORK, ETC. THESE DRAWINGS ARE DIAGRAMMATIC. ALL OFFSETS REQUIRED VERTICAL AND HORIZONTAL NOT SHOWN ON PLANS SHALL BE INCLUDED IN THIS CONTRACT.
5. DIFFUSER, REGISTER AND SPRINKLER HEAD LOCATIONS SHALL BE COORDINATED WITH LIGHT FIXTURE LOCATIONS AND SHALL BE IN ACCORDANCE WITH CEILING PATTERNS WHERE SUSPENDED CEILINGS ARE TO BE PROVIDED. REFER TO SPECIFICATIONS FOR COORDINATION DRAWING REQUIREMENTS.
6. ALL CHILLED WATER PIPING INSULATION SHALL USE EXTENDED TYPE VALVE STEMS. INSULATE ALL VALVE ASSEMBLIES PER DETAILS.
7. ALL DUCT INSULATION SHALL USE EXTENDED TYPE HANDLES FOR DAMPERS. REFER TO SPECIFICATIONS FOR DUCTS REQUIRING INSULATION.
8. WHERE SHEET METAL HOUSING, PLENUMS AND DUCTWORK ARE FASTENED TO GENERAL CONSTRUCTION, TAKE SPECIAL CARE TO MAKE AN AIRTIGHT SEAL BETWEEN THE METAL AND THE ADJACENT CONSTRUCTION. USE APPROVED SEALANT TO MAKE JOINTS AIRTIGHT AND WATER TIGHT.
9. AIR HANDLING UNITS, PIPING AND DUCT CONSTRUCTION SHALL PERMIT FOR COIL AND FILTER REMOVAL WITHOUT DISMANTLING UNIT HOUSING, PIPING VALVE ASSEMBLIES OR DUCTWORK.
10. FOR DETAILS, EQUIPMENT CONNECTIONS AND SIZES NOT SHOWN ON FLOOR PLANS, REFER TO ELEVATIONS, DIAGRAMS, DETAILS AND SCHEDULES.
11. PROVIDE ALL REQUIRED DAMPERS PER INDICATED RATINGS. INCLUDE COMPLETE INSTALLATION OF CONTROLS.
12. KEEP OPEN ENDS OF PIPING AND DUCTWORK CAPPED TO PREVENT CONSTRUCTION DUST AND DEBRIS FROM ENTERING.
13. WHERE PIPING OR DUCTWORK IS SHOWN CONNECTING TO EXISTING MAINS, EQUIPMENT, ETC., THIS CONTRACTOR SHALL VERIFY EXACT LOCATIONS, SIZES AND SERVICES PRIOR TO MAKING TAP.
14. DURING CONSTRUCTION TAKE SPECIAL CARE OF SURROUNDINGS. MOVE FURNITURE, MAKE USE OF DRIP PANS, DROP CLOTHS ETC. TO PROTECT PROPERTY ON FLOORS IN CONSTRUCTION.
15. COORDINATE THE LOCATIONS FOR ALL CORE DRILLING AND WALL CUTTING WITH OTHERS.
16. OPENINGS FOR DUCTWORK THROUGH WALLS AND FLOORS SHALL BE NEATLY SAW-CUT WITH A MAXIMUM OVER CUT OF 1" AROUND REQUIRED DUCT OPENINGS. REPAIR ALL AREAS AROUND PENETRATIONS WITH BACK-UP WALL AND FINISH TO MATCH EXISTING. DO NOT REDUCE INSULATION THICKNESS WHERE DUCT PASSES THROUGH OPENINGS.
17. WHERE OPENINGS ARE CUT THRU WALL PROVIDE STEEL ANGLE REINFORCING TO STABILIZE THE STRUCTURE. REFER TO STRUCTURAL PLANS FOR REQUIREMENTS.
18. OPENINGS FOR PIPING AND ROUND DUCT THROUGH WALLS AND FLOORS SHALL BE NEATLY CORE-DRILLED LARGE ENOUGH FOR INSULATION TO PASS THROUGH, SLEEVED AND GROUTED. PROVIDE FIRE CAULKING AND/OR F.S. DAMPERS AT RATED FLOORS AND WALLS.
19. REFER TO DETAIL SHEETS FOR PIPE SUPPORT, GUIDES & EXPANSION JOINTS DETAIL.
20. REFER TO ALL DETAILS FOR EQUIPMENT INSTALLATION REQUIREMENTS. ALL DETAILS SHALL APPLY IN THESE DOCUMENTS.
21. PROVIDE CONCRETE HOUSE KEEPING PADS FOR ALL FLOOR MOUNTED MECHANICAL EQUIPMENT.

GENERAL DEMOLITION PLAN NOTES

1. COORDINATE ROOF PATCHING AND INSTALLATION OF NEW MECHANICAL SYSTEMS AND WITH ROOFING CONTRACTOR.
2. ALL EXISTING EQUIPMENT, PIPING, DUCTWORK, AND MATERIALS INDICATED BY A NOTE, DARK DASHED LINE INDICATED OR CROSS-HATCH SHALL BE REMOVED UNDER THIS CONTRACT.
3. WHERE EQUIPMENT IS REMOVED, ALL ASSOCIATED PIPING, DUCTWORK, INSULATION, SUPPORTS, ETC. SHALL BE REMOVED BACK TO MAINS. ALL PIPING RUN-OUTS ARE NOT NECESSARILY SHOWN ON THE DEMOLITION PLANS; HOWEVER, THE CONTRACTOR SHALL REMOVE AS REQUIRED TO FACILITATE NEW WORK.
4. COORDINATE REMOVAL OF ALL EQUIPMENT AND SERVICES WITH OWNER TO AVOID INTERFERENCE WITH BUILDING OCCUPANCY.
5. PROTECT ALL EXISTING WIRING & PANELS FOR THE BUILDING AUTOMATION.
6. THE MECHANICAL CONTRACTOR SHALL PATCH ALL WALL, FLOOR, AND ROOF OPENINGS UNLESS NOTED OTHERWISE.
7. FOLLOWING REMOVAL, ALL EQUIPMENT & MATERIALS MUST BE REMOVED FROM THE JOBSITE UNLESS WANTED FOR SALVAGE BY THE OWNER. OWNER RETAINS THE RIGHT TO KEEP ANY EQUIPMENT/MATERIALS UNTIL REMOVED FROM SITE WITH OWNER'S PERMISSION.
8. PROTECT ALL LOW VOLTAGE COMMUNICATION WIRING (I.E. DATA VOICE AND FIBER OPTIC) AND CONDUITS DURING DEMOLITION FROM DAMAGE, BREAKAGE OR KINKING. CONTRACTOR SHALL REPLACE ANY DAMAGED WIRING.

MECHANICAL DRAWING INDEX

PROJECT TEAM / CONTACTS

OWNER CONTACT
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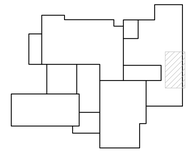
KEYPLAN

SHADED SECTIONS INDICATE AREAS OF WORK UNDER THIS CONTRACT.



MECHANICAL ABBREVIATIONS

AHU-	AIR HANDLING UNIT	HTR.	HEATER
A.F.F.	ABOVE FINISHED FLOOR	L.F.	LINEAL FEET
B	BOILER	MD-	MOTORIZED DAMPER
B.F.F.	BELOW FINISHED FLOOR	MIN.	MINIMUM
B.F.F.	BELOW FINISHED FLOOR	MOT.	MOTORIZED
CFM	CUBIC FEET PER MINUTE	O.A.	OUTSIDE AIR
CHWS	CHILLED WATER SUPPLY	PEW	PLANT EFFLUENT WATER
CHWR	CHILLED WATER RETURN	PRV	POWER ROOF VENTILATOR
C.O.	CLEANOUT	RA	RETURN AIR
CU-	CONDENSING UNIT	SF-	SUPPLY FAN
DN.	DOWN	UH-	UNIT HEATER
(E)	EXISTING	VTR	VENT THRU ROOF
EF-	EXHAUST FAN	WL-	WALL LOUVER
EG	EXHAUST GRILLE		
EH-	ELECTRIC HEATER		
FT.	FOOT OR FEET		
F.D.	FLOOR DRAIN		
F.C.O.	FLOOR CLEANOUT		

DUCTWORK SYMBOLS

- SUPPLY DUCT UP
- RETURN OR EXHAUST DUCT UP
- SUPPLY DUCT DOWN
- RETURN OR EXHAUST DUCT DOWN
- MOTORIZED DAMPER

PIPING SYMBOLS

- CD — CONDENSATE DRAIN PIPING
- V — VENT PIPING
- DCW — DOMESTIC COLD WATER PIPING
- G — GAS PIPING
- DHW — DOMESTIC HOT WATER PIPING
- IG — INTERRUPTIBLE GAS
- FG — FIXED GAS
- FOS — FUEL OIL SUPPLY
- FOR — FUEL OIL RETURN
- HWS — HEATING WATER SUPPLY
- HWR — HEATING WATER RETURN
- SCW — SOFTENED COLD WATER

CONTROL SYMBOLS

- T — THERMOSTAT OR TEMPERATURE SENSOR

GENERAL SYMBOLS

- @ AT
- 3 NUMBERED NOTE
- 1 REVISION (NO.1)

No:	Date:	By:	Revision:

I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.
PRINT NAME: ZACHARY C. THOMPSON
DATE: 8/18/2022 REG. NO.: 57835

KFI ENGINEERS
670 County Road B West
St. Paul, Minnesota 55113
Tel: (651) 771-0880 Fax: (651) 771-0878
Email: kfi@kfi-eng.com

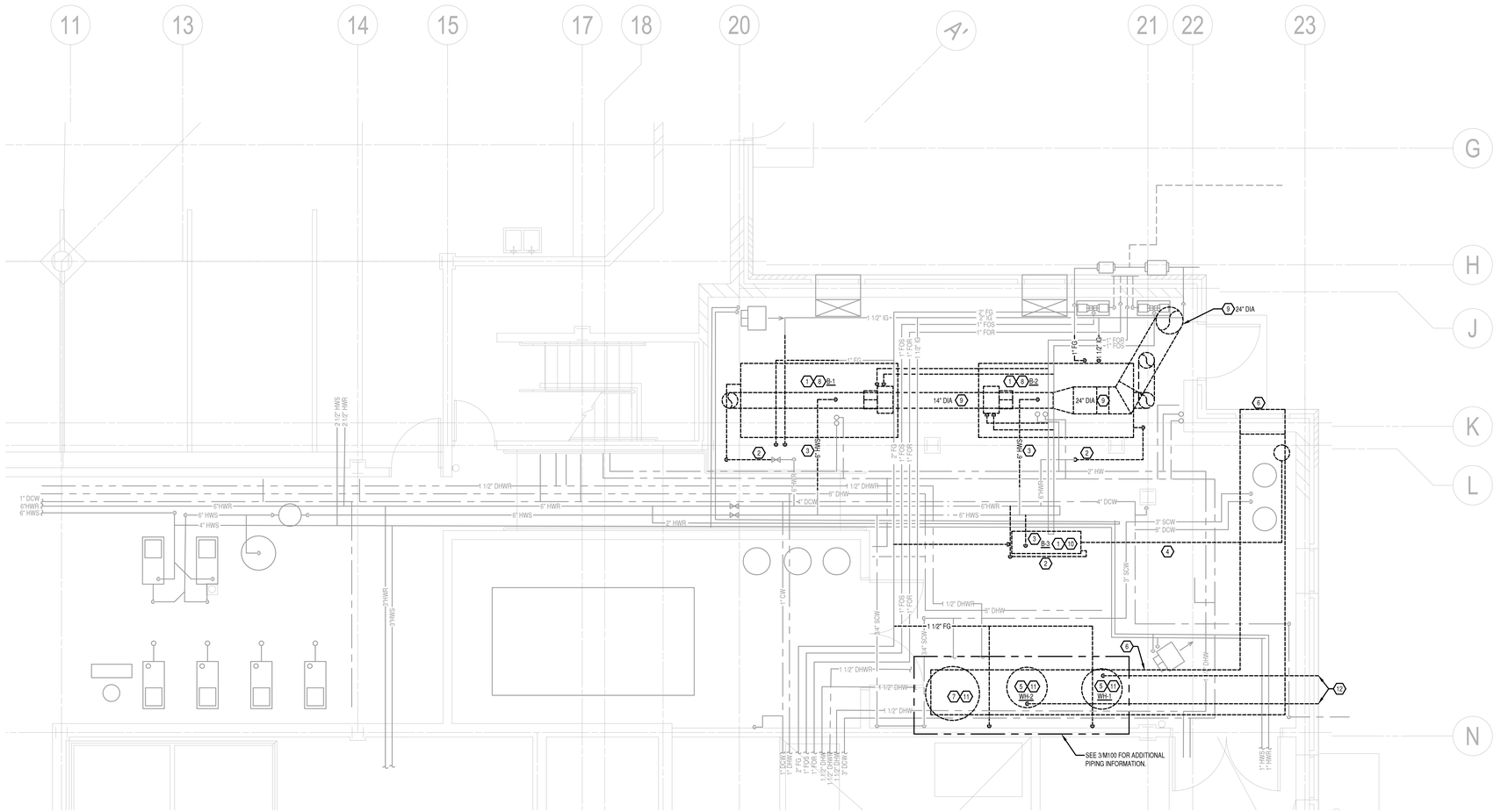
Project Title: GOODHUE COUNTY LAW ENFORCEMENT CENTER BOILER AND WATER HEATER REPLACEMENT
460 WEST SIXTH STREET
REDWING, MN 55066

Sheet Title: MECHANCIAL TITLE SHEET

Date:	8/18/2022
Drawn By:	CRE
Checked By:	ZCT
Project No:	22-0188.00
DWG Scale:	AS NOTED
Sheet Size:	30x42

Revision Number: 0

Sheet Number: M000



KEY NOTES:

1. DEMOLISH EXISTING BOILER. DISCONNECT AND REMOVE EXISTING FOS AND FOR PIPING BACK TO MAIN PIPING. VERIFY ROUTING, SIZE, AND LOCATION ON SITE.
2. DEMOLISH EXISTING STRAINER, TRIPLE DUTY VALVE, AND PUMP FROM 6" HWR PIPING. VERIFY ROUTING, SIZE AND LOCATION ON SITE.
3. DEMOLISH EXISTING 6" HWS PIPING BACK TO SHUT-OFF VALVE NEAR MAIN. VERIFY ROUTING, SIZE AND LOCATION ON SITE.
4. DEMOLISH EXISTING FLUE DUCTWORK FOR BOILER #3. CAP AND SEAL ROOF AS REQUIRED. VERIFY ROUTING, SIZE, AND LOCATION ON SITE.
5. DEMOLISH EXISTING DOMESTIC WATER HEATER. DISCONNECT AND REMOVE EXISTING HW, HWR, CW, AND FG PIPING BACK TO MAIN PIPING. DISCONNECT EXISTING FLUE GAS DUCTWORK. VERIFY ROUTING, SIZE, AND LOCATION ON SITE.
6. DEMOLISH EXISTING WATER HEATER COMBUSTION AIR DUCTWORK. PROVIDE INSULATED BLANK-OFF PANEL ON REAR OF INLET LOUVER. VERIFY ROUTING, SIZE, AND LOCATION ON SITE.
7. DEMOLISH EXISTING DOMESTIC HOT WATER STORAGE TANK.
8. DEMOLISH EXISTING IG AND FG PIPING FROM BOILER. COORDINATE AMOUNT OF DEMO ON SITE WITH NEW BOILER GAS TRAIN LOCATION. VERIFY ROUTING, SIZE, AND LOCATION ON SITE.
9. DEMOLISH EXISTING FLUE DUCTWORK FROM EXISTING BOILERS AND UP THRU ROOF. VERIFY SIZE, ROUTING, AND LOCATION ON SITE.
10. DEMOLISH EXISTING HOUSEKEEPING PAD UNDER BOILER, TO EVEN SURFACE WITH EXISTING FLOOR.
11. DEMOLISH A PORTION OF EXISTING HOUSEKEEPING PAD UNDER STORAGE TANK AND WATER HEATERS. COORDINATE REQUIRED SIZE NEEDED FOR INSTALLATION OF NEW WATER HEATER. MAINTAIN A EVEN SURFACE WITH EXISTING FLOOR.
12. DEMOLISH EXISTING FLUE DUCTWORK FROM EXISTING WATER HEATER AND THRU EXTERIOR WALL. VERIFY SIZE, ROUTING, AND LOCATION ON SITE.

GENERAL NOTES:

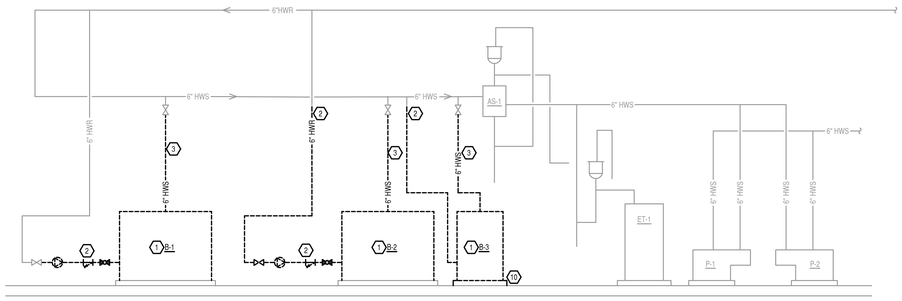
1. WHERE PIPING/DUCTWORK HAS BEEN REMOVED AND OPENING WILL NOT BE USED PATCH UNUSED OPENING TO MATCH EXISTING CONDITIONS.
2. REMOVED ALL UNUSED HANGERS AND SUPPORTS FROM REMOVED PIPING AND DUCTWORK.

1 M100 BOILER ROOM DEMOLITION PLAN

1/4"=1'-0"

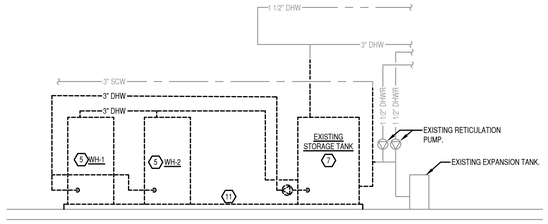
NORTH

0 2' 4' 8'



2 M100 HEATING WATER SYSTEM SCHEMATIC

NONE



3 M100 DOMESTIC WATER HEATER SYSTEM SCHEMATIC

NONE

No:	Date:	By:	Revision:

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PRINT NAME: ZACHARY C. THOMPSON

DATE: 8/18/2022 REG. NO.: 57835

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Project Title:
GOODHUE COUNTY LAW ENFORCEMENT CENTER BOILER AND WATER HEATER REPLACEMENT

460 WEST SIXTH STREET
REDWING, MN 55066

Sheet Title:
BOILER ROOM DEMO PLAN

Date:	8/18/2022
Drawn By:	CRE
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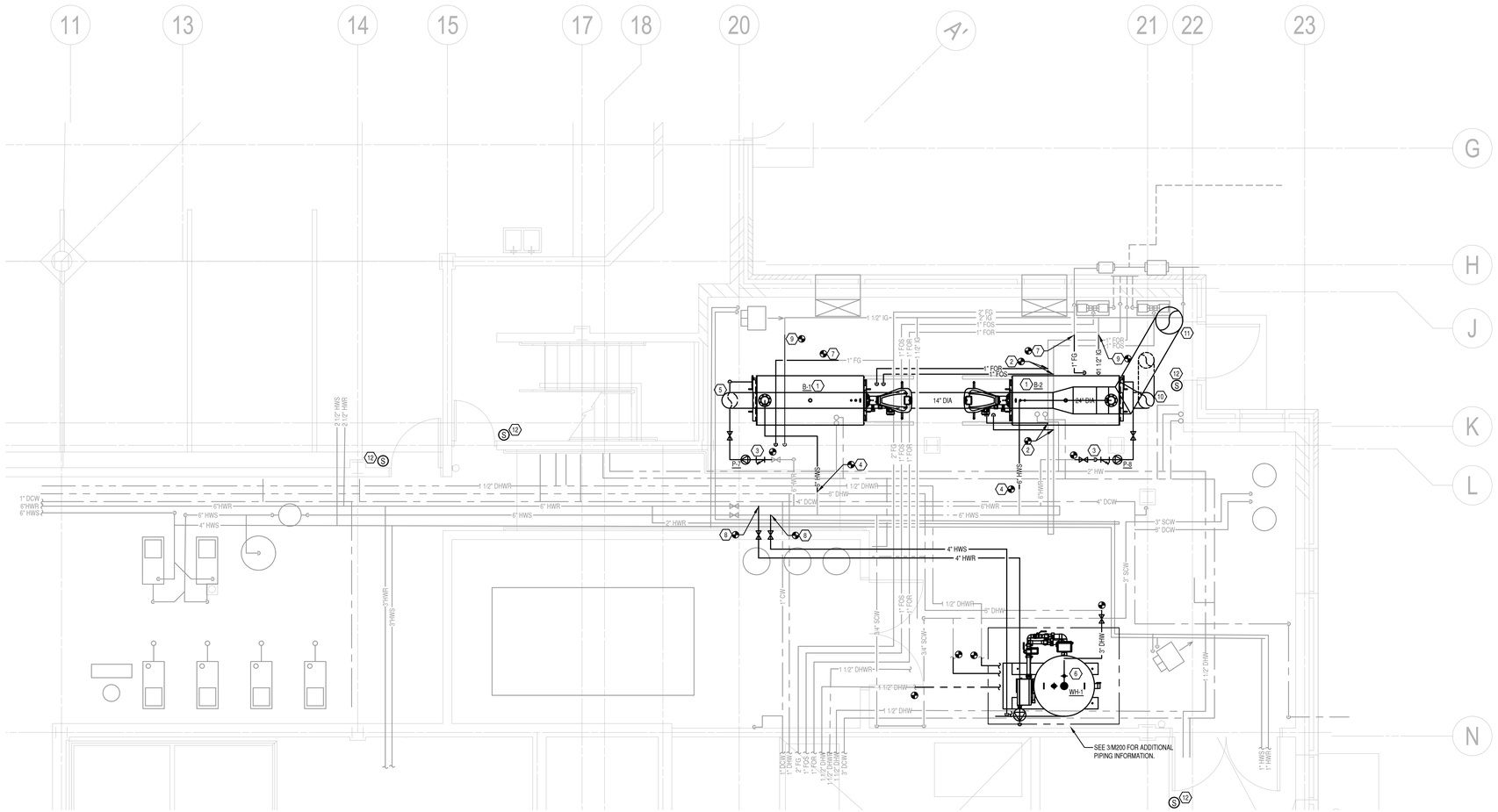
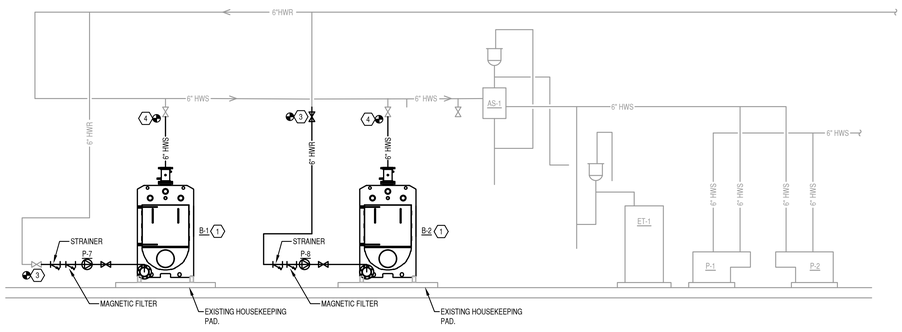
Project No:	22-0188.00
DWG Scale:	AS NOTED
Sheet Size:	30x42

Revision Number: 0

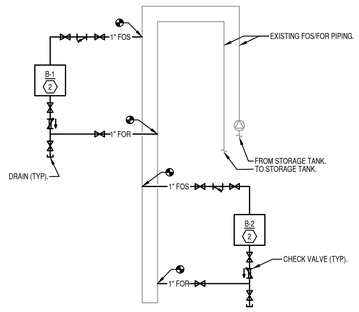
Sheet Number: M100



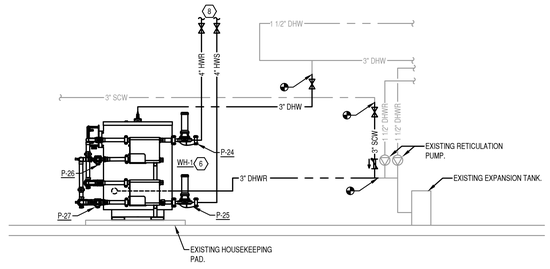
1 M200 BOILER ROOM NEW PLAN
1/4"=1'-0"



2 M200 HEATING WATER SYSTEM SCHEMATIC
NONE



3 M100 FUEL OIL SYSTEM PIPING DIAGRAM
NONE



4 M100 DOMESTIC WATER HEATER SYSTEM SCHEMATIC
NONE

KEY NOTES:

1. NEW BOILER TO BE INSTALLED ON EXISTING PAD. SEE SCHEDULE FOR SPECIFICATIONS. VERIFY EXACT LOCATION ON SITE.
2. CONNECT NEW 1" FOS AND 1" FOR PIPING TO EXISTING MAINS AND ROUTE TO NEW BOILER. VERIFY ROUTING AND CONNECTION LOCATION ON SITE. CONFIRM CONNECTION REQUIREMENT WITH NEW BOILER.
3. INSTALL NEW STRAINER, CIRCULATION PUMP AND MAGNACLEAM FILTER MODEL FL1-03-2704 IN 6" HWR PIPING. VERIFY EXACT LOCATIONS ON SITE.
4. INSTALL NEW 6" HWS PIPING FROM NEW BOILER TO EXISTING HWS MAIN. VERIFY ROUTING AND LOCATION ON SITE.
5. NEW 14" DIA FLUE DUCT FROM NEW BOILER WITH STACK DAMPER, FOLLOW ROUTING OF REMOVED FLUE DUCT. VERIFY ROUTING AND LOCATION ON SITE.
6. NEW WATER HEATER WITH VFD CIRCULATION PUMP. SEE SCHEDULE FOR SPECIFICATION. EXTEND EXISTING HOUSE KEEPING PAD AS REQUIRED.
7. EXTEND NEW 1" FG GAS TO NEW BOILER GAS TRAIN. VERIFY ROUTING AND LOCATION ON SITE.
8. ROUTE NEW 6" HWS AND HWR PIPING TO EXISTING MAINS. VERIFY ROUTING AND LOCATION ON SITE.
9. EXTEND NEW 1 1/2" IG PIPING TO NEW BOILER GAS TRAIN. VERIFY ROUTING AND LOCATION ON SITE.
10. CONNECT NEW 14" DIA FLUE DUCT WITH STACK DAMPER FROM NEW BOILER TO NEW 24" DIA FLUE DUCT. VERIFY ROUTING AND LOCATION ON SITE.
11. NEW 24" DIA FLUE DUCT UP THRU ROOF. REUSE EXISTING ROOF PENETRATION. COORDINATE ROOF FLASHING WITH ROOFING REQUIREMENTS. VERIFY ALL CONDITIONS AND REQUIREMENTS ON SITE.
12. BOILER SHUT-DOWN SWITCH, TO BE INSTALLED AT 4'-0" ABOVE FINISHED FLOOR.

GENERAL NOTES:

1. EXTEND EXISTING HOUSEKEEPING PAS AS REQUIRED FOR INSTALLATION OF NEW WATER HEATER. VERIFY ALL CONDITIONS AND REQUIREMENTS ON SITE.

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460 WEST SIXTH STREET
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Sheet Title:
BOILER ROOM NEW PLAN

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BOILER SCHEDULE

GENERAL					MECHANICAL																	ELECTRICAL		NOTES
EQUIP NO.	LOCATION	SERVES/APPLICATION	MANUFACTURER	MODEL NO.	TYPE	WORKING PRESSURE (PSIG)	GROSS INPUT MBH	NET OUTPUT MBH	GAS TURNDOWN RATIO	INLET GAS PRESSURE (PSI)	FLUE SIZE (IN DIA)	WATER DATA						BURNER					OIL PUMP MOTOR (HP)	FLA	VOLTAGE & PHASE	
												GPM FLOW	FLUID TYPE	WATER VOLUME (GAL)	TEMPERATURE (F) IN	TEMPERATURE (F) OUT	GAS CFH	GAS TYPE	OIL GPH	FUEL TYPE	HP				
B-1	BOILER ROOM	BUILDING HEAT	ALDRICH	A3C-600-RS160E	CONDENSING	30	6000	570	8.5:1	2	14	270	WATER	540	140	180	6000	NG	43	#2 OIL	7.5	1	13.5	460/3/60	ALL
B-2	BOILER ROOM	BUILDING HEAT	ALDRICH	A3C-600-RS160E	CONDENSING	30	6000	570	8.5:1	2	14	270	WATER	540	140	180	6000	NG	43	#2 OIL	7.5	1	13.5	460/3/60	ALL

NOTES:

1. BOILERS TO BE FACTORY PACKAGED WITH BURNER AND CONTROLS MOUNTED AND WIRED. GAS TRAIN TO BE PREPIPED AND PREWIRED.
2. BOILERS MUST HAVE ENTIRE HEAT EXCHANGER CONSTRUCTED OF STAINLESS STEEL.
3. BOILERS TO HAVE A MAXIMUM ALLOWABLE TEMPERATURE RATING OF 250°F.
4. BURNERS TO HAVE SIEMENS LMV36 LINKAGELESS CONTROLS AND SIEMENS RWF55 MODULATING CONTROLLER WITH MODBUS PORT.
5. BURNERS TO BE SUPPLIED WITH SIEMENS CSD-1 FM GAS TRAIN
6. BURNERS TO HAVE A REMOTE OIL PUMP MOUNTED TO BURNER AS STANRARD FROM MANUFACTURER.
7. BURNERS TO HAVE HIGH AND LOW OIL PRESSURE SWITCHES AND OIL PRESSURE GAUGE
8. BURNERS TO HAVE MODULATING FIRING CONTROL ON BOTH GAS AND OIL
9. PROVIDE THE FOLLOWING NEW OIL ACCESSORIES FOR EACH BURNER TO BE FIELD INSTALLED BY THE CONTRACTOR:
   A. (2) ISOLATION VALVES
   B. (1) FUSIBLE LINK VALVE
   C. (1) CHECK VALVE
   D. (1) 0-15 PSI 2" BOTTOM MOUNT PRESSURE GAUGE
   E. (1) OIL STRAINER/FILTER WITH 30 MICRON RATING
10. BURNER/BOILER TO HAVE QUICK WIRING HARNESS TO FACILITATE EAS OF REMOVAL AND REINSTALLATION OF BURNER
11. BURNERS TO HAVE INTEGRRAL CONTROL PANEL WITH THE FOLLOWING:
    A. UV SCANNER, ALARM HORN, LOCAL/REMOTE SWITCH, ON/OFF SWITCH, FUEL SWITCH
    B. CONTROL CIRCUIT TRANSFORMER FOR SINGLE POINT CONNECTION
    C. 5 INDICATING LIGHTS: POWER ON, IGNITION ON, CALL FOR HEAT, FUEL ON & ALARM
12. PROVIDE BOILER MASTER LEAD/LAG SEQUENCING CONTROLLER WITH THE FOLLOWING:
    A. COLOR TOUCH SCREEN, 15" MINIMUM
    B. LOGIC TO CONTROL BOILER MOTORIZED ISOLATION VALVES/PUMPS
    C. ACCEPTS BOILER INFORMATION INCLUDING FAULT STATUS VIA ETHERNET CONNECTION TO EACH BOILER
    D. FAILURE OF ANY COMPONENT WITHIN THE MASTER PANEL WILL NOT RESULT IN LOSS OF BOILER OPERATION
    E. SUPPLY WATER HEADR SENSOR (SHIPPED LOSE FOR FIELD INSTALLATION BY CONTRACTOR)
    F. BAS COMMUNICATION: BacNet
13. BOILERS TO HAVE MANUAL STACK DAMPER
14. INSTALLING CONTRACTOR MUST MAKE THE FOLLOWING PROVISIONS TO ALLOW FOR BURNER/DOOR SWING:
    A. PROVIDE ADEQUATE AMOUNT OF ELECTRICAL FLEXIBLE CONDUIT
    B. PROVIDE GAS PIPING UNIONS
    C. PROVIDE ADEQUATE AMOUNT OF FLEXIBLE OIL HOSE

PUMP SCHEDULE

GENERAL					MECHANICAL									ELECTRICAL		NOTES
EQUIP NO.	LOCATION	APPLICATION	MANUFACTURER	MODEL NO.	TYPE	FLUID	GPM	TOTAL DISCHARGE HEAD (FT)	BHP	MOTOR RPM	IMPELLER SIZE (IN)	SUCTION SIZE (IN)	DISCHARGE SIZE (IN	HP OR LOAD	VOLTAGE & PHASE	
P-7	BOILER ROOM	BOILER 1	GRUNDOS	TPE3 80-180 S-A-G-A-BQQE-ICB	IN-LINE	35% P.G.	270	15	1.63	3900	3.54	6	6	3	480/3	1
P-8	BOILER ROOM	BOILER 1	GRUNDOS	TPE3 80-180 S-A-G-A-BQQE-ICB	IN-LINE	35% P.G.	270	15	1.63	3900	3.54	6	6	3	480/3	1
P-24	BOILER ROOM	WH-1	TACO	1915e-F	IN-LINE	35% P.G.	81	16.6	0.75	3900	-	2	2	0.75	208/1	2
P-25	BOILER ROOM	WH-1	TACO	1915e-F	IN-LINE	35% P.G.	81	16.6	0.75	3900	-	2	2	0.75	208/1	2
P-26	BOILER ROOM	WH-1 - TANK CIRCULATION	TACO	0012-SF4-1	IN-LINE	WATER	26	10	0.13	3250	-	1-1/2	1-1/2	0.13	115/1	2
P-27	BOILER ROOM	WH-1 - TANK CIRCULATION	TACO	0012-SF4-1	IN-LINE	WATER	26	10	0.13	3250	-	1-1/2	1-1/2	0.13	115/1	2

NOTES:

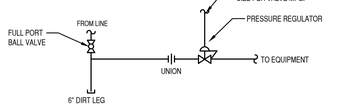
1. EC MOTOR WITH INTEGRAL CONTROLLER
2. PUMP PROVIDED WITH WH-1

WATER HEATER SCHEDULE

EQUIP NO.	MANUFACTURER	MODEL NO.	STORAGE CAPACITY (GAL)	DOMESTIC WATER SIDE FLUID	FLOW RATE (GPM)	INLET TEMP. (°F)	OUTLET TEMP (°F)	PRESSURE DROP (PSIG)	HEAT TRANSFERRED (BTUH)	BOILER WATER SIDE FLUID	FLOW RATE (GPM)	INLET TEMP. (°F)	OUTLET TEMP (°F)	PRESSURE DROP (PSIG)	V/PH/HZ	NOTES
WH-1	DHT DIVERSIFIED	CM233-STP-D222D-500G-P	500	WATER	53	40	130	0.1	2,385,000	35% P.G.	162	135	103	2	120/1/60	ALL

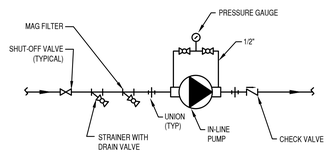
NOTES:

1. FULLY ASSEMBLED SKID MOUNTED PACKAGE INCLUDING TANK CIRCULATION PUMP, VFD DRIVEN BOILER WATER PUMPS, DUPLEX HEAT EXCHANGERS AND CONTROL PACKAGE.



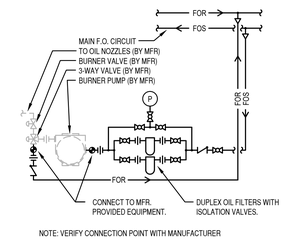
4 M300 GAS CONNECTION

NOT TO SCALE QMF NO. 07-7017 ISSUE NO. 01



3 M300 INLINE PUMP DETAIL W/O SUCTION DIFFUSER

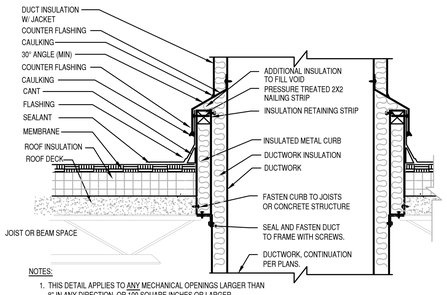
NOT TO SCALE QMF NO. 07-6049 ISSUE NO. 01



NOTE: VERIFY CONNECTION POINT WITH MANUFACTURER

2 M300 BOILER BURNER FUEL OIL P. & I.D.

NOT TO SCALE QMF NO. 07-6014 ISSUE NO. 01



NOTES:

1. THIS DETAIL APPLIES TO ANY MECHANICAL OPENINGS LARGER THAN 8" IN ANY DIRECTION, OR 100 SQUARE INCHES OR LARGER.
2. SECURE CURB CAP TO PRESSURE TREATED WOOD NAILING STRIP WITH 3/8" CADIUM PLATED LAG BOLTS NOT OVER 12" ON CENTER.
3. SECURE ROOF CURB, DUCTWORK TO ROOF WITH STAINLESS STEEL EXPANSION BOLTS.
4. PROVIDE CAULKING AT 4 CORNERS OF COUNTER FLASHING AND ON DUCT JACKET.
5. ROOF TYPE MAY VARY ON PROJECT. SEE ARCH DRAWINGS FOR CORRECT ROOF TYPE.

1 M300 DUCT THROUGH ROOF

NOT TO SCALE QMF NO. 07-5109 ISSUE NO. 01

No:	Date:	By:	Revision:

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Project Title: GOODHUE COUNTY LAW ENFORCEMENT CENTER BOILER AND WATER HEATER REPLACEMENT

460 WEST SIXTH STREET
REDWING, MN 55066

Sheet Title: MECHANCIAL SCHEDULES AND DETAILS

Date:	8/18/2022
Drawn By:	CRE
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Project No:	22-0188.00
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Revision Number: 0

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COMMON CONTROL NOTES

A. CONTROL DEVICE COMPATIBILITY
1. Contractor shall be responsible for notifying the design team prior to final controls point check-out if any new or existing controls devices or equipment (valves, dampers, actuators, sensors, controllers, etc.) are not capable of meeting the designed sequence of operations.

B. DDC POINT ADJUSTABILITY DEFINITION
1. Front graphic page setpoints, (adj.)
   a. Software point values followed by (adj.) shall be adjustable by operators on front graphic screens. These values are expected to be adjusted frequent by operators.
2. Back graphic page setpoints, (mod.)
   a. Software point values followed by (mod.) shall be modifiable by operator on back graphic screens. These values may be rarely adjusted by more advanced operators. These values shall be placed on back graphic screens, requiring two mouse clicks to access. Intent is to guide operators toward (adj.) values first, and allow advanced users to drill-down deeper and modify the (mod.) setpoints when required.
3. Parameters
   a. Software point values without any following annotations are not required to be placed on graphic screens. However, modifications to these values shall be readily available using software programming tool. It is not acceptable to require additional steps, such as downloading controllers to apply these modifications.
4. Hardware Points
   a. Operator override of hardware input and output points is required. Operators with more advanced privileges override these points.

C. NETWORK COMMUNICATION FAILURE VALUE
1. For every network communicated value apply one of these strategies.
2. Evaluate failure by using communication status method provided by controls manufacturer.
3. Primary-Last Value
   a. When device communication associated with the primary input fails, programming shall hold last known primary input value until communication is restored.
4. Primary-Secondary-Last Value
   a. When device communication associated with the primary input fails, programming shall immediately pass the secondary input value instead.
      i. When device communication associated with the primary input is restored, programming shall immediately restore the use of the primary input.
   b. If secondary input value is in use and device communication associated with the secondary input fails, programming shall hold last known secondary input value until communication associated with secondary input is restored.
5. Primary-Failsafe Value
   a. When device communication associated with the primary input value fails, programming shall hold the last known primary input value for 15 minutes.
      i. After delay time expires, then the failsafe value is used until communication is restored.
   b. When device communication associated with the primary input value is restored, programming shall restore the use of the primary input value after 5 minutes.
6. Primary-Secondary-Failsafe Value
   a. When device communication associated with the primary input fails, programming shall immediately pass the secondary input value instead.
      i. When device communication associated with the primary input is restored, programming shall restore the use of the primary input.
   b. If secondary input value is in use and device communication associated with the secondary input fails, programming shall hold last known secondary input value for 15 minutes.
      i. After delay time expires, then the failsafe value is used until communication is restored.

D. MOTOR CONTROL
1. Fans and pumps with VFDs:
   a. Each VFD shall include a minimum of three points – DDC outputs to issue command and speed, and DDC input to receive frequency feedback (Hz). It is acceptable to read frequency via BACnet integration, but command and speed must be hardwired.
   b. Frequency shall be used to determined motor status. If the frequency feedback is greater than 8 Hz the motor shall be considered on. Virtual status value shall be included on the graphics.
2. Fans and pumps with combination motor starters or disconnects:
   a. Each motor/combination motor starter or disconnect shall include two wired points – DDC output to issue command, and DDC input to receive status.
   b. The wired point for command, and status shall be displayed on unit graphic.

HARDWARE POINTS	AI	AO	DI	DO	INT	NET	FAIL POS	NOTES
VFD Command				1				A
VFD Speed		1						
VFD Frequency (Hz)	1				R			
Motor Command				1				A
Motor Current (Amps)	1							

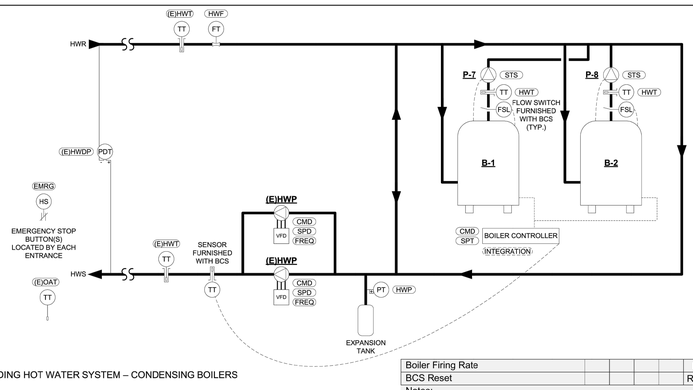
Notes:
A. Provide additional hardwired safety to stop the unit, taking priority over any local hand overrides.

E. ALARMING - TYPICAL
1. It is required that a logical and consistent alarm strategy be used. The alarm strategy described here may be used or an alternative strategy may be submitted for engineer's approval prior to implementation. The typical alarms listed here show common situations. It is expected that additional alarms shall be added when applicable or when specified in equipment sequence of operation or mechanical drawings.
2. If the Owner has a standardized alarming scheme, follow their requirements.
3. Full point name shall be included in every alarm message, including the name of the mechanical system, and building, as required.
4. These steps shall be taken to prevent nuisance alarming. False alarms can quickly fill alarms logs causing real alarms to get overlooked.
   a. All indicated alarm threshold, limit, and time delay values to be user adjustable.
   b. Configure appropriate alarm deadband values to prevent rapid cycling of alarm transitions.
5. Alarm routing via email and/or text shall be configured and sent to desired Owner staff.
6. Classes: Three alarm classes as described here shall be programmed for each building. Create a separate console recipient for the three classes at each building. Intent is to provide a limited view of alarms in the log that pertain only to a particular building.
   a. Level 3 - Class for maintenance type notifications. Log is checked daily/weekly.
   b. Level 2 - Class for most alarms. Log is checked throughout the day.
   c. Level 1 - Class for critical alarms. Emails are sent immediately.
7. Types: Four alarm types as described here shall be programmed.
   a. Supervisory Alarms, where the BAS system monitors itself. Programming to issue an alarm when a predicted result is not achieved as the result of a programmed control action, typically applies to outputs.
      i. Command fail alarm shall be sent to the BAS any time a fan or pump start/stop and status don't match for 2 minutes (adj.).
   b. Range Alarms, where an input sensor is outside of its pre-defined operating range. Indicates when a sensor has failed, power to the sensor has failed, wiring has been shorted or opened, etc. It is required to determine how every controller reads both an open and short for every input and program a specific range alarm for each.
   c. Absolute Alarms, where an input sensor is above or below a fixed threshold or where an alarm contact closes.
   d. Communication Alarms, where a controller is offline for 10 minutes.

F. HISTORY TRENDING - TYPICAL
1. It is required that a logical and consistent history trend strategy be used. The history trend strategy described here may be used or alternative strategy may be submitted for engineer's approval prior to implementation. The typical history trends listed here show common situations, it is expected that additional history trends be added when applicable.
2. History trend extensions shall be added and configured for every hardware point and every calculated software point that changes automatically by way of program logic.
3. Full point name shall be included in every trend name, including the name of the mechanical system, and building, as required.
4. All indicated trend configuration parameter values to be user adjustable.
5. Change of Value (COV) trends are where a sample is logged whenever the value changes by a specified amount. Use for boolean and enumerated points.
6. Interval trends are where a sample is logged according to a preset regular time interval. Use for numeric points.

G. POINT NAMING - TYPICAL
1. It is required that a logical and consistent point naming strategy be used. If the client currently has a naming convention in place, this shall be used.
2. Actual point names of Boolean, Numeric, Enumerated and String points shall be simple short names that are repeated as much as possible throughout system to take advantage of batch commands.
3. Title case is used in this naming strategy to efficiently group abbreviations without the need to use several separator characters. When it is prudent to use a separator character, the use of the underscore character is preferred over spaces or dashes.

H. POINT NAMING, ALARMING AND HISTORY TRENDING
Refer to specification section 23 09 23, Direct Digital Control for HVAC, for additional details and examples.



BUILDING HOT WATER SYSTEM – CONDENSING BOILERS

A. ADDITIONAL REFERENCE
1. See Common Controls Notes for additional information related to this sequence.
2. See specifications sections 23 09 00 and 23 09 23 for additional information related to this sequence.

B. EMERGENCY SAFETY/LIMIT CONTROLS
1. The safety devices listed in this paragraph must be hardwired. They shall not be passed via software through any building automation system (BAS) controller.
2. A secondary set of contacts from each type of device shall be input to the BAS and a software alarm generated upon change of state.
3. Safety contacts shall be wired such that a closed circuit is a normal condition whenever possible.
4. Provide emergency shutdown buttons that require twist or pull to reset, and have clear hinged covers to prevent accidental shutdown.
   a. Located at every entrance to the boiler mechanical room, buttons shall immediately stop all boiler(s) when pressed.
5. Confirm the following safety devices have been furnished with each boiler and have been installed by others. Confirm or complete the required wiring from each safety device to boiler per manufacturer's instruction. Boilers shall not operate, no gas ignition, if any safety device senses an alarm condition. Common alarm status from boiler via integration shall serve for monitoring on BAS.
   a. Proof of water flow interlock switch.
   b. Proof of combustion air flow interlock switch.
   c. Low gas pressure interlock switch.
   d. High gas pressure interlock switch.
   e. Low water cutout interlock switch.
   f. High temperature limit interlock switch.
   g. Any and all other required safety interlock switches.

HARDWARE POINTS	AI	AO	DI	DO	INT	NET	FAIL POS	NOTES
Emergency Shutdown Buttons			1					A
Boiler Alarm					R			B

Notes:
A. A single digital input point may be used to monitor all buttons.
B. Separate point required for each boiler.

C. MAIN CONTROL
1. The heating water (HW) System shall always be enabled unless manually disabled by the operator.
2. When the HW system is enabled, the boiler(s) shall operate through the boiler control system (BCS) package provided with the boiler(s).
3. The BCS shall be capable of completely independent control via local display/keypad on the boilers if necessary.

HARDWARE POINTS	AI	AO	DI	DO	INT	NET	FAIL POS	NOTES
Outside Air Temperature						1	0 F	A
BCS Command				1			On	

Notes:
A. Only one sensor required for building, value to be shared over network.

D. BOILER CONTROL
1. BAS shall enable, and provide a setpoint to the BCS. Provide required wiring manufacturer's instruction.
2. Confirm the well type temperature sensor furnished with the boiler(s) has been installed in the secondary HW loop after the pumps. Complete the required wiring to the boiler(s) per manufacturer's instruction.
3. Provide all required communication wiring and other field wiring for the boiler(s), BCS, and primary pump(s) as required per manufacturer's instruction.
4. HW System Enabled:
   a. Elected pump(s) shall be enabled.
   b. Upon proof of status for enabled pump(s) for 2 minutes (adj.), the BCS shall be enabled.
   c. BCS shall be configured by equipment provider to operate according to the boiler manufacturer's published sequence of operation. A summary of the desired control is listed here.
      i. BCS shall enable/disable and modulate boilers to most efficiently meet system load. When multiple boilers are enabled, all boilers shall fire at the same rate. The minimum on time of any boiler shall be 5 minutes to avoid short-cycling the burner.
      ii. BCS shall rotate boilers to equalize run time, and provide fail-over operation to enable stancby boilers in the event of a boiler failure.
      iii. BCS shall enable/disable associated primary pump(s) to allow boiler(s) to perform most efficiently. This shall include optimum pre- and post-purge firing speeds, and continued run after boiler stops firing to capture residual heat.
      iv. BCS shall modulate boiler's burner to maintain secondary HW loop supply temperature at resetting supply water temperature at setpoint, set from BAS.
         a. As outside air temperature drops from 50°F to -10°F the HW supply temperature will reset between 135°F and 180°F (all adj.).
      v. Provide a back-up option for HW system temperature control that allows continuous HW system operation if the controlling sensor fails.
      vi. Each boiler shall have its own HW supply temperature sensor, and control using this sensor has a high modulating temperature limit for the respective boiler. Set at 170°F (adj.).
5. HW System Disabled:
   a. BCS shall be disabled. Boiler(s) and associated primary pump(s) shall gradually ramp down and shut off.
   b. Secondary pump(s) shall be disabled once primary pump(s) have been disabled.
6. Boiler(s) are provided with open protocol communication interface(s) as required for hardware integration into BAS. Provide any additional hardware devices or protocol convertors required to connect to BAS.
7. At a minimum, the listed integrated software points shall be available from BCS. Integrated points shall be displayed on graphics. If integrated software point is not available, provide devices and hardware points as required to provide these values.
8. Include time to gather and research the information necessary to complete the integration. This includes equipment interface configuration, addressing Instruction, integrated point descriptions, etc.

HARDWARE POINTS	AI	AO	DI	DO	INT	NET	FAIL POS	NOTES
BCS Command				1			On	
Boiler Water Flow Proof					R			B
Primary Pump Command					R			
Primary Pump Status			2					B
BCS Alarm – Dry Contact					R			
BCS Alarm – Status Message					R			
BCS Mode – Status Message					R			
Boiler Alarm – Status Message					R			B
Boiler Mode – Status Message					R			B
BCS Supply Water Temp Setpoint		1					Max Spt	
Boiler Leaving Water Temp	2							A, B
Boiler Leaving Water Temp					R			B
Boiler Firing Rate					R			B
BCS Reset					R/W			

Notes:
A. Second sensor shall be provided as a troubleshooting reference for comparison.
B. Separate point required for each boiler.

E. SECONDARY PUMP CONTROL
1. Refer to Common Controls Notes for details on pump motor status.
2. When HW System is enabled the lead pump shall be enabled. Pump shall be disabled otherwise.
3. Lead/Lag rotation method shall be selectable between user command, schedule, or runtime. Runtime difference changeover setpoint shall be initially set to 168 hours (adj.) and displayed on graphics. Initial rotation method shall be selected as runtime.
4. When rotating pumps, the new lead shall enable and ramp up to speed as the new lag ramps down to minimum speed and disables.
5. If a pump fails, the next available pump shall be enabled and the failed pump shall remain enabled. Once status returns on failed pump, failover strategy shall automatically be reset and the additional pump shall be disabled.
6. Pump speed shall modulate to maintain the differential pressure. Differential pressure sensor shall be located 2/3 down the longest piping run or as shown on drawing. All running pumps shall modulate in unison, equal speeds.
7. If pump speed exceeds 95% (adj.) for 5 minutes (adj.) the next available pump shall enable. If pump speed drops below 60% (adj.) for 5 minutes, the additional pump shall be disabled.
8. Speed signal shall only be sent to pumps that are enabled or status is on. Otherwise pumps shall receive a zero speed signal.

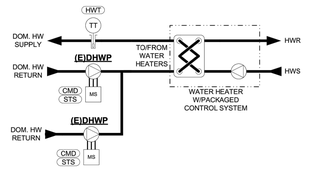
HARDWARE POINTS	AI	AO	DI	DO	INT	NET	FAIL POS	NOTES
Pump VFD Command				2			Off	
Pump VFD Frequency (Hz)	2							
Pump VFD Speed		2					Min	
HW Differential Pressure	1							
HW System Flow	1							

Notes:
A. Values to be shared from other controllers.

F. MISCELLANEOUS MONITORING
1. In addition to all the required typical alarms described in the "ALARMS – Typical" portion of the Direct Digital Control for HVAC section 230923, the following non-typical alarms shall be created:
   a. Hot water system pressure may fall too low, indicating loop needs to be filled. Low limit alarms shall be sent to the BAS anytime the system static pressure sensor reads below the low limit threshold for 10 minutes. This threshold to be 30% less than the required system pressure determined during start-up. "HW System Fill Pressure Low."
   b. When HW System is enabled, and HW supply temperature falls 15°F below setpoint for 15 minutes, issue an alarm on the BAS. "HW System Low Temperature."

HARDWARE POINTS	AI	AO	DI	DO	INT	NET	FAIL POS	NOTES
HW System Return Pressure	1							
HW Supply Temperature	1							

Notes:



DOMESTIC HOT WATER HEAT EXCHANGER SEQUENCE

A. ADDITIONAL REFERENCE
1. See Common Controls Notes for additional information related to this sequence.
2. See specifications sections 23 09 00 and 23 09 23 for additional information related to this sequence.

B. PUMP CONTROL
1. System shall be indexed to occupied and unoccupied mode according to a time schedule. Applied schedule shall be selectable on graphic with the following options: Always Unocc, Always Occ, Bldg Sched 1, Bldg Sched 2, or Custom Sched.
2. The pump shall be on while occupied and off while unoccupied.
3. Pump command and status shall be displayed on graphic.
4. The domestic hot water supply temperature shall also be monitored.

HARDWARE POINTS	AI	AO	DI	DO	INT	NET	FAIL POS	NOTES
DHW Pump Command				2				
DHW Pump Status			2					
DHW Supply Temperature	1							
Notes:								

C. HEAT EXCHANGER CONTROL
1. Heat exchanger contains packaged controls, which shall be integrated via BACnet. Domestic hot water setpoint shall be adjustable from the BAS. All other points are read-only.

HARDWARE POINTS	AI	AO	DI	DO	INT	NET	FAIL POS	NOTES
DHW Setpoint		1					Max Spt	
DHW Outlet Temp					R			
DCW Inlet Temp					R			
Over Temp Alarm					R			
Flow					R			
Pump Status					R			
Pump Speed					R			
Peak Temp					R			
Average Temp					R			
Low Temp					R			
Notes:								

D. ADDITIONAL ALARMING
1. Absolute Alarms
   a. Cold domestic hot water temperature, low limit alarm shall be sent to the BAS anytime the domestic hot water supply temperature sensor reads below 100 °F (adj) for 5 minutes when occupied. Alarm is to be disabled when unoccupied. "Domestic Hot Water is Cold"

Common alarm from integrated hot water heater points. "Domestic Hot Water Heater Alarm"

No:	Date:	By:	Revision:

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Project Title:
GOODHUE COUNTY LAW ENFORCEMENT CENTER BOILER AND WATER HEATER REPLACEMENT
460 WEST SIXTH STREET
REDWING, MN 55066

Sheet Title:
CONTROL SCHEMATIC AND SEQUENCES

Date:	8/18/2022
Drawn By:	CRE
Checked By:	ZCT
Project No:	22-0188.00
DWG Scale:	AS NOTED
Sheet Size:	30x42

Revision Number: 0
Sheet Number: M400

SINGLE LINE DIAGRAM SYMBOLS

SCREENED LINES INDICATE EXISTING CIRCUITS OR EQUIPMENT

SOLID LINES INDICATE NEW CIRCUITS OR EQUIPMENT

O C — ALL WORK BY CONTRACTOR, EXCEPT AS NOTED BY CONTRACT BOX. LEFT SIDE INDICATES SUPPLIER AND RIGHT SIDE INDICATES INSTALLER.
- 0 - OWNER
- C - CONTRACTOR
- # - CONTRACT NUMBER

DISCONNECT SWITCH

FUSE IN HOOKSTICK-OPERABLE MOUNTING

FUSE

400A 3P — CIRCUIT BREAKER

DRAW-OUT FUSE

52-12 1200A — POWER CIRCUIT BREAKER, MEDIUM AND HIGH VOLTAGE

E.O. 1200AF 1200AT — CIRCUIT BREAKER, DRAW-OUT
- E.O. - ELECTRICALLY OPERATED
- M.O. - MANUALLY OPERATED

XF-1 — 13.8kV 2500kVA 480V — TRANSFORMER
- DELTA CONNECTION
- WYE CONNECTION
- GRD. WYE CONNECTION
- OPEN DELTA CONNECTION

4160V-120V (1) — POTENTIAL TRANSFORMER
- (1) NUMBER OF PT'S
- 4160-120V - PT RATIO

BATTERY

FVNR — MOTOR STARTER
- NEMA SIZE AS INDICATED
- TYPE AS INDICATED:
- FVNR- FULL VOLTAGE NON-REVERSING
- FVR- FULL VOLTAGE REVERSING
- FVC- FULL VOLTAGE CONTACTOR
- RV- REDUCED VOLTAGE
- 2SPR- TWO SPEED REVERSING
- DPC- DEFINITE PURPOSE CONTACTOR

4 — INDICATES APPLICABLE CONTROL SCHEMATIC DIAGRAM

.5uF — CAPACITOR

750 — MOTOR
- 750 - HORSEPOWER

PM — METER
- AM - AMMETER
- FM - FREQUENCY METER
- PFM - POWER FACTOR METER
- PM - POWER MONITOR
- VM - VOLTMETER
- VAR - VARMETER
- WM - WATTMETER
- ET - ELAPSE TIME METER

WMT — TRANSDUCER
- AT - CURRENT TRANSDUCER
- PFT - POWER FACTOR TRANSDUCER
- VT - VOLT TRANSDUCER
- WT - WATT TRANSDUCER
- WMT - WATTMETER TRANSDUCER

CS — ROTARY SWITCH
- AS - AMMETER SWITCH
- VS - VOLTMETER SWITCH
- TS - TEST SWITCH
- 43 - SELECTOR SWITCH
- CS - CONTROL SWITCH
- SS - SYNCHRONIZING SWITCH

PB — CONTROL STATION
- Pa - START-STOP PUSHBUTTONS
- R - RUN INDICATING LIGHT
- Pb - JOG PUSHBUTTON
- Pc - OPEN-CLOSE PUSHBUTTONS
- Pd - OPEN-STOP-CLOSE PUSHBUTTONS
- Pe - FORWARD-REVERSE PUSHBUTTONS
- PI - NORMAL-STOP-BACKWASH PUSHBUTTONS
- HOA - HAND-OFF-AUTO MAINT. SELECTOR SW
- PB - PUSH TO STOP - PULL TO RUN PUSHBUTTON

VFD — VARIABLE SPEED DRIVE

K — KEY INTERLOCK, KIRK OR EQUAL

E — ELECTRICAL INTERLOCK

SWITCHBOARD, LOW VOLTAGE DISTRIBUTION

BUS

TRIP SIGNAL FROM RELAY TO DEVICE

RELAY OR CONTROL CIRCUIT CONNECTION

OR — RELAY OR CONTROL CIRCUIT CROSSING WITH NO CONNECTION

1 1 — CABLE SPLICE
- 1-TYPE NUMBER DEFINED BY SPECIFICATIONS

1 — CABLE TERMINATOR

STG — GENERATOR
- STG - STEAM TURBINE DRIVEN
- CTG - COMBUSTION TURBINE DRIVEN
- EG - ENGINE DRIVEN

INDICATES SWITCHGEAR OR EQUIPMENT GROUP BOUNDARIES

SG1 100XS — INDICATES CONNECTION TO DISTRIBUTED CONTROL SYSTEM
- SG1100XS - TAG NUMBER

GROUND CONNECTION

INDICATES REMOVAL OF DEVICE

N S E L — AUTOMATIC TRANSFER SWITCH

5-PPL-0-01 — PANELBOARD

UTILITY SOURCE

PLAN SYMBOLS

DISTRIBUTION PANELBOARD

RECESSED PANELBOARD

SURFACE MOUNTED PANELBOARD

20 — MOTOR (20 HP)

MOTOR STARTER

DISCONNECT

COMBINATION MOTOR STARTER/DISCONNECT

DUPLEX RECEPTACLE

SW — SPECIAL RECEPTACLE (WELDING)

DATA RECEPTACLE

PHONE RECEPTACLE

POWER AND DATA FLOORBOX

MS — MOTOR RATED STARTER SWITCH

GROUNDING PLAN SYMBOLS

COPPER GROUND ROD, 5/8" X 10'-0" LONG

GROUND CONNECTION TO EQUIPMENT

IRREVERSIBLE COMPRESSION CONNECTOR

GROUNDING PIGTAIL

2" X ¼" X 24" GROUND BUS BAR

#4/0 AWG BARE STRANDED COPPER.

#4/0 AWG CONTINUOUS BARE STRANDED COPPER GROUND CONDUCTOR TO BE RUN IN CABLE TRAY.

ABBREVIATIONS

A OR AMP	AMPERE
AB	ABOVE BACKSPLASH
AC	ALTERNATING CURRENT
A/C	AIR CONDITIONING
ADA	AMERICANS WITH DISABILITIES ACT
ADD	ADDENDUM
ADJ	ADJACENT
ADJS	ADJUSTABLE
AFF	ABOVE FINISHED FLOOR
AHU	AIR HANDLING UNIT
AIC	AMPERE INTERRUPTING CAPACITY
ALT	ALTERNATE
AL	ALUMINUM
AMPL	AMPLIFIER
APPROX	APPROXIMATELY
ARC	ARC FAULT
ARCH	ARCHITECT
AUTO	AUTOMATIC
C	CONDUIT
CAB	CABINET
CB	CIRCUIT BREAKER
CLG	CEILING
CCT	CIRCUIT
CCTV	CLOSED CIRCUIT CAMERA/TV
COND	CONDUCTOR
CONTR	CONTRACTOR
CR	CRITICAL
CTR	COUNTER
CU	COPPER
DC	DIRECT CURRENT
DET	DETAIL
DIA	DIAMETER
DISC	DISCONNECT
DN	DOWN
DWG	DRAWING
EA	EACH
EC	ELECTRICAL CONTRACTOR
EF	EXHAUST FAN
EH	ELECTRIC HEAT
ELEC	ELECTRIC / -AL)
ELEV	ELEVATOR
EMERG	EMERGENCY
EMT	ELECTRICAL METALLIC TUBING
ENCL	ENCLOSURE
EP	ELECTRIC PNEUMATIC
EPO	EMERGENCY POWER OFF
EQUIP	EQUIPMENT
EWC	ELECTRIC WATER COOLER
EXH	EXHAUST
EXIST	EXISTING
F	FUSE
FA	FIRE ALARM
FA-SD	FIRE ALARM SMOKE DETECTOR
FA-S	FIRE ALARM STROBE LIGHT
FA-SL	FIRE ALARM SPEAKER STROBE
FA-PS	FIRE ALARM PULL STATION
FA	FIRE ALARM
FC	FOOT CANDLE
FCU	FAN COIL UNIT
FIN	FINISHED
FLOUR	FLUORESCENT
FLR	FLOOR
FREQ	FREQUENCY
FSD	FIRE SMOKE DAMPER
FSS	FUSED SAFETY SWITCH
FT	FEET
FVNR	FULL VOLTAGE NON-REVERSING
FVR	FULL VOLTAGE REVERSING
GC	GENERAL CONTRACTOR
GEN	GENERATOR
GFI	GROUND FAULT INTERRUPTER
GR	GRADE
GRC	GALVANIZED RIGID CONDUIT
GRD	GROUND
HC	HANDICAP
HOA	HAND-OFF AUTO SWITCH
HOR	HORIZONTAL
HP	HORSEPOWER
HPS	HIGH PRESSURE SODIUM
HT	HEIGHT
HTR	HEATER
HZ	HERTZ
IG	ISOLATED GROUND
IN	INCH
INC	INCANDESCENT
INSUL	INSULATION
J-BOX	JUNCTION BOX
KV	KILOVOLT
KVA	KILOVOLT-AMPERE
KW	KILOWATT
KWH	KILOWATT HOUR
LED	LIGHT EMITTING DIODE
LS	LIFE SAFETY
LTG	LIGHTING
MA	MASTER ANTENNA
MAX	MAXIMUM
MC	MOMENTARY CONTACT
MCA	MINIMUM CIRCUIT AMPERE
MCC	MOTOR CONTROL CENTER
MCP	MOTOR CIRCUIT PROTECTOR
MECH	MECHANICAL
MEZZ	MEZZANINE
MFR	MANUFACTURER
MH	METAL HALIDE
MIC	MICROPHONE
MIN	MINIMUM
MS	MAGNETIC STARTER
MSS	MOTOR SENTINEL SWITCH
MT	EMPTY
MTD	MOUNTED
MTR	MOTOR
NEC	NATIONAL ELECTRICAL CODE
NF	NON-FUSED
NFS	NON-FUSED SAFETY SWITCH
NIC	NOT IN CONTRACT
NL	NIGHT LIGHT
NTS	NOT TO SCALE
NOM	NOMINAL
NO OR #	NUMBER
OC	ON CENTER
OD	OUTSIDE DIAMETER
OLSW	OVERLOAD SWITCH
PB	PUSHBUTTON
PF	POWER FACTOR
PH OR Ø	PHASE
PL	PILOT LIGHT
PNL	PANEL
PR	PAIR
PRI	PRIMARY
PRV	POWER ROOF VENTILATOR
PVC	POLYVINYL CHLORIDE CONDUIT
REC	RECESSED
RECEPT	RECEPTACLE
REQD	REQUIRED
RM	ROOM
RMS	ROOT MEAN SQUARE
RPM	REVOLUTIONS PER MINUTE
RTD	RESISTANCE TEMPERATURE DETECTOR
RTU	ROOF TOP UNIT
RVAT	REDUCED VOLTAGE AUTO TRANSFORMER
SEC	SECONDARY
SHT	SHEET
SPEC	SPECIFICATIONS
SQ	SQUARE
SS	STAINLESS STEEL
STD	STANDARD
SUSP	SUSPENDED
SW	SWITCH
SWBD	SWITCHBOARD
TEMP	TEMPERATURE
TF	TRANSFORMER
TS	TOGGLE SWITCH
T-STAT	THERMOSTAT
TYP	TYPICAL
TABC	TRIP & BLOCK CLOSE
UC	UNDER COUNTER
UG	UNDERGROUND
UH	UNIT HEATER
UL	UNDERWRITERS LABORATORY
V	VOLT
VA	VOLT AMPERE
VENT	VENTILATE (-ING OR -ION)
VERT	VERTICAL
VFD	VARIABLE FREQUENCY DRIVE
VOL	VOLUME
W	WATT
WP	WEATHERPROOF
W/	WITH
W/O	WITHOUT
XFMR	TRANSFORMER

MECHANICAL DRAWING INDEX

SCOPE OF WORK:

DEMO EXISTING EQUIPMENT AND PROVIDE POWER TO NEW BOILERS, PUMPS AND WATER HEATERS.

No:	Date:	By:	Revision:

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Project Title:
GOODHUE COUNTY LAW ENFORCEMENT CENTER BOILER AND WATER HEATER REPLACEMENT

460 WEST SIXTH STREET
REDWING, MN 55066

Sheet Title:
ELECTRICAL SYMBOLS & ABBREVIATIONS

Date:	8/18/2022
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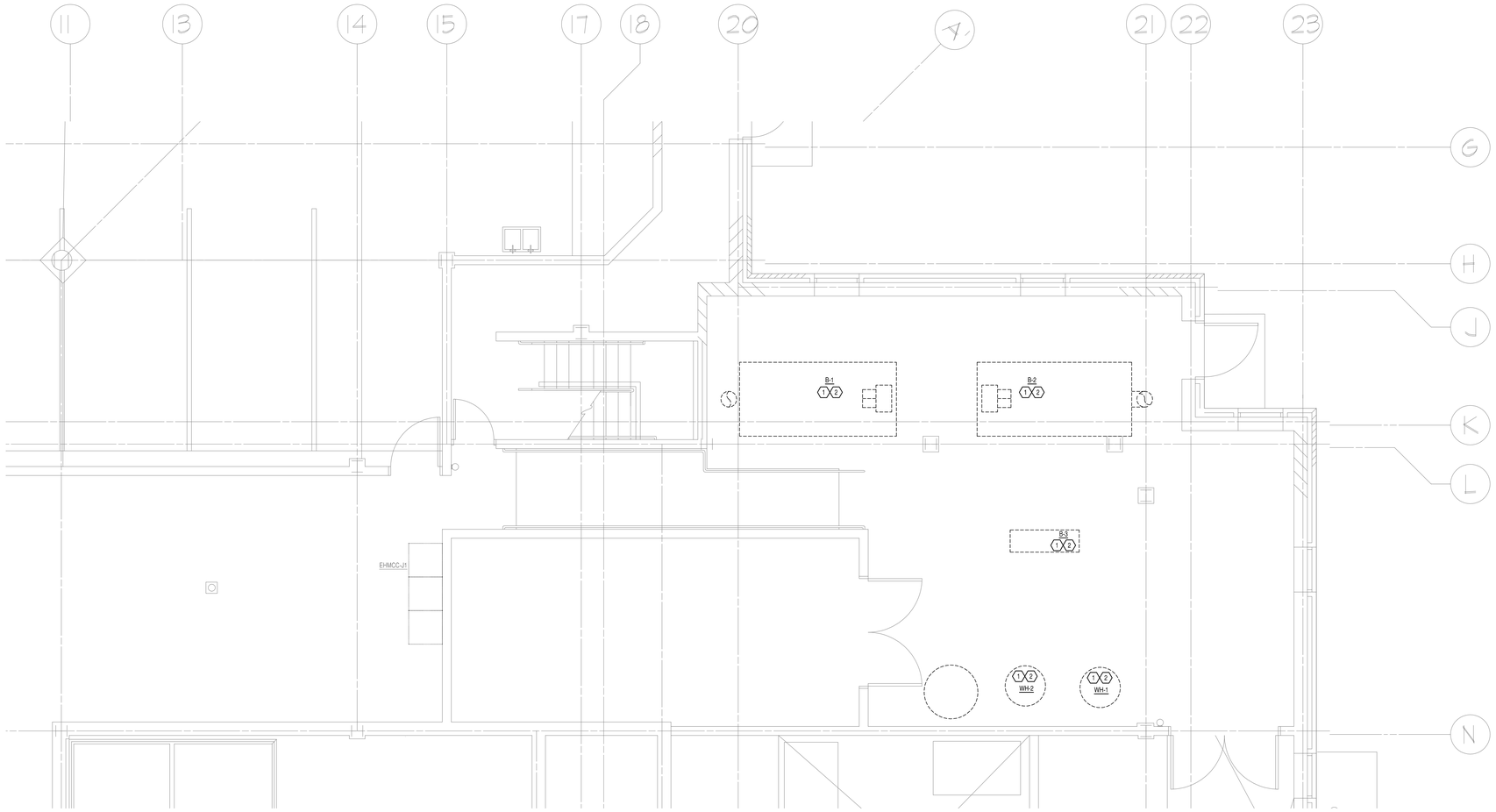
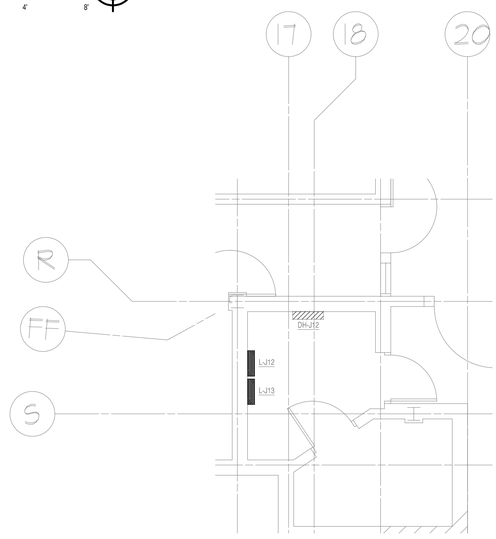


1 BOILER ROOM DEMOLITION PLAN
E100 1/4" = 1'-0"

NORTH

0 2' 4' 8'



2 ELECTRIC ROOM B134A
E100 1/4" = 1'-0"

NORTH

0 2' 4' 8'

DEMOLITION GENERAL NOTES

1. SOME AREAS OF THE FACILITY, OUTSIDE THE DEMOLITION WORK AREA LIMITS, WILL BE OCCUPIED DURING THE DEMOLITION PHASE. VERIFY WHICH ELEMENTS OF DEMOLITION WORK MAY CAUSE DISRUPTION OF SERVICES TO OCCUPIED AREAS, AND NOTIFY OWNER AT LEAST 48 HOURS IN ADVANCE BEFORE DISRUPTING SERVICES. MINIMIZE DISRUPTION OF SERVICES TO OCCUPIED AREAS TO THE GREATEST EXTENT POSSIBLE, INCLUDING SCHEDULING TEMPORARY OUTAGES AFTER NORMAL OCCUPIED HOURS IF SO DIRECTED BY OWNER.
2. PRIOR TO COMMENCEMENT OF DEMOLITION, VERIFY WITH OWNER WHICH COMPONENTS IF ANY, ARE TO BE SALVAGED AND RETURNED TO THE OWNER.
3. FIELD VERIFY ALL COMPONENTS SHOWN TO BE DEMOLISHED BEFORE BEGINNING DEMOLITION WORK.
4. REFER TO ARCHITECTURAL DRAWINGS FOR ALL CONSTRUCTION BOUNDARIES.
5. RE-USE OR REMOVE ALL HANGERS, HARDWARE AND SUPPORTS ASSOCIATED WITH DEMOLISHED CONDUIT AND EQUIPMENT.
6. EXISTING VOICE AND DATA COMMUNICATIONS, AND EGRESS LIGHTING MUST BE MAINTAINED DURING DEMOLITION. PROTECT AND PRESERVE DEVICES, CABLES, CABLE ROUTES, CABLE TRAY AND TERMINATIONS.
7. WHERE CONDUITS/BOXES ARE REMOVED FROM EXISTING FIRE RATED WALLS, THE GENERAL CONTRACTOR SHALL PATCH HOLES TO MATCH EXISTING MATERIALS, METHODS AND WALL RATINGS, EXCEPT WHERE PENETRATIONS ARE SHOWN TO BE REUSED FOR INSTALLATION OF NEW WORK.
8. ANY WALL PATCHING THAT IS REQUIRED TO PERFORM THIS WORK SHALL BE INCLUDED. PATCHING SHALL MATCH SURROUNDING MATERIALS.

DEMOLITION DRAWING NOTES:

1. REFER TO ELECTRICAL SPECIFICATIONS "DEMOLITION" SECTION FOR ADDITIONAL INFORMATION.
2. REMOVE ALL DEVICES, WIRE AND CONDUIT BACK TO SOURCE.

LEGEND

- EXISTING ELECTRICAL EQUIPMENT TO REMAIN
- EXISTING ELECTRICAL EQUIPMENT TO BE REMOVED
- NEW ELECTRICAL EQUIPMENT

No:	Date:	By:	Revision:

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Project Title:
GOODHUE COUNTY LAW ENFORCEMENT CENTER BOILER AND WATER HEATER REPLACEMENT

460 WEST SIXTH STREET
REDWING, MN 55066

Sheet Title:
BOILER ROOM DEMO PLAN - ELECTRICAL

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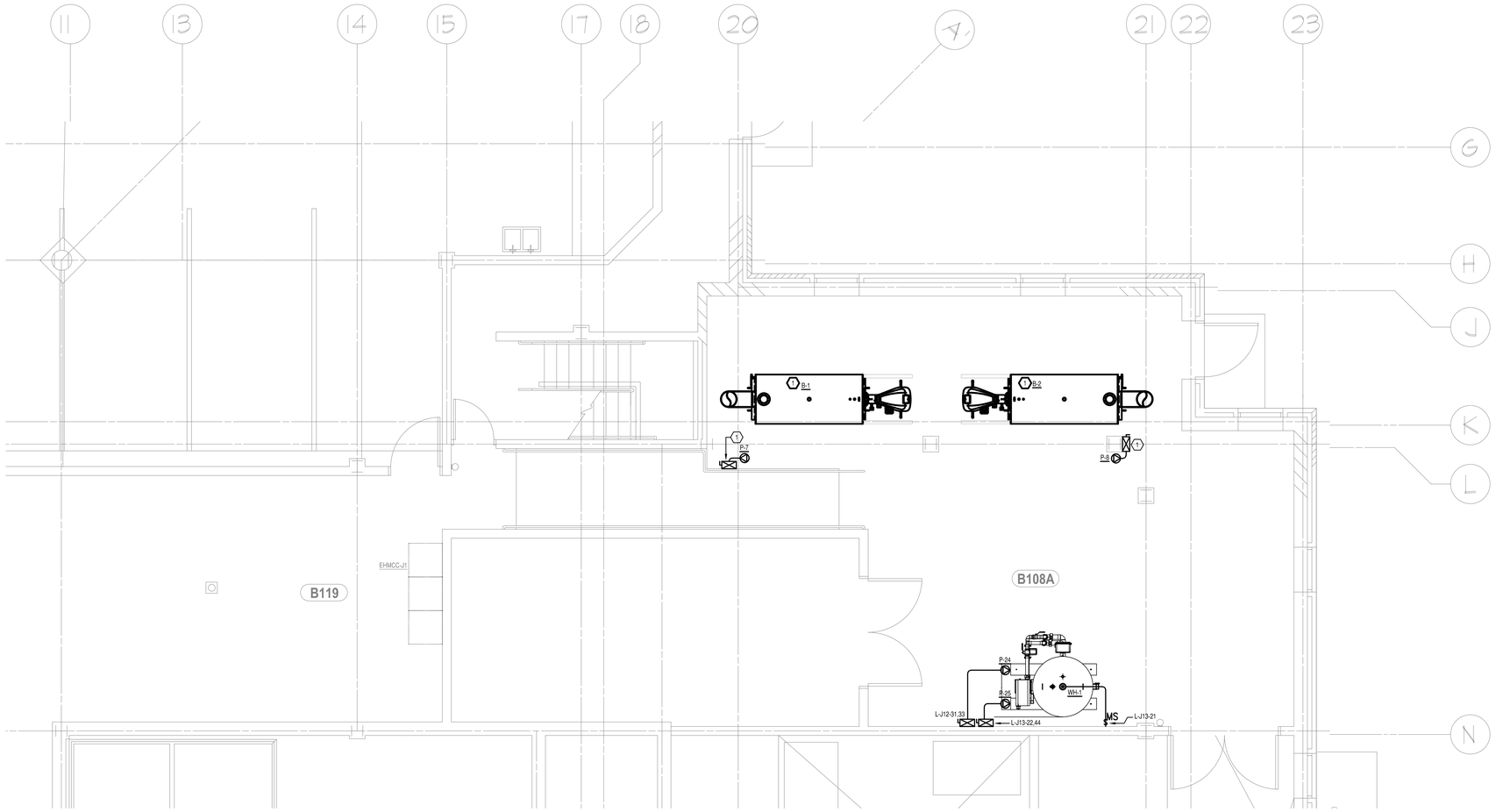
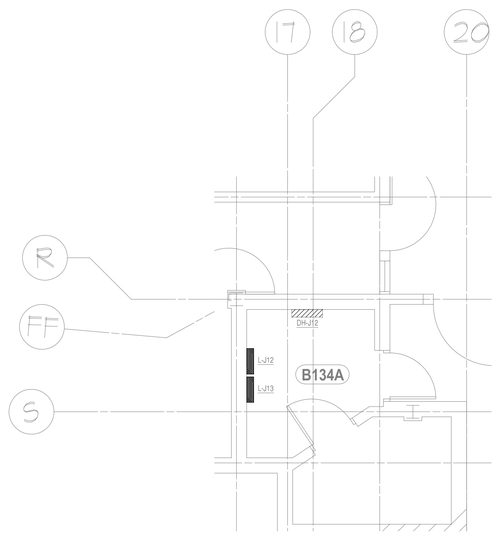


1 E200 BOILER ROOM NEW PLAN - ELECTRICAL
1/4" = 1'-0"
NORTH
0 2' 4' 8'



2 E200 ELECTRIC ROOM B134A
1/4" = 1'-0"
NORTH
0 2' 4' 8'

GENERAL NOTES:

1. ELECTRICAL CONTRACTOR SHALL COORDINATE ALL ELECTRICAL DEVICES IN OR ABOVE ALL CEILINGS WITH ALL DISCIPLINES. ANY DEVIATIONS IN DESIGN, INCLUDING THE SHIFTING OF THE CEILING GRID IN ANY DIRECTION, NEED TO BE APPROVED BY THE ENGINEER.
2. INSTALLATION OF POWER TO THE EQUIPMENT SHALL FOLLOW THE 2020 NATIONAL ELECTRIC CODE.
3. ALL EXISTING CIRCUIT BREAKERS SHALL BE REPLACED WITH NEW IF CIRCUIT IS TO BE USED FOR THE NEW EQUIPMENT.

DRAWING NOTES:

1. REFER TO MECHANICAL EQUIPMENT SCHEDULES ON ELECTRICAL SCHEDULES AND DETAILS SHEET FOR ADDITIONAL INFORMATION.
2.

LEGEND

- EXISTING ELECTRICAL EQUIPMENT TO REMAIN
- EXISTING ELECTRICAL EQUIPMENT TO BE REMOVED
- NEW ELECTRICAL EQUIPMENT

No:	Date:	By:	Revision:

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PRINT NAME: JAMES S. SOMMER

DATE: 8/18/2022 REG. NO.: 54049

KFI ENGINEERS
670 County Road B West
St. Paul, Minnesota 55113
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Project Title:
GOODHUE COUNTY LAW ENFORCEMENT CENTER BOILER AND WATER HEATER REPLACEMENT

460 WEST SIXTH STREET
REDWING, MN 55066

Sheet Title:
BOILER ROOM NEW PLAN - ELECTRICAL

Date:	8/18/2022
Drawn By:	SRA
Checked By:	ZCT
Project No:	22-0188.00
DWG Scale:	AS NOTED
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Sheet Number: E200

MECHANICAL EQUIPMENT SCHEDULE

EQUIPMENT NAME	EQUIPMENT LOCATION	PANEL	BRANCH CIRCUIT SIZE	HP	ELECTRICAL DATA	STARTER TYPE	STARTER PROVIDED BY	STARTER INSTALLED BY	DISCONNECT TYPE	DISCONNECT PROVIDED BY	DISCONNECT INSTALLED BY	NOTES:
P-7	BOILER ROOM	EHMCC-J1	(3) #12 AWG, (1) #12 AWG GND., 3/4" C.	3	480V/3-3991 VA	ECM	MANUFACTURER	ELECTRICAL CONTRACTOR	NEMA 1 HEAVY DUTY	ELECTRICAL CONTRACTOR	ELECTRICAL CONTRACTOR	
P-8	BOILER ROOM	EHMCC-J2	(3) #12 AWG, (1) #12 AWG GND., 3/4" C.	3	480V/3-3991 VA	ECM	MANUFACTURER	ELECTRICAL CONTRACTOR	NEMA 1 HEAVY DUTY	ELECTRICAL CONTRACTOR	ELECTRICAL CONTRACTOR	
P-24	BOILER ROOM	L-J12	(2) #12 AWG, (1) #12 AWG GND., 3/4" C.	0.75	208V/1-1436 VA	ECM	MANUFACTURER	ELECTRICAL CONTRACTOR	NEMA 1 HEAVY DUTY	ELECTRICAL CONTRACTOR	ELECTRICAL CONTRACTOR	
P-25	BOILER ROOM	L-J12	(2) #12 AWG, (1) #12 AWG GND., 3/4" C.	0.75	208V/1-1436 VA	ECM	MANUFACTURER	ELECTRICAL CONTRACTOR	NEMA 1 HEAVY DUTY	ELECTRICAL CONTRACTOR	ELECTRICAL CONTRACTOR	
B-1	BOILER RROM	EHMCC-J1	(3) #12 AWG, (1) #12 AWG GND., 3/4" C.		480V/3-11224 VA	-	MANUFACTURER	MANUFACTURER	NEMA 1 HEAVY DUTY	ELECTRICAL CONTRACTOR	ELECTRICAL CONTRACTOR	
B-2	BOILER ROOM	EHMCC-J1	(3) #12 AWG, (1) #12 AWG GND., 3/4" C.		480V/3-11224 VA	-	MANUFACTURER	MANUFACTURER	NEMA 1 HEAVY DUTY	ELECTRICAL CONTRACTOR	ELECTRICAL CONTRACTOR	
WH-1	BOILER ROOM	L-J13	(2) #12 AWG, (1) #12 AWG GND., 3/4" C.		120V/3-160 VA	-	-	-	UNIT MOUNTED	ELECTRICAL CONTRACTOR	ELECTRICAL CONTRACTOR	

MOTOR CONTROL CENTER SCHEDULE EHMCC-J1(EXISTING)

EQUIPMENT NAME	EQUIPMENT LOCATION	CKT NO.	BRANCH CIRCUIT SIZE	HP	ELECTRICAL DATA	C.B. FRAME SIZE	TRIP	STARTER INSTALLED BY	DISCONNECTION TYPE	DISCONNECTION PROVIDED BY	DISCONNECTION INSTALLED BY	NOTES:
AHU-1 (EXIST)	B119	1	EXISTING	70	480V/3-83100 VA	200A	125	-	-	-	-	
EF-32 (EXIST)	B108	2	EXISTING	1	480V/3-9972 VA	30A	15	-	-	-	-	
BOILER B1	**B108A**	**3**	**(3) #12 AWG, (1) #12 AWG GND., 3/4" C.**	**5**	**480V/3-10756 VA**	**30A**	**20**		**INTEGRAL TO VFD**	**ELECTRICAL CONTRACTOR**		
BOILER B2	**B108A**	**4**	**(3) #12 AWG, (1) #12 AWG GND., 3/4" C.**	**5**	**480V/3-10756 VA**	**30A**	**20**		**INTEGRAL TO VFD**	**ELECTRICAL CONTRACTOR**		
HRU-1 (EXIST)	ROOF	5	EXISTING	15 & 20	480V/3-39888 VA	100A	60	-	-	-		
AHU-4 (EXIST)	B108A	6	EXISTING	2	480V/3-9972 VA	30A	15	-	-	-		
P7	**B108A**	**7**	**(3) #12 AWG, (1) #12 AWG GND., 3/4" C.**	**3**	**480V/3-3991 VA**	**30A**	**15**	**ELECTRICAL CONTRACTOR**	**WALL MOUNTED**	**ELECTRICAL CONTRACTOR**		
P8	**B108A**	**8**	**(3) #12 AWG, (1) #12 AWG GND., 3/4" C.**	**3**	**480V/3-3991 VA**	**30A**	**15**	**ELECTRICAL CONTRACTOR**	**WALL MOUNTED**	**ELECTRICAL CONTRACTOR**		
P9 (EXIST)	B108A	9	EXISTING	0.5	480V/3-13296 VA	30A	20	-	-	-		
P1 (EXIST)	B119	10	EXISTING	3	480V/3-3991 VA	30A	15					
P2 (EXIST)	B119	11	EXISTING	3	480V/3-3991 VA	30A	15					
SPARE		12				30A	---					
SPARE		13				30A	15					
SPARE		14				30A	15					
SPACE		15										
SPACE		16										

TOTAL VA 193704
AMPS 233.10

No:	Date:	By:	Revision:

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Project Title:
GOODHUE COUNTY LAW ENFORCEMENT CENTER BOILER AND WATER HEATER REPLACEMENT
460 WEST SIXTH STREET
REDWING, MN 55066

Sheet Title:
ELECTRICAL SCHEDULES AND DETAILS

Date:	8/18/2022
Drawn By:	SRA
Checked By:	ZCT
Project No:	22-0188.00
DWG Scale:	AS NOTED
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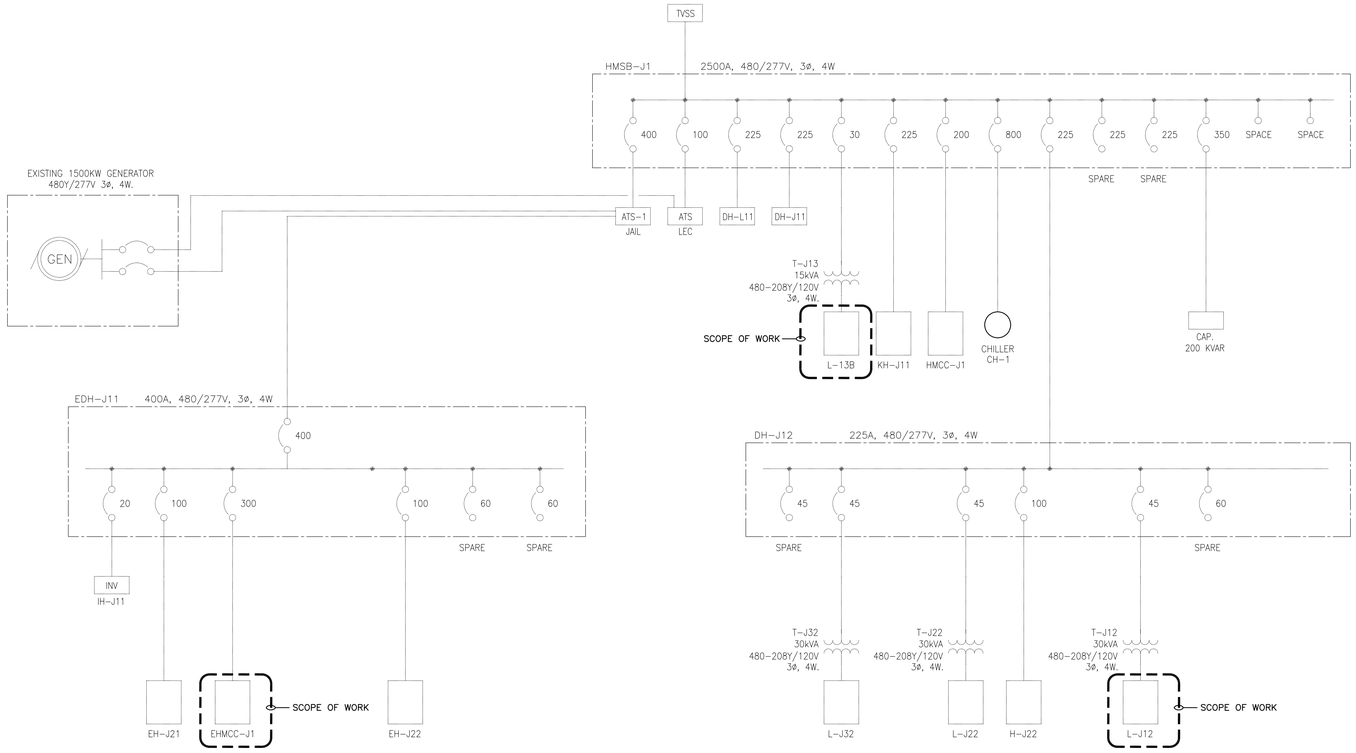

1 E400 PARTIAL ONELINE DIAGRAM
NTS

Location: RM B134A

*	LOAD SUMMARY	CL	DF	CONNECTED LOAD A	B	C	DEMAND TOTAL
L	Lighting		1.25				
R	Convenience Recept						
H	Heating (Space)		1.25				
C	Cooling		1.00				
A	HVAC		1.00				
P	Process	1.44	1.00	0.72	0.72		1.44
O	Other Continuous		1.25				
K	Kitchen						
N	Noncontinuous		1.00				
			1.00				
	Total	**1.44**		0.72	0.72		1.44

Total Demand Load (KVA)	1.44
Total Demand Current (A)	3.98
Min. Feeder Ampacity (A)	4.98

L-J12 (EXISTING)
PANELBOARD DESIGNATION

SYSTEM VOLTAGE	208/120V, 3ø, 4W
BUS SIZE	100A
SYSTEM TYPE	NORMAL
FEEDER PROT	100A-3P C/B
CONDUCTOR SIZE	2 AWG - #6G CU
CONDUCTOR/PHASE	4
MAINS	100A M.O
SCCR	SERIES RATED
MCB RATING	80%
GROUND FAULT	NO
FEEDER LENGTH (FT)	EXISTING
FEEDER V. DROP (%)	EXISTING
FAULT CURRENT	EXISTING
KAIC RATING	10
ENCLOSURE	TYPE 1

	DESCRIPTION	*	CB	KVA	A	B	C	KVA	CB	DESCRIPTION	*	
1	B113, B11 (EXIST)	O	20A-1P						20A-1P	B143 (EXIST)	O	2
3	B111 (EXIST)	O	20A-1P						20A-1P	B140, B141, B142 (EXIST)	O	4
5	B110, B113 (EXIST)	O	20A-1P						20A-1P	B135, B136, B138 (EXIST)	O	6
7	B109, B114 (EXIST)	O	20A-1P						20A-1P	B138 (EXIST)	O	8
9	B134A, B134B (EXIST)	O	20A-1P						20A-1P	B126, B133 (EXIST)	O	10
11	WASHER (EXIST)	P							20A-1P	B132, B133 (EXIST)	O	12
13		P	15A-3P						20A-1P	B133 (EXIST)	O	14
15		P							20A-1P	B130, B144 (EXIST)	O	16
17	DRYER #2 (EXIST)	P	20A-3P						20A-1P	B123B, B127 (EXIST)	O	18
19		P							20A-1P	B123B, B124 (EXIST)	O	20
21		P							20A-1P	CPT-1,2,3 (EXIST)	P	22
23	DRYER #1 (EXIST)	P							20A-1P	TF-5, TF-6 (EXIST)	A	24
25		P	20A-3P						20A-1P	EF-31 (EXIST)	A	26
27		P							20A-1P	UH-5, UH-6 (EXIST)	H	28
29	SPARE	P	20A-1P						20A-1P	UH-7, UH-8 (EXIST)	H	30
31	**P-24**	**P**	**20A-2P**		**0.72**	0.72			20A-1P	TF-5, TF-6 (EXIST)	A	32
33		P			**0.72**		0.72		20A-1P	EF-29, EF-46 (EXIST)	P	34
35	P14, P15 (EXIST)	P	20A-1P						20A-1P	CUH-7 (EXIST)	A	36
37	UNIT HEATER B145 (EXIST)	H	20A-2P						20A-1P	UH-12 (EXIST)	H	38
39		H							20A-1P	SPARE		40
41	SPARE		20A-1P						20A-1P	PARKING LOT RECEPT (EXIST)	R	42
				(KVA)								
				Total Connected Load	0.72	0.72						

Updated xx.xx.xxxx

Location: RM B134A

*	LOAD SUMMARY	CL	DF	CONNECTED LOAD A	B	C	DEMAND TOTAL
L	Lighting		1.25				
R	Convenience Recept						
H	Heating (Space)		1.25				
C	Cooling		1.00				
A	HVAC		1.00				
P	Process	1.60	1.00		0.88	0.72	1.60
O	Other Continuous		1.25				
K	Kitchen						
N	Noncontinuous		1.00				
			1.00				
	Total	**1.60**			0.88	0.72	1.60

Total Demand Load (KVA)	1.60
Total Demand Current (A)	4.43
Min. Feeder Ampacity (A)	5.53

L-J13 (EXISTING)
PANELBOARD DESIGNATION

SYSTEM VOLTAGE	208/120V, 3ø, 4W
BUS SIZE	100A
SYSTEM TYPE	NORMAL
FEEDER PROT	100A-3P C/B HMSB-1
CONDUCTOR SIZE	3 AWG - #6G CU
CONDUCTOR/PHASE	4
MAINS	100A MCB
SCCR	SERIES RATED
MCB RATING	80%
GROUND FAULT	NO
FEEDER LENGTH (FT)	EXISTING
FEEDER V. DROP (%)	EXISTING
FAULT CURRENT	EXISTING
KAIC RATING	10
ENCLOSURE	TYPE 1

	DESCRIPTION	*	CB	KVA	A	B	C	KVA	CB	DESCRIPTION	*	
1	REFR.DET. PNL. (EXIST)	O	20A-1P						20A-1P	SPARE	N	2
3	FUEL OIL MON. PNL. (EXIST)	O	20A-1P						20A-1P	SPARE	N	4
5	B108A (EXIST)		20A-1P						20A-1P	CUH-5 (EXIST)	H	6
7	B108A, B108B (EXIST)		20A-1P						20A-1P	UH-9, UH-11 (EXIST)	H	8
9	B108B (EXIST)		20A-1P						20A-1P	UH-10, UH-16 (EXIST)	H	10
11	B108B (EXIST)		20A-1P						20A-1P	PKG STALL REC (EXIST)	R	12
13	PKG STALL REC (EXIST)	R	20A-1P						20A-1P	PKG STALL REC (EXIST)	R	14
15	PKG STALL REC (EXIST)	R	20A-1P						20A-1P	PKG STALL REC (EXIST)	R	16
17	PKG STALL REC (EXIST)	R	20A-1P						20A-1P	PKG STALL REC (EXIST)		18
19	PKG STALL REC (EXIST)	R	20A-1P						20A-1P	PKG STALL REC (EXIST)		20
21	**WH-1**	**P**	**20A-1P**	**0.16**		0.88		**0.72**	**20A-2P**	**P-25**	P	22
23			20A-1P				0.72	**0.72**			P	24
25	UH-19 (EXIST)	H	20A-1P						20A-1P	OHD-6 (EXIST)	N	26
27	UH-20 (EXIST)	H	20A-1P						20A-1P	OHD-7 (EXIST)	N	28
29	OHD-4 (EXIST)	N	20A-1P						20A-1P	OHD-8 (EXIST)	N	30
31	OHD-5 (EXIST)	N	20A-1P						20A-1P	OHD-9 (EXIST)	N	32
33	SPARE		20A-1P						20A-1P	OHD-10 (EXIST)	N	34
35	WS-1 (EXIST)	N	20A-1P								H	36
37	GENERATOR HEATERS (EXIST)	H	20A-2P						20A-2P	GENERATOR HEATERS (EXIST)	H	38
39		H							20A-1P	BOSCH BOILER MOTOR (EXIST)		40
41	SPARE		20A-1P						20A-1P	BOSCH BOILER CONTROL (EXIST)		42
				(KVA)								
				Total Connected Load		0.88	0.72					

Updated xx.xx.xxxx

LOAD SUMMARY

PANEL L-J12 (100A), 208/120V, 3PH, 4W

DEMO'D DEMAND LOAD	1.20 KVA
NEW DEMAND LOAD	1.44 KVA
NET CHANGE	0.24 KVA
0.24 KVA EQUALS	0.65 AMPS
DOES NOT EXCEED AMPACITY OF PANEL	

PANEL L-J13 (100A), 208/120V, 3PH, 4W

DEMO'D DEMAND LOAD	1.20 KVA
NEW DEMAND LOAD	1.60 KVA
NET CHANGE	0.40 KVA
0.40 KVA EQUALS	1.10 AMPS
DOES NOT EXCEED AMPACITY OF PANEL	

EHMCC-J1 (400A), 480, 3PH, 3W
UPSTREAM OCP IS 300A FROM EDH-J11

DEMO'D DEMAND LOAD	14.63 KVA
NEW DEMAND LOAD	29.49 KVA
NET CHANGE	14.87 KVA
14.87 KVA EQUALS	17.89 AMPS
DOES NOT EXCEED AMPACITY OF MCC	

No:	Date:	By:	Revision:

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460 WEST SIXTH STREET
REDWING, MN 55066

Sheet Title:
PARTIAL ONELINE DIAGRAM & PANEL SCHEDULES

Date:	8/18/2022
Drawn By:	SRA
Checked By:	ZCT
Project No:	22-0188.00
DWG Scale:	AS NOTED
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Revision Number: 0
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ELECTRICAL SPECIFICATIONS

PART 1 - GENERAL

A. INTENT

The intent of this section is to cover Basic Electrical Requirements specifically applicable to Electrical Work.

B. GENERAL REQUIREMENTS

Visit the building site prior to bidding, examine all existing conditions, and verify all dimensions. No extras will be awarded after the contract is signed if conflicts or obstructions between new work and existing construction are not reported.

Work installed by this Contractor which interferes with or affects the existing structures shall be changed as directed and all costs incident to such changes shall be paid by this Contractor.

Any existing condition uncovered during the construction process which, by generally accepted construction practices, should be remedied, should be brought to the attention of the architect immediately and in writing.

Specific locations, mounting heights and overall dimensions of devices and fixtures are to be obtained from the architectural details when available and from site data.

All work of this contract shall be done neatly and proficiently and only by workers skilled in their particular craft.

Except where modified by specific notation to the contrary, it shall be understood that the indication and/or description of any item in the drawings, specifications, or both carries with it the instruction to furnish and install the item, regardless of whether or not this instruction is explicitly stated as part of the indication or description.

All work shall be done during normal working hours.

C. SCOPE OF WORK

Provide all materials, labor, equipment and services necessary for the installation of all systems as indicated on the drawings.

D. CONTRACT DRAWINGS

The contract drawings for the work are diagrammatic, intended to convey the scope of work and indicate the general arrangement and approximate location of equipment and wiring, the Contractor shall be responsible for checking and verifying all conditions and dimensions. Do not scale drawings.

Drawing Definitions: Where the term "provide" is used, this shall mean furnish and install, complete and ready for the intended use. "Furnish" means supply and deliver to the Project site, ready for unloading, unpacking, assembly, and installation. "Install" describes the operations at the Project site including the actual assembly, erection, anchoring, and all similar operations.

Provide any fittings, etc., necessary for the complete installation of all work of this contract. Provide any accessories required for the complete installation and operation of all systems.

Include all costs to make any alterations and offsets of conduits, etc., and of equipment as necessary to avoid installation conflicts with existing work.

The drawings and specifications are complementary and any work and material required by the drawings and not mentioned in the specifications or vice versa, shall be executed as if same were both specified and shown.

Any questions or conflict between drawings and specifications, shall be referred to the Engineer.

The Engineer reserves the right to require any and or all Contractors to make minor changes in arrangements at no additional cost to the Owner.

E. CODES, STANDARDS AND TESTS

The latest edition of the National Electric Code shall be the minimum requirement for all work. All electrical materials used in this work and all workmanship and tests performed therein, unless specifically stated otherwise, shall conform to the latest rules, regulations and specifications for the Nation Board of Fire Underwriters, local and state codes, authorities having jurisdiction and local utility company. Examine the drawings and specifications for compliance with prevailing codes, regulations and ordinances and base bid and work accordingly. Any minor discrepancy between these drawings / specifications and codes, laws, ordinances, rules and regulations shall be corrected by the Contractor as required. Major discrepancies shall immediately be brought to the attention of the architect, prior to installation.

All tests shall be performed in accordance with state, county, local, Owner's and engineer's requirements.

F. PERMITS

The Contractor is responsible for applying for all required permits and paying for all permits, inspection, licensing, and service fees to Authorities having jurisdiction over the work. The Contractor is responsible for arranging for all inspection visits.

G. COORDINATION

Perform work under this contract in close harmony with other contractors so completed work shall present a neat and workmanlike installation. The electrical Contractor shall consult the plans of all other trades in all instances before installing his work so that their installations will not interfere with other disciplines. In the event of a conflict, the Contractor shall report to the Owner's representative at once and do no further work until a satisfactory arrangement is decided upon. Any work done, or equipment placed in position by the Contractor, creating a conflict in violation hereof, shall be readjusted to the satisfaction of the Owner's representative at the expense of the Contractor. The decision of the Owner's representative shall be final in regard to changes due to conflicting conditions.

H. SUBMITTALS

Submit to engineer/architect an electronic version of certified shop Drawings, descriptive data, diagrams and specifications on all SPECIFIED materials and equipment for review in ample time before manufacturers are authorized to make shipment. The information submitted shall be prepared and arranged in a format which will permit easy identification and comparison by the engineer / architect of specified equipment. In other words, all submittals shall be CLEARLY HIGHLIGHTED to indicate the exact device to be installed (This shall include LED drivers and ballasts.). It shall be the responsibility of the Contractor to furnish any additional copies (showing architect / engineer stamp and comments) as necessary for suppliers and/or building officials.

The make, type and finish of all materials, equipment and apparatus shall be approved by the engineer/ architect in writing before the Contractor installs it. Any substitution for any specified Equipment or material shall first be approved by the engineer / architect in writing.

Items to be submitted include the following:

- Panelboards and Circuit Breakers
- Disconnect Switches
- Wiring Devices
- Motor Starters and Control Devices

Shop drawings shall include, but are not limited to the following: make, model number, dimensions, electrical characteristics (rating), lighting control wiring diagrams. Shop drawings shall bear name of project and location.

Any changes to items specified must be submitted as a substitution with complete documentation of price differential and equipment details.

Contractor to provide a lead time for each piece of major equipment or assembly. This shall include each light fixture with its proper ballast or LED driver. This shall be presented to the construction and design teams prior to or at the time of submittal review.

I. AS BUILT AND RECORD DRAWINGS

All utilities which are installed below grade or concealed within walls shall be dimensionally located on the record drawings.

Keep a set of the contract and coordination drawings at the job site on which a running record of changes in routing services and location of equipment shall be kept in a neat and legible manner. Changes shall be made using a red pen or pencil and be documented on the latest sheet revision. Engineer shall require evidence that "as-built" drawings are up to date prior to approval of pay requests.

At the completion of the job, all changes required as a result of coordination shall be incorporated by the contractor, into the AutoCAD drawings developed by the Engineer. While the "as-built" drawing coordination effort may be done manually, the record drawings shall be done in AutoCAD, version 2009 or better. One copy each of the record drawings shall be given to the Engineer and to the Owner. Two copies of all AutoCAD files utilizing the latest floor plans, room names and room numbers shall be given to the Engineer on CD-ROM. This shall include any fire alarm, auxiliary and lighting control drawings/submittals that were developed for the project. The "as-built" drawings shall be scanned as red-line PDF files and two copies shall be given to the Engineer on CD-ROM.

J. OWNER FURNISHED EQUIPMENT

All equipment that is furnished by the Owner is assigned to the Contractor that is designated to install the equipment as though the Contractor furnished the equipment itself. The Contractor is responsible for all aspects of the equipment including verifying the order, coordinating and accepting delivery, rigging, installation, start-up coordination, warranty repairs, collection and submittal of equipment manuals, and all other activities associated with the equipment unless specifically indicated otherwise. Refer to the pre-purchase specifications or order forms used by the Owner to select the equipment for any features included with each piece of equipment

K. CUTTING AND PATCHING

This Contractor is responsible for any cutting, patching, painting, supports, and roofing as required to complete work indicated on drawings. Restoration shall be handled in a manner acceptable to the engineer/architect. All floor or fire wall penetrations are to be firestopped. Use Dow Corning 3-6548 silicone RTV foam or approved equal.

Repair adjacent construction and finishes in ceilings, walls, floors or partitions that have been damaged during demolition or created during extension of work. Repair all penetrations in fire rated ceilings, walls, floors or partitions to the original fire ratings using approved fire stop materials.

L. PREPARATION

Coordinate the installation of equipment with the schedules of other trades to prevent unnecessary delays in the total project.

M. EQUIPMENT VERIFICATION

Verify all equipment ratings, connections and locations with installing Contractor before installation.

This Contractor shall verify that all equipment furnished will properly fit in the space provided, that it will function properly, and that all parts of equipment requiring service are readily accessible.

N. CLEANING / DEBRIS REMOVAL

This Contractor shall remove from the premises all accumulation of dirt, debris, waste materials and rubbish caused by his employees or work, at least once a week, except that combustible materials shall be removed daily.

Clean equipment to remove foreign objects and markings. Touch up paint as required. The Contractor is responsible for any damages caused by work of his trade.

O. SUBSTITUTIONS

Certain makes of materials and equipment are specified and drawings are detailed according to this material. Contractor shall base his bid on furnishing and installing the specified make and model or the "equivalent" model of another of the specified manufacturers which meets all the qualifications of the specified items.

"Equivalent" materials and equipment are those of manufacturer which meet the same standards of performance, have equal or better materials of construction, and equal or better maintenance characteristics. All equivalents must fit the space provided in the building structure. Where the use of equivalents results in changes, this Contractor shall be responsible for such changes and any costs resulting from them.

If the Contractor intends to use equipment or materials not specified, he must receive written approval from the engineer/architect prior to the award of the contract. This prior approval only permits submittal of a particular manufacturer's equipment in general. The specified item to be used must again be submitted for final review as specified under "shop drawings."

P. DEMOLITION

Maintain service to other parts of the building during demolition.

Coordinate all demolition work with the new work of all other trades.

Patch all holes in floors and ceiling resulting from the demolition which will not be used for the new work with the material to match the existing finish and fire rating.

Turn over to the Owner all removed equipment that the Owner wishes to keep. Properly dispose of all remaining equipment according to all regulatory agency requirements.

The Contractor shall disconnect and remove all existing light fixtures, receptacles, and other electrical equipment, in areas of construction unless otherwise noted on drawings. All equipment and fixtures not reused shall be disposed of by Contractor as directed by Owner or his representative.

Remove all existing conduit and wire not to remain in use to the first junction box above ceiling.

Disconnect and remove all branch circuit wiring from existing circuit breakers feeding electrical devices which are removed. Maintain continuity of all existing circuits that are to remain.

All changes or code corrections that are required to existing electrical work not noted on the contract documents must be submitted to the engineer for approval, prior to commencing work.

Q. PROTECTION OF BUILDING COMPONENTS

Provide protection from damage of any kind to the existing roof and paved surfaces during all phases of this project.

R. CONTRACTOR USE OF PREMISES

Limit use of premises to allow Owner and tenant occupancy, work by others and Owner, and comfort conditions to be maintained in the occupied spaces during normal business hours.

S. WARRANTY

This Contractor shall provide a written warranty of all work done under this contract for a period of one year from date of substantial completion. The Contractor shall, at his own expense, remedy any defects due to faulty materials and or workmanship and pay any damage to other work resulting from such defects and or the remedying thereof, which shall appear within the warranty period.

All materials shall be free of defects or errors which would result in poor application or cause defects in workmanship.

T. PROJECT CLOSEOUT

Furnish three final copies of installation and maintenance manuals, warranties, and other submittal data indicated for inclusion. Bind in 3-ring binders with tabs for each division or major piece of equipment. Include wiring diagrams, parts listings, and other manufacturer's information.

Submit a certificate of final inspection and approval. Submit release of liens for all subcontractors and suppliers. Submit record drawings

Final payment will not be approved until all closeout items are received.

PART 2 - PRODUCTS

A. EQUIPMENT

All equipment shall be as specified on the drawings and in the schedules. Provisions for substitutions are listed in Part 1.

B. IDENTIFICATION

All equipment shall be identified with laminated three-layer plastic engraved nameplates mechanically fastened to the equipment except contact-type permanent adhesive where screws cannot or should not penetrate substrate. Glued application is not acceptable. Identify and permanently and neatly type all circuits on panelboard directory. Hand written directories are not acceptable.

All raceways shall be identified with manufacturer's standard self-adhesive vinyl tape no less than three mils thick by two inches wide. Where applicable, install on all concealed raceways at connection to junction boxes, pull boxes, equipment and wall / floor penetrations. Unless otherwise indicated or required by governing regulations, provide orange tape with black letters.

All current carrying conductors smaller than #10 AWG and grounded conductors smaller than #6 AWG shall be identified with colored insulation. For larger sizes, provide field-applied conductor color, self-adhesive colored vinyl tape, three mils thick by one inch wide. Heat-shrink markers shall be white polyolefin sleeves, text applied with compatible printer, or marker tapes shall be vinyl or vinyl-cloth, self-adhesive wrap-around type, with preprinted letters and numbers. For existing systems, match existing color codes. If existing color codes are not apparent, or unmarked, use the following color codes:

480/277V System - Brown (Phase A), Orange (Phase B), Yellow (Phase C)
208/120V System - Black (Phase A), Red (Phase B), Blue (Phase C)
240/120V System - Black (Line 1), Red (Line 2)
Neutral Conductor - White
Ground Conductor - Green
Control Conductor, 120V - Red
Control Conductor, Neutral - White
Control Conductor, 24V - Blue
Control Conductor, External Source - Yellow

C. GROUNDING

Properly ground all motors, transformers, equipment, conduits, switchgear, etc. in compliance with the latest edition of the NEC, article 250 and as indicated on drawings.

All wiring for grounding purpose shall be copper as required for type and sizes indicated on drawings and shall be stranded conductors.

Building electrode ground rods shall be 10 feet long x 3/4 inch diameter (minimum dimensions). Ground rods shall be copper clad steel. Maximum resistance for the electrode system is 25 ohms. All ground rods shall be tested with proper test equipment for rod to earth resistance before connecting ground wire.

Equipment grounding conductor: provide separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.

Metal raceways may not be used for equipment grounding.

Provide exothermic type weld connections at all connections to building steel and buried ground rods. All gas lines and water pipes shall be grounded. Ground rods in test wells shall have bronze mechanical (bolted) connections to the grounding grid.

Ground all light fixtures by installing a separated green wire in any flexible conduit between outlet box and fixture.

D. ELECTRICAL RACEWAYS

Interior conduit shall conform to National Electric Code (NEC.) and be of sufficient size and installed so that the required number of conductors can be inserted or removed without injury to, or excessive strain upon, the insulation. The minimum conduit size shall be 3/4 Inch unless otherwise noted.

Rigid steel conduit shall be used for all conduit runs installed in concrete slabs, in all poured concrete construction and all applications inside building requiring 2 inches or larger in size. Conduit shall be supported at intervals not-to-exceed 7 feet for 3/4 inch conduit, 8 feet intervals for conduit 1 inch to and including 2 inches, and 10 feet for conduits 2-1/2 inches or larger.

Electrical metallic tubing (thin wall) may be used for switch legs (except in poured concrete walls) and branch circuits in partitions, above ceilings, and where conduit run is exposed. Conduit shall be supported at intervals not-to-exceed 7 feet for 3/4 inch conduit, 8 feet intervals for conduit 1 inch to and including 1-1/2 inch. EMT larger than 1-1/2 inch will not be permitted.

Flexible metallic conduit shall be used between outlet boxes in hung or furred ceilings and recessed lighting fixtures. Flexible conduit shall not exceed 6 feet in length, except for recessed incandescent fixtures, length shall be 12 feet.

Liquid tight flexible metallic conduit shall be used for final connections to all motors, transformers and equipment subject to vibration.

Provide conduit expansion fittings where conduit crosses a building expansion joint and in all straight conduit runs 200 feet or longer.

Provide conduit sealing fitting on conduit runs passing through the building exterior walls or roof. Conduit seal shall be installed on the warm side of penetration within six inches of conduit passage or as close to passage point as conditions will allow

E. CONDUCTORS, WIRE AND CONNECTORS

All conductors shall be new, NEC grade copper and free from defects. building wires shall be type THHN or THWN for dry locations and type THHW or THWN for wet or dry location (90 degrees C. Dry) (75 degrees C. Wet) except as otherwise noted on the drawings.

Fixture wire conforming to NEC requirements shall be used in all lighting fixtures and from lighting fixture to first junction or outlet box.

In general, conductors smaller than #12 AWG will be permitted only for communication, signal, or control circuits. Wire #10 AWG and smaller shall be solid or stranded conductors. Wire #8 AWG and larger shall be stranded. stranded conductors smaller than #8 AWG may be used only if "Sta-kon" or equal compression lugs are used for all terminations.

Color coding is required for all service, feeder, branch, control, and signaling circuit conductors. Insulation color for neutrals shall be white for 120 volt circuits. Equipment grounding conductors shall be green.

Use no wire smaller than #12 AWG, rated at 600 volts, for power and lighting circuits and no smaller than #14 AWG for control wiring.

Type MC cable shall be accessible for power wiring as permitted by Article 330 of the National Electric Code.

F. OUTLET BOXES AND FITTINGS

Outlet boxes shall be NEC gauge steel, galvanized, of ample size to accommodate wire, switches, receptacles, or other devices mounted in the box without crowding. Use gang boxes where more than one device is to be installed at the same location.

Outlet boxes for lighting fixtures shall have 3/8 inch fixture stud where required. Ceiling outlet boxes shall be 4 inches octagonal, 2-1/8 inches deep for furred plaster and exposed work and 3 inches deep for concrete work. All boxes for concrete work shall be of type especially designed for installation in concrete.

Outlet boxes for switches, receptacles, telephone, or other devices recessed in walls shall be 4 inch square boxes with extension rings and plaster covers where required to bring box flush with wall. Use of cover plate as tension of rigidity device will not be permitted.

Provide outlet box accessories as required for each installation, including mounting brackets, wallboard hangers, extension rings, fixture studs, cable clamps, and metal straps for supporting outlet boxes, compatible with outlet boxes being used and meeting requirements of individual wiring situations. Junction and pull boxes shall be of NEC gauge steel, galvanized, and of sufficient size to accommodate the conductors served without crowding. Boxes shall be equipped with screwed or hinged covers as conditions warrant. Pull boxes located in floors shall be flush with finished floor, and of cast wrought iron, aluminum, or bronze with gasketed, waterproof cover. Conduit entrances shall be threaded.

Provide corrosion resistant cast metal weatherproof outdoor wiring boxes, of the type, shape, and size required for each application, with threaded conduit ends, cast metal face plate with spring-hinge waterproof cap, suitably configured for each application, including face plate gasket and corrosion proof fasteners.

G. WIRING DEVICES

Duplex receptacles shall be white, Heavy Duty Specification Grade 20 amp, 125 volt, 3 wire grounding type. Provide smooth white thermoplastic cover plate and matching screws. Approved manufacturers: Hubbell, Arrow-Hart, Bryant, Leviton, or Slater equal; with Hubbell p8 or equal cover plate.

Ground fault circuit interrupter receptacles shall be white, duplex, 20 amp, 125 volt, 3 wire grounding type. Provide smooth white thermoplastic cover plate and matching screws. Approved manufacturers: Hubbell, Bryant, Leviton, or Slater equal; with Hubbell P8 or equal cover plate.

Wall switches shall be white, 20 amp, 120-277 volt, quiet, high capacity, toggle type. Wall switch type occupancy sensors shall be Acuity or Crestron equal.

Ceiling mounted occupancy sensors shall be Acuity CMPDT or Crestron equal. Furnished complete with power packs and all required accessories. Ceiling sensor locations and quantities shall be provided as recommended by the specific manufacturer to ensure suitable coverage throughout each space.

Wall plates for switches, dimmers, telephone outlets and other special outlets shall match the wall plates previously specified with the receptacles. All plates in each room shall match unless otherwise approved by the Owner's Representative. Approved products: Leviton or Hubbell. Dimmers shall be 20 amperes, rated for 120-277 volts. Basis of design for wall dimmer switch type vacancy sensor shall be Acuity WSXA or Crestron equal.

Digital wall timer: Gamut/ Grainger 308X179

Disconnect switches shall be heavy duty, single throw disconnect switches. Enclosure shall be NEMA 1 indoor and NEMA 3R (raintight) where they are required to be weatherproof. The ampere rating, fusible or non-fusible and voltage characteristics shall be as indicated on drawings. Square 'D', Siemens or Eaton

H. SAFETY SWITCHES / DISCONNECTS

Furnish and install safety switches and disconnects as shown on the drawings. Equipment shall be safety type, quick make, quick break, externally operated, heavy duty type. Enclosures shall be NEMA 1 or NEMA 3R as required. Sizing shall be for load unless indicated larger on the drawings.

PART 3 - EXECUTION

B. SCHEDULING OF WORK

Work is to be scheduled with Owner's representative and all other trades to accommodate occupancy dates and to expedite the timely completion of the project. Any utility outages or work which interferes with use of facility must be scheduled 24 hours in advance.

Coordinate the installation with all conditions and the work of other Contractors. The Contractor shall incur all costs for relocation of equipment conflicting with existing equipment or new work by other disciplines.

Trenching, saw cutting, coring, or other structural modifications shall not be performed without notification of the Owner and careful field verification by the Contractor to insure that no adverse effect to the building's structural integrity will occur.

Ceiling mounted sprinkler, lighting, and electrical requirements take precedence over ceiling mounted mechanical requirements. See reflected ceiling plans for ceiling grid and lighting layout for coordination of final diffuser locations.

C. TESTING

Testing of all wiring, devices, lighting and equipment is to be conducted to ensure the electrical continuity of all connections, and to demonstrate compliance with all requirements of drawings and specifications. Clean all luminaries and relamp with new any lamps used during construction for lighting. Testing shall be witnessed by Owner's representative.

D. INSTALLATION

Install all equipment and products in accordance with manufacturer's published instructions and recommendations.

Provide dual element, time delay RK5 fuses on all motors and disconnects as required whether indicated on drawings or not.

E. ELECTRICAL RACEWAYS

Conduit run exposed shall run parallel or perpendicular to walls, ceilings, or principal framing members. It is required that all conduit be installed to reflect neat, careful workmanship throughout the job. Do not install conduit which has been crushed, damaged, or deformed in any way. Install conduit in such a manner as to ensure against trouble from collection of trapped condensate, all runs of conduit shall be free of such traps wherever possible.

Conduits shall be installed a minimum of 12 inches from steam or hot water piping in parallel runs, at least 6 inches from cross runs and at least 3 inches from cold water piping. Conduits shall not be secured to other piping or other piping supports.

The full number of threads must project beyond knockout in boxes and cabinets to allow the bushing to butt up tight against the end of the conduit.

All conduit hangers and supports shall be rigidly fastened to the building structure. No conduit shall be supported from ductwork, piping, or ceiling grid systems.

Provide fire seals wherever conduit penetrates fire walls or rated floor slabs.

F. CONDUCTORS, WIRE AND CONNECTORS

Conductors shall be continuous from outlet to outlet, no splices shall be permitted except at outlets. All electrical connections shall be made in accordance with NEC.

END OF SECTION

No:	Date:	By:	Revision:

I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.

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DATE: 8/18/2022 REG. NO.: 54049

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GOODHUE COUNTY LAW ENFORCEMENT CENTER BOILER AND WATER HEATER REPLACEMENT
460 WEST SIXTH STREET
REDWING, MN 55066

Sheet Title:
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