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Addendum No. 3
Solicitation #25-0431
Scope 1: Coal Burner to Natural Gas and Fuel Oil Burner: Balance of Plant and Fuel Oil System

This addendum serves to notify all bidders of the following changes to the solicitation documents:

1. Please insert the attached document labeled 'SECTION 013000 – ADMINISTRATIVE SERVICES' into the Bid Packet.
2. Please insert the attached document labeled 'GROUND FLOOR ATOMIZING STEAM AND CONDENSATE' into the Bid Packet.
3. Please insert the attached document labeled 'FIRST FLOOR ATOMIZING STEAM' into the Bid Packet.

Below are questions asked by various contractors and their subsequent answers.

1. **Question: Emissions numbers? Are they accurate? What should they be?**

   Answer: Emissions limits and stack testing requirements for burners are specified in section 235230.

2. **Question: Atomizer tapping? Deleting tap into soot blower?**

   Answer: Atomizing steam will come from an existing high-pressure steam line on the ground floor. DES will add valving for the contractor to connect to and run the atomizing steam header and laterals to each burner skid. Drawings M202 and M203 have been updated and are included with this addendum.

3. **Clarification: Demo is not included in base bid.**

   Answer: Demo shall be provided only as required for the installation of new equipment and/or to provide reasonable clearances for equipment maintenance.

4. **Question: Steam Line will be down for tapping?**

   Answer: HPS line (and other active lines) will be taken down for tie-ins. No hot-taps are envisioned as part of this project.

5. **Clarification: There will be no hot tap work.**

   Answer: Correct

6. **Clarification: Does the bucket elevator need to be removed?**

   Answer: The bucket elevator shall remain in place and in service during the construction of

the project. No demo for any coal equipment shall be included unless called out on plans or if absolutely necessary for installation of new equipment.

7. **Question: Is there a preference for location of vent silencer? Further, is there any desire to keep vent silencer?**

   Answer: The silencer can be located as needed with approval from facility. The discharge from silencer shall be to a safe location to prevent any impact to personnel. Silencer will be temporary and shall be removed after construction is complete.

8. **Clarification: Do the feeder ducts need to be cut back?**

   Answer: Coal bunker feed ducts should be cut back and capped by the contractor with their own millwrights and riggers. Contractor will remove coal handling equipment as required to provide space for construction and future equipment maintenance.

9. **Question: Is existing take off connection adequate for Boiler 1? Does one need to be added to boiler 4?**

   Answer: Boiler #1's gas connection is in-place with that take-off and block valve coming off the main gas header. Contractor will be required to install new piping from the existing valve to Boiler 1.

   Drawings show Boiler #4's gas connection outside along the south wall of the plant. The Contractor will be required to install new piping from the existing blind flange on the exterior of building to Boiler 4.

10. **Clarification: What existing info is available for the boilers that we can provide? Matterport scan available for contractor use/viewing?**

    Answer: This is the Link to existing plant drawings for Contractor Use.

    https://ever-greenenergy.sharefile.com/d-s6ad4d16bf21642ae87ee3a3986566722

    Matterport scan is not available at this time and it will not be provided by DES prior to bid due date. Contractors are welcome to schedule follow up visit to review existing conditions as needed.

11. **Question: Asbestos abatement?**

    Answer: Contractor to mark limits of abatement required at contract award. DES will coordinate abatement at that time. Abatement will commence within one month from mark out of abatement limits.

12. **Clarification: A set of stairs will be removed for access point temporarily.**

    Answer: The SCS pump mezzanine access stairs will be removed to allow a forklift movement from the elevated double-doors by the PRV. DES will make stairs removable in advance of project.

13. **Question: Is there a Buy America clause?**

    Answer: No, there is not.

14. **Question: Has a 3D scan been completed for the contractors use?**

Answer: A 3d scan is not available currently and likely will not be available prior to the bid due date.

15. **Please confirm if the contractor is to carry the cost of local permits. These are often waived for City funded projects.**

    Answer: Contractor to carry the cost of local permits.

16. **Please confirm if testing and inspections shown on S002 are considered special inspections and costs are included by Owner.**

    Answer: The Owner is responsible for contracting the special inspections agency and for covering the costs of the special inspections.

17. **Are duct work drawings available for BLR 1 & 4 with details on the FD damper size?**

    Answer: If drawings are available they can be found at the following link:

    https://ever-greenenergy.sharefile.com/d-s6ad4d16bf21642ae87ee3a3986566722

18. **What type of damper is requested? Pneumatic or electric actuator?**

    Answer: Electric.

19. **Are there drawings available of the existing coal/gas burners on BLR 2 & 3?**

    Answer: If drawings are available they can be found at the following link:

    https://ever-greenenergy.sharefile.com/d-s6ad4d16bf21642ae87ee3a3986566722

20. **Is there information available on the fans for review to confirm air flow capacity? In the event there is no air flow information, please confirm if/how bidders can provide a performance guarantee for steam capacity as the air flow will be a primary factor.**

    Answer: Available information for fans is located in following link.

    https://ever-greenenergy.sharefile.com/d-s6ad4d16bf21642ae87ee3a3986566722

21. **Is fuel analysis available for the natural gas and No 2 oil? Please note that several of the performance guarantees (particulate, sulfur, etc) are all direct functions of fuel/air source and cannot be guaranteed without this information.**

    Answer: Natural gas and fuel oil are commercially available fuels and will follow commercial fuel specs. The following information is provided for site specific fuels.

    Northern Natural Gas Transmission delivers the natural gas. Their gas quality is provided here (Northern Natural Gas). See Wrenshall Superior take station for gas quality.

    Low sulfur number 2 fuel oil, ASTM D396 No. 2 S15 (less than 15 ppm), is specified.

22. **Are there boiler drawings showing furnace geometry available on all four boilers? It will be difficult to guarantee no flame impingement without boiler furnace dimensions.**

    Answer: If drawings are available they can be found at the following link:

    https://ever-greenenergy.sharefile.com/d-s6ad4d16bf21642ae87ee3a3986566722

23. **Are there drawings available for the "Multicone ash separators" showing what has to be removed?**

    Answer: If drawings are available they can be found at the following link:

    https://ever-greenenergy.sharefile.com/d-s6ad4d16bf21642ae87ee3a3986566722

24. **We will need the boiler capacity, operating pressure and MAWP to size the vent silencer as well as confirm the selection of the boiler drum level instruments.**

    Answer: Boiler original design is for 125 kpph at 420 psig. Boiler is currently operated at 225 psig with a design steam output at completion of project of 100 kpph.

25. **Is the silencer a permanent installation?**

    Answer: No.

26. **What is the allowable decibel rating for venting steam?**

    Answer: Less than 70 dBa at property line.

27. **Are there logic diagrams, control logic, etc. available for the existing Plant Master?**

    Answer: The existing plant master is bypassed currently. Selected vendor can work with DES I&E to generate logic diagram for existing system.

28. **What hardware is used for the Plant Master?**

    Answer: Allen Bradley 1756-L81E Control Logix controller with 1794 Flex IO.

29. **Is the program accessible or password protected?**

    Answer: Yes. Passwords will be provided to the selected vendor.

30. **Section 7 list oil, gas, steam and feedwater flow meters. Air flow is not listed.**

    Answer: Air flow metering shall be added for FD fan.

31. **Are flow meters required for oil and natural gas?**

    Answer: Yes. These are specified.

32. **In order to provide accurate sizing and pricing information for the economizer option price, the following information is needed:**

    - **What size is the ductwork at the economizer installation point?**
    - Answer: Vendor shall confirm. Drawings, if available, are located on previously linked Sharefile.
    - **What is the allowable air pressure drop?**
    - Answer: Less than 0.5 in w.c.
    - **Are soot blowers requested on the economizer?**
    - Answer: No.
    - **What are the air and water flow rates through the economizer?**

- Answer: ~100,000 pph water side, ~120,000 pph exhaust side. Vendor to confirm.

33. **Confirm if the basis of bid for pile caps should be 50ft or 60ft as both depths are listed on sheet S201.**

    Answer: Basis should be 60 feet.

34. **Please confirm if there is a preference for pump type for the fuel oil pumps. Our opinion is that positive displacement pumps generally provide a better long-term product, but are more expensive than gear/centrifugal/etc. This may be unnecessary for a backup system which is planned to be used in limited situations only.**

    Answer: Positive displacement pumps are preferred. Vendor to specify pump type and note in proposal.

35. **We are needing the frame size to get a motor quoted.**
    Answer: 365TS (75 Hp), 445T (100 Hp)

36. **Our team is needing the piping spec sheets for this facility for all systems related to this work. Could you please provide these, and if not could you please direct us towards someone who has access to these?**
    Answer: Pipe specs are provided in Section 23 of specifications. Project specifications are attached to this addendum.

37. **"Burners shall be rated at 130 MMBtu/hr fuel input". Is this the total input for two (2) burners or the input per burner?**
    Answer: The total heat input to each boiler shall be 130 MMBTU/HR (higher heating value) on natural gas or fuel oil.

Please acknowledge receipt of this Addendum by checking the acknowledgement box within the www.bidexpress.com solicitation.

Posted: **July 10, 2025**

SECTION 013000
ADMINISTRATIVE REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Preconstruction meeting.

B. Site mobilization meeting.

C. Progress meetings.

D. Construction progress schedule.

E. Contractor's daily reports.

F. Progress photographs.

G. Submittals for review, information, and project closeout.

H. Number of copies of submittals.

I. Requests for Interpretation (RFI) procedures.

J. Submittal procedures.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 PRECONSTRUCTION MEETING

A. Schedule meeting after Notice of Award.

B. Attendance Required:
   1. Owner.
   2. Engineer.
   3. Contractor.

C. Agenda:
   1. Execution of Owner-Contractor Agreement.
   2. Submission of executed bonds and insurance certificates.
   3. Distribution of Contract Documents.
   4. Submission of list of subcontractors, list of products, schedule of values, and progress schedule.
   5. Submission of initial Submittal schedule.
   6. Designation of personnel representing the parties to Contract and Engineer.
   7. Procedures and processing of field decisions, submittals, substitutions, applications for payments, proposal request, Change Orders, and Contract closeout procedures.
   8. Scheduling.

D. Record minutes and distribute copies within two days after meeting to participants, with two copies to Engineer, Owner, participants, and those affected by decisions made.

3.02 SITE MOBILIZATION MEETING

A. Schedule meeting at the Project site prior to Contractor occupancy.

B. Attendance Required:
   1. Contractor.
   2. Owner.
   3. Engineer.
   4. Contractor's superintendent.
   5. Major subcontractors.

C. Agenda:

1. Use of premises by Owner and Contractor.
2. Owner's requirements.
3. Construction facilities and controls provided by Owner.
4. Temporary utilities provided by Owner.
5. Survey and building layout.
6. Security and housekeeping procedures.
7. Schedules.
8. Application for payment procedures.
9. Procedures for testing.
10. Procedures for maintaining record documents.
11. Requirements for start-up of equipment.
12. Inspection and acceptance of equipment put into service during construction period.

D. Record minutes and distribute copies within two days after meeting to participants, with two copies to Engineer, Owner, participants, and those affected by decisions made.

3.03 PROGRESS MEETINGS

A. Schedule and administer meetings throughout progress of the work at maximum weekly intervals.

B. Make arrangements for meetings, prepare agenda with copies for participants, preside at meetings.

C. Attendance Required:
1. Contractor.
2. Owner.
3. Engineer.
4. Contractor's superintendent.
5. Major subcontractors.

D. Agenda:
1. Review minutes of previous meetings.
2. Review of work progress.
3. Field observations, problems, and decisions.
4. Identification of problems that impede, or will impede, planned progress.
5. Review of submittals schedule and status of submittals.
6. Review of RFIs log and status of responses.
7. Maintenance of progress schedule.
8. Corrective measures to regain projected schedules.
9. Planned progress during succeeding work period.
10. Maintenance of quality and work standards.
11. Effect of proposed changes on progress schedule and coordination.
12. Other business relating to work.

E. Record minutes and distribute copies within two days after meeting to participants, with two copies to Engineer, Owner, participants, and those affected by decisions made.

3.04 CONSTRUCTION PROGRESS SCHEDULE

A. Within 10 days after date of the Agreement, submit preliminary schedule defining planned operations for the first 60 days of work, with a general outline for remainder of work.

B. If preliminary schedule requires revision after review, submit revised schedule within 10 days.

C. Within 20 days after review of preliminary schedule, submit draft of proposed complete schedule for review.
1. Include written certification that major contractors have reviewed and accepted proposed schedule.

D. Within 10 days after joint review, submit complete schedule.

E. Submit updated schedule with each Application for Payment.

3.05 DAILY CONSTRUCTION REPORTS

A. Include only factual information. Do not include personal remarks or opinions regarding operations and/or personnel.

B. In addition to transmitting electronically a copy to Owner and Engineer, submit electronic printed copies at weekly intervals.

C. Prepare a daily construction report recording the following information concerning events at Project site and project progress:
   1. Date.
   2. High and low temperatures, and general weather conditions.
   3. List of subcontractors at Project site.
   4. Approximate count of personnel at Project site.
      a. Include a breakdown for supervisors, laborers, journeymen, equipment operators, and helpers.
   5. Material deliveries.
   6. Safety, environmental, or industrial relations incidents.
   7. Meetings and significant decisions.
   8. Stoppages, delays, shortages, and losses. Include comparison between scheduled work activities (in Contractor's most recently updated and published schedule) and actual activities. Explain differences, if any. Note days or periods when no work was in progress and explain the reasons why.
   9. Directives and requests of Authority(s) Having Jurisdiction (AHJ).
   10. Testing and/or inspections performed.
   11. List of verbal instruction given by Owner and/or Engineer.
   12. Signature of Contractor's authorized representative.

3.06 PROGRESS PHOTOGRAPHS

A. Submit new photographs weekly, within 3 days after being taken.

B. Photography Type: Digital; electronic files.

C. Provide photographs of site and construction throughout progress of work, acceptable to Engineer.

D. In addition to periodic, recurring views, take photographs of each of the following events:
   1. Excavations in progress.
   2. Foundations in progress and upon completion.
   3. Structural framing in progress and upon completion.
   4. Individual boiler conversions.

E. Views:
   1. Provide non-aerial photographs from four cardinal views at each specified time, until date of Substantial Completion.
   2. Consult with Engineer for instructions on views required.
   3. Provide factual presentation.
   4. Provide correct exposure and focus, high resolution and sharpness, maximum depth of field, and minimum distortion.

F. Digital Photographs: 24 bit color, minimum resolution of 1600 by 1200 ("2 megapixel"), in JPG format; provide files unaltered by photo editing software.
   1. Delivery Medium: Via email.
   2. File Naming: Include project identification, date and time of view, and view identification.

3.07 REQUESTS FOR INFORMATION (RFI)

A. Definition: A request seeking one of the following:
   1. An interpretation, amplification, or clarification of some requirement of Contract Documents arising from inability to determine from them the exact material, process, or system to be installed; or when the elements of construction are required to occupy the same space (interference); or when an item of work is described differently at more than one place in Contract Documents.
   2. A resolution to an issue which has arisen due to field conditions and affects design intent.

B. Whenever possible, request clarifications at the next appropriate project progress meeting, with response entered into meeting minutes, rendering unnecessary the issuance of a formal RFI.

C. Preparation: Prepare an RFI immediately upon discovery of a need for interpretation of Contract Documents. Failure to submit a RFI in a timely manner is not a legitimate cause for claiming additional costs or delays in execution of the work.
   1. Prepare a separate RFI for each specific item.
      a. Review, coordinate, and comment on requests originating with subcontractors and/or materials suppliers.
      b. Do not forward requests which solely require internal coordination between subcontractors.
   2. Prepare in a format and with content acceptable to Owner.

D. Reason for the RFI: Prior to initiation of an RFI, carefully study all Contract Documents to confirm that information sufficient for their interpretation is definitely not included.
   1. Include in each request Contractor's signature attesting to good faith effort to determine from Contract Documents information requiring interpretation.
   2. Unacceptable Uses for RFIs: Do not use RFIs to request the following::
      a. Approval of submittals (use procedures specified elsewhere in this section).
      b. Changes that entail change in Contract Time and Contract Sum (comply with provisions of the Conditions of the Contract).
      c. Different methods of performing work than those indicated in the Contract Drawings and Specifications (comply with provisions of the Conditions of the Contract).
   3. Improper RFIs: Requests not prepared in compliance with requirements of this section, and/or missing key information required to render an actionable response. They will be returned without a response, with an explanatory notation.
   4. Frivolous RFIs: Requests regarding information that is clearly indicated on, or reasonably inferable from, Contract Documents, with no additional input required to clarify the question. They will be returned without a response, with an explanatory notation.

E. Content: Include identifiers necessary for tracking the status of each RFI, and information necessary to provide an actionable response.
   1. Discrete and consecutive RFI number, and descriptive subject/title.
   2. Issue date, and requested reply date.
   3. Reference to particular Contract Document(s) requiring additional information/interpretation. Identify pertinent drawing and detail number and/or specification section number, title, and paragraph(s).
   4. Annotations: Field dimensions and/or description of conditions which have engendered the request.
   5. Contractor's suggested resolution: A written and/or a graphic solution, to scale, is required in cases where clarification of coordination issues is involved, for example; routing, clearances, and/or specific locations of work shown diagrammatically in Contract Documents. If applicable, state the likely impact of the suggested resolution on Contract Time or the Contract Sum.

F. Attachments: Include sketches, coordination drawings, descriptions, photos, submittals, and other information necessary to substantiate the reason for the request.

G. RFI Log: Prepare and maintain a tabular log of RFIs for the duration of the project.
   1. Indicate current status of every RFI. Update log promptly and on a regular basis.
   2. Note dates of when each request is made, and when a response is received.
   3. Highlight items requiring priority or expedited response.

H. Review Time: Engineer will respond and return RFIs to Contractor within seven calendar days of receipt. For the purpose of establishing the start of the mandated response period, RFIs received after 12:00 noon will be considered as having been received on the following regular working day.
   1. Response period may be shortened or lengthened for specific items, subject to mutual agreement, and recorded in a timely manner in progress meeting minutes.

I. Responses: Content of answered RFIs will not constitute in any manner a directive or authorization to perform extra work or delay the project. If in Contractor's belief it is likely to lead to a change to Contract Sum or Contract Time, promptly issue a notice to this effect, and follow up with an appropriate Change Order request to Owner.
   1. Response may include a request for additional information, in which case the original RFI will be deemed as having been answered, and an amended one is to be issued forthwith. Identify the amended RFI with an R suffix to the original number.
   2. Do not extend applicability of a response to specific item to encompass other similar conditions, unless specifically so noted in the response.
   3. Upon receipt of a response, promptly review and distribute it to all affected parties, and update the RFI Log.
   4. Notify Engineer within seven calendar days if an additional or corrected response is required by submitting an amended version of the original RFI, identified as specified above.

3.08 SUBMITTAL SCHEDULE

A. Submit to Engineer for review a schedule for submittals in tabular format.
   1. Coordinate with Contractor's construction schedule and schedule of values.
   2. Format schedule to allow tracking of status of submittals throughout duration of construction.
   3. Account for time required for preparation, review, manufacturing, fabrication and delivery when establishing submittal delivery and review deadline dates.

3.09 SUBMITTALS FOR REVIEW

A. When the following are specified in individual sections, submit them for review:
   1. Product data.
   2. Design data.
   3. Shop drawings.

B. Submit to Engineer for review for the limited purpose of checking for compliance with information given and the design concept expressed in Contract Documents.

C. After review, provide copies and distribute in accordance with SUBMITTAL PROCEDURES article below and for record documents purposes described in Section 017800 - Closeout Submittals.

3.10 SUBMITTALS FOR INFORMATION

A. When the following are specified in individual sections, submit them for information:
   1. Design data.
   2. Certificates.
   3. Test reports.
   4. Inspection reports.
   5. Manufacturer's instructions.
   6. Manufacturer's field reports.

7. Other types indicated.

B. Submit for Engineer's knowledge as contract administrator or for Owner.

3.11 SUBMITTALS FOR PROJECT CLOSEOUT

A. Submit Correction Punch List for Substantial Completion.

B. Submit Final Correction Punch List for Substantial Completion.

C. When the following are specified in individual sections, submit them at project closeout in compliance with requirements of Section 017800 - Closeout Submittals:
   1. Project record documents.
   2. Operation and maintenance data.
   3. Warranties.
   4. Other types as indicated.

D. Submit for Owner's benefit during and after project completion.

3.12 NUMBER OF COPIES OF SUBMITTALS

A. Electronic Documents: Submit one electronic copy in PDF format; an electronically-marked up file will be returned. Create PDFs at native size and right-side up; illegible files will be rejected.

3.13 SUBMITTAL PROCEDURES

A. General Requirements:
   1. Submit separate packages of submittals for review and submittals for information, when included in the same specification section.
   2. Transmit using approved form.
      a. Use Contractor's form, subject to prior approval by Engineer.
   3. Sequentially identify each item. For revised submittals use original number and a sequential numerical suffix.
   4. Identify: Project; Contractor; subcontractor or supplier; pertinent drawing and detail number; and specification section number and article/paragraph, as appropriate on each copy.
   5. Apply Contractor's stamp, signed or initialed certifying that review, approval, verification of products required, field dimensions, adjacent construction work, and coordination of information is in accordance with the requirements of the work and Contract Documents.
      a. Submittals from sources other than the Contractor, or without Contractor's stamp will not be acknowledged, reviewed, or returned.
   6. Deliver each submittal on date noted in submittal schedule, unless an earlier date has been agreed to by all affected parties, and is of the benefit to the project.
   7. Schedule submittals to expedite the Project, and coordinate submission of related items.
      a. For each submittal for review, allow 15 days excluding delivery time to and from the Contractor.
      b. For sequential reviews involving approval from authorities having jurisdiction (AHJ), in addition to Engineer's approval, allow an additional 30 days.
   8. Identify variations from Contract Documents and product or system limitations that may be detrimental to successful performance of the completed work.
   9. Provide space for Contractor and Engineer review stamps.
   10. When revised for resubmission, identify all changes made since previous submission.
   11. Distribute reviewed submittals. Instruct parties to promptly report inability to comply with requirements.
   12. Incomplete submittals will not be reviewed.
   13. Submittals not requested will be recognized, and will be returned "Not Reviewed",

B. Product Data Procedures:
   1. Submit only information required by individual specification sections.

2. Collect required information into a single submittal.
3. Submit concurrently with related shop drawing submittal.
4. Do not submit (Material) Safety Data Sheets for materials or products.

C. Shop Drawing Procedures:
1. Prepare accurate, drawn-to-scale, original shop drawing documentation by interpreting Contract Documents and coordinating related work.
2. Do not reproduce Contract Documents to create shop drawings.
3. Generic, non-project-specific information submitted as shop drawings do not meet the requirements for shop drawings.

D. Samples Procedures:
1. Transmit related items together as single package.
2. Identify each item to allow review for applicability in relation to shop drawings showing installation locations.

3.14 SUBMITTAL REVIEW

A. Submittals for Review: Engineer will review each submittal, and approve, or take other appropriate action.

B. Submittals for Information: Engineer will acknowledge receipt and review. See below for actions to be taken.

C. Engineer's actions will be reflected by marking each returned submittal using virtual stamp on electronic submittals.
1. Notations may be made directly on submitted items and/or listed on appended Submittal Review cover sheet.

D. Engineer's and consultants' actions on items submitted for review:
1. Authorizing purchasing, fabrication, delivery, and installation:
a. "Approved", or language with same legal meaning.
b. "Approved as Noted, Resubmission not required", or language with same legal meaning.
1) At Contractor's option, submit corrected item, with review notations acknowledged and incorporated.
c. "Approved as Noted, Resubmit for Record", or language with same legal meaning.
1) Resubmit corrected item, with review notations acknowledged and incorporated. Resubmit separately, or as part of project record documents.
2. Not Authorizing fabrication, delivery, and installation:
a. "Revise and Resubmit".
1) Resubmit revised item, with review notations acknowledged and incorporated.
2) Non-responsive resubmittals may be rejected.
b. "Rejected".
1) Submit item complying with requirements of Contract Documents.

E. Engineer's and consultants' actions on items submitted for information:
1. Items for which no action was taken:
a. "Received" - to notify the Contractor that the submittal has been received for record only.
2. Items for which action was taken:
a. "Reviewed" - no further action is required from Contractor.

END OF SECTION 013000

SECTION 024100
DEMOLITION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Selective demolition of building elements for alteration purposes.

1.02 DEFINITIONS

A. Demolish: Dismantle, raze, destroy, or wreck any building or structure or any part thereof.

B. Remove: Detach or dismantle items from existing construction and dispose of them off site, unless items are indicated to be salvaged or reinstalled.

C. Remove and Salvage: Detach or dismantle items from existing construction in a manner to prevent damage. Clean, package, label and deliver salvaged items to Owner in ready-for-reuse condition.

D. Remove and Reinstall: Detach or dismantle items from existing construction in a manner to prevent damage. Clean and prepare for reuse and reinstall where indicated.

E. Existing to Remain: Designation for existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.

1.03 REFERENCE STANDARDS

A. 29 CFR 1926 - Safety and Health Regulations for Construction; Current Edition.

B. NFPA 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations; 2022, with Errata (2021).

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Site Plan: Indicate:
   1. Areas for temporary construction and field offices.
   2. Areas for temporary and permanent placement of removed materials.

C. Demolition Plan: Submit demolition plan as required by OSHA and local AHJs.
   1. Indicate extent of demolition, removal sequencing, bracing and shoring, and location and construction of barricades and fences.
   2. Demolition firm qualifications.

D. Project Record Documents: Accurately record actual locations of capped and active utilities and subsurface construction.

1.05 QUALITY ASSURANCE

A. Demolition Firm Qualifications: Company specializing in the type of work required.

PART 2 PRODUCTS -- NOT USED

PART 3 EXECUTION

3.01 DEMOLITION

A. Remove paving and curbs required to accomplish new work.

B. Remove concrete slabs on grade within site boundaries.

C. Remove other items indicated, for salvage, relocation, and recycling.

D. Fill excavations, open pits, and holes in ground areas generated as result of removals, using specified fill; compact fill as required so that required rough grade elevations do not subside within one year after completion.

3.02 GENERAL PROCEDURES AND PROJECT CONDITIONS

A. Comply with applicable codes and regulations for demolition operations and safety of adjacent structures and the public.
   1. Obtain required permits.
   2. Take precautions to prevent catastrophic or uncontrolled collapse of structures to be removed; do not allow worker or public access within range of potential collapse of unstable structures.
   3. Provide, erect, and maintain temporary barriers and security devices.
   4. Use physical barriers to prevent access to areas that could be hazardous to workers or the public.
   5. Conduct operations to minimize effects on and interference with adjacent structures and occupants.
   6. Do not close or obstruct roadways or sidewalks without permits from authority having jurisdiction.
   7. Conduct operations to minimize obstruction of public and private entrances and exits. Do not obstruct required exits at any time. Protect persons using entrances and exits from removal operations.
   8. Obtain written permission from owners of adjacent properties when demolition equipment will traverse, infringe upon, or limit access to their property.

B. Do not begin removal until receipt of notification to proceed from Owner.

C. Protect existing structures and other elements to remain in place and not removed.
   1. Provide bracing and shoring.
   2. Prevent movement or settlement of adjacent structures.
   3. Stop work immediately if adjacent structures appear to be in danger.

D. Minimize production of dust due to demolition operations. Do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.

E. Partial Removal of Paving and Curbs: Neatly saw cut at right angle to surface.

3.03 EXISTING UTILITIES

A. Coordinate work with utility companies. Notify utilities before starting work, comply with their requirements, and obtain required permits.

B. Protect existing utilities to remain from damage.

C. Do not disrupt public utilities without permit from authority having jurisdiction.

D. Locate and mark utilities to remain; mark using highly visible tags or flags, with identification of utility type; protect from damage due to subsequent construction, using substantial barricades if necessary.

E. Remove exposed piping, valves, meters, equipment, supports, and foundations of disconnected and abandoned utilities.

3.04 SELECTIVE DEMOLITION FOR ALTERATIONS

A. Existing construction and utilities indicated on drawings are based on casual field observation and existing record documents only.
   1. Verify construction and utility arrangements are as indicated.
   2. Report discrepancies to Engineer before disturbing existing installation.
   3. Clearly mark the demolition limits for piping, utilities, and equipment requiring abatement.

B. Separate areas in which demolition is being conducted from areas that remain occupied.

C. Remove existing work as indicated and required to accomplish new work.
   1. Remove items indicated on drawings.

D. Protect existing work to remain.

1. Prevent movement of structure. Provide shoring and bracing as required.
2. Perform cutting to accomplish removal work neatly and as specified for cutting new work.
3. Repair adjacent construction and finishes damaged during removal work.
4. Patch to match new work.

3.05 DEBRIS AND WASTE REMOVAL

A. Remove debris, junk, and trash from site.

B. Leave site in clean condition, ready for subsequent work.

C. Clean up spillage and wind-blown debris from public and private lands.

END OF SECTION 024100

SECTION 033000
CAST IN PLACE CONCRETE

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 specifies cast-in place concrete, including formwork, reinforcement, vapor retarder, joint dowels, concrete materials, mixture design, placement procedures, finishes and all related accessories, for the following:
   1. Footings.
   2. Foundation walls and piers.
   3. Slabs-on-grade.
   4. Miscellaneous concrete items.
   5. Placement of embedded items provided by other trades

B. Related Requirements:
   1. Division 01 Section “Structural Tests and Special Inspections”.
   2. Division 05 Sections for items cast into concrete.
   3. Division 31 Section “Earth Moving” and “Filled Steel Pipe Piles”.

1.03 REFERENCES

A. American Association of State Highway and Transportation Organization (AASHTO): M182 Burlap Cloth made from Jute or Kenaf.

B. American Concrete Institute (ACI):
   1. ACI 117 – Specifications for Tolerances for Concrete Construction and Materials.
   2. ACI 214 - Recommended Practice for Evaluation of Strength Test Results of Concrete.
   3. ACI 301 - Specifications for Structural Concrete for Buildings.
   4. ACI 302 – Guide for Concrete Floor and Slab Construction.
   5. ACI 304 - Guide for Measuring, Mixing, Transporting and Placing Concrete.
   6. ACI 305 - Hot Weather Concreting.
   7. ACI 306 - Cold Weather Concreting.
   8. ACI 308 – Standard Practice for Curing Concrete.
   9. ACI 308.1 – Standard Specification for Curing Concrete.
   10. ACI 309 - Guide for Consolidation of Concrete.
   11. ACI 318 - Building Code Requirements for Structural Concrete.

C. American Institute of Steel Construction (AISC): Code of Standard Practice for Buildings and Bridges.

D. American National Standards Institute (ANSI): NSF Standard 61.

E. American Plywood Association (APA) - Product Standard PS 1, Construction and Industrial Plywood.

F. American Society for Testing and Materials (ASTM).

G. Council of American Structural Engineers of Minnesota (CASE/MN): Guideline for Special Structural Inspection and Testing.

H. Concrete Reinforcing Steel Institute (CRSI):
   1. Manual of Standard Practice.
   2. Placing Reinforcing Bars.

I. International Building Code (IBC).

J. Minnesota State Building Code (MSBC).

K. National Ready Mixed Concrete Association (NRMCA): Certification of Ready Mixed Concrete Production Facilities.

L. Portland Concrete Association (PCA): Sandblasting of Concrete Surfaces IS 180T.

1.04 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans; subject to compliance with requirements.

1.05 SUBMITTALS

A. Product Data: For each type of product indicated.
   1. Form-release agents
   2. Concrete Admixtures.
   3. Curing Materials.
   4. Waterstops.
   5. Bonding Agents.
   6. Adhesives.
   7. Synthetic fibers.

B. Shop Drawings: Submit in accordance with ACI 315, “Standards on Details and Detailing of Concrete Reinforcement”.
   1. Provide detail placing drawings that illustrate fabrication, bending, and placement of reinforcement.
   2. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.

C. Concrete Mix Designs: Each concrete mix design submittal shall contain the following information:
   1. Mix Number (which will correspond to mix ticket on trucks delivered to site).
   2. Application for which concrete is designed (i.e. – footings, slabs, etc...)
   3. Applicable mix performance criteria including:
      a. Final Design strength at 28 days.
      b. Unit Weight.
      c. Air Content.
      d. Slump (with water only and after addition of WRA and/or HRWRA).
   4. Applicable mix ingredients including quantities, ASTM designations, and sources for:
      a. Cementitious materials.
      b. Aggregate source, geological type, size, and shape.
         1) Include total gradation for combined coarse and fine aggregates for mixes specified to contain Well Graded Aggregate.
         2) Included calculated Coarseness Factor and Workability Factor for mixes specifying limits on these values.
      c. Water.
         1) Indicate amount of mixing water to be withheld for later addition at Project site.
      d. Water cementitious materials ratio, w/cm.
      e. Admixtures.
      f. Fibers and other additions.
   5. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

D. Proposed construction joint and saw-cut contraction joint locations for slabs-on-grade.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94 requirements for production facilities and equipment.
   1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

1.07 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Avoid damaging coatings on steel reinforcement.

B. Synthetic Fibers: Deliver fiber reinforcement in manufacturer’s original, unopened, undamaged containers and packaging, with labels clearly identifying product name, unique identification number, code approvals, and directions for use, manufacturer, and weight of fibers. Store fiber reinforcement in clean, dry area indoors in accordance with manufacturer’s instructions. Keep packaging sealed until ready for use.

C. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

D. Joint Sealers and Curing Materials: Deliver in original factory packaging and unopened containers and protect from damage and contamination.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
   2. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.02 FORM-FACING MATERIALS

A. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

B. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.

C. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
   1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

D. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
   1. Furnish units that will leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
   2. Furnish ties that, when removed, will leave holes no larger than 1 inch in diameter in concrete surface.

2.03 STEEL REINFORCEMENT

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

B. Epoxy-Coated Reinforcing Bars: ASTM A 615, Grade 60, deformed bars, ASTM A 775, epoxy coated.

C. Headed Shear Connectors: ASTM A108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1, Type B.
   1. Available Manufacturers:
      a. Erico Fastening.
      b. Nelson Stud Welding.

D. Plain-Steel Wire: ASTM A 82, as drawn.

E. Epoxy-Coated Wire: ASTM A 884, Class A, Type 1 coated, as-drawn, plain-steel wire, with less than 2 percent damaged coating in each 12-inch wire length.

F. Plain-Steel Welded Wire Reinforcement: ASTM A 185, plain, fabricated from as-drawn steel wire into flat sheets.

2.04 FIBER REINFORCEMENT

A. Synthetic Fiber: Polypropylene fibers engineered and designed for use in concrete pavement, complying with ASTM C 1116, Type III.
   1. Synthetic Fiber Blend: Blend of macro-monofilament self-fibrillating fibers.
      a. Euclid Chemical Company; Tuf-Strand SF
      b. FORTA Corporation; FERRO
      c. Grace Construction Products, W. R. Grace & Co.; STRUX 90/40
      d. SI Concrete Systems; Novomesh 850.

2.05 JOINT DOWELS

A. Diamond Plate Dowels: Saw cut from ASTM A 36 hot rolled plate.
   1. Available Products:
      a. Diamond DowelTM by PNA, Inc.

B. Smooth Plate Dowels and Baskets:
   1. Approved Manufacturers:
      a. PNA, Inc.

2.06 REINFORCEMENT ACCESSORIES

A. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A 775.
   1. Available Products:
      a. 3M Scotchkote 213PC or liquid, two-part, epoxy repair coating or approved equal.

B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, or plastic according to CRSI's "Manual of Standard Practice," and as follows:
   1. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.

C. Supports for slabs-on-grade with steel reinforcement: Use supports with sand plates or horizontal runners.
   1. Dayton Richmond: Aztec E-Z Chair – PEZ with E-Z Chair Sand Plate PSP.
   2. General Technologies, Inc.: Composite Chairs on Sand Plates.

2.07 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice" and accepted shop drawings.

B. Do not re-bend or straighten steel reinforcement except where specifically accepted.

2.08 CONCRETE MATERIALS

A. Cementitious and Pozzolanic Materials: Use the following materials, of the same type, brand, and source for each required type of concrete and on which selection of concrete proportions was based:
   1. Portland Cement: ASTM C 150, Type I
      a. Use white Portland cement where indicated for decorative concrete such as, colored concrete, or other applications noted by Architect.
      b. For exposed concrete, use same brand throughout.
   2. Fly Ash: ASTM C618, Class C or F, and as specified herein.
      a. Available Alkalis, as Na2O equivalent: 1.5% maximum
      b. Loss On Ignition (LOI): 1% maximum
      c. Calcium Oxide Limit (CaO): 20% maximum
   3. Replacement Ratio: Portland cement shall be replaced on an equal mass (not weight) basis. Material replacements shall be expressed as a percent, by mass, of the total cementitious materials content, with proportions selected for 28 day compressive strengths equal to those specified. The change in volume resulting from the substitutions shall be determined and an adjustment in both coarse and fine aggregate proportions shall be determined in order to ensure a unit volume.

B. Normal-Weight Aggregates: ASTM C 33. Do not use aggregates containing soluble salts or other substances which can cause stains on exposed surfaces. Use aggregates from one source of supply corresponding to that on which selection of concrete proportions was based.
   1. Coarse Aggregate: Minimum Class Designation:
      a. Class 3S Typical
      b. Class 4S Exterior horizontal concrete
         1) Maximum absorption 1.7%
      c. Class 5S Exterior exposed architectural concrete
         1) Maximum absorption 1.7%
   2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Water: ASTM C 94 and potable.

2.09 ADMIXTURES

A. General: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use admixtures containing calcium chloride or thiocyanates.

B. Air-Entraining Admixture (AEA): ASTM C 260.

C. Water-Reducing Admixture (WRA): ASTM C 494, Type A.

D. Mid-Range Water-Reducing Admixture (MRWRA): ASTM C 494, Type A.

E. Polycarboxylate High-Range Water-Reducing Admixture (HRWRA): ASTM C 494, Type F.

F. Water-Reducing and Retarding Admixture: ASTM C 494, Type B and D.

G. Non-Corrosive, Non-Chloride Accelerator: ASTM C494, Type C or E.

H. Prohibited Admixtures: Calcium chloride, thiocyanates or admixtures effectively containing chloride ions (more than 0.05 percent) are not permitted.

2.10 CURING, CLEANING, AND SEALING MATERIALS

A. Water Cure:
   1. Waterproof paper.
   2. Reef Industries: Transguard Economy Grade. (((ASTM C171)), 20-mils thick, polypropylene sheet with nonperforforated white coating.)
   3. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.
   4. Dayton Bag and Burlap: Burlene.

5. Reef Industries: Transguard 4000; 42-mil thick, fiber mat with polyethylene sheet backing.

B. Water: ASTM C 94 and potable.

C. Clear, Solvent-Borne, Membrane-Forming Curing and Sealing Compound: ASTM C1315, Type 1, Class A, minimum 25 percent total solids.
   1. Available Products:
      a. ChemMasters; Spray-Cure & Seal Plus.
      b. Dayton Superior Corporation; Day-Chem Cure and Seal (J-22UV).
      c. Euclid Chemical Company; Super Diamond Clear.
      d. L&M Construction Chemicals, Inc.; Lumiseal Plus.
      e. Meadows, W. R., Inc.; CS-309/30.
      f. SpecChem, LLC; Cure & Seal 25 UV

D. Clear, Non-yellowing, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C1315, Type 1, Class A, minimum 25 percent total solids.
   1. Available Products:
      a. BASF; Kure 1315
      b. Burke by Edoco; Cureseal 1315 WB.
      c. ChemMasters; Polyseal WB.
      d. Euclid Chemical Company; Super Diamond Clear VOX.
      e. L&M Construction Chemicals, Inc.; Lumiseal WB Plus.
      f. Meadows, W. R., Inc.; Vocomp-30.
      g. SpecChem, LLC; Cure & Seal WB 25

2.11 JOINT MATERIALS

A. Equipment Control joint saw:
   1. Available Products:
      a. Soff-Cut International; “Soff-Cut System,” early-entry dry-cut saw with Skid Plate.

B. Expansion Joint Material: ASTM D1751, asphalt-saturated cellulosic fiber.
   1. Available Manufacturers:
      a. W.R. Meadows.
      b. BASF.

C. Joint Backer Rod: Flexible, compressible, closed-cell polyethylene foam, not less than 10 psi compression deflection.

D. Interior Joint Sealer: Mameco, Vulkem 45.

E. Interior Bond Breaker Joint: 30 pound asphalt felt, unperforated.

2.12 RELATED MATERIALS

A. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

B. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:
   1. Types I and II (non-load bearing); Types IV and V (load bearing) for bonding hardened or freshly mixed concrete to hardened concrete.

C. Under Slab Vapor Retarder: ASTM E1745, Class A.
   1. Manufacturers and Products:
      a. Barrier Bac, Inc., VB250 or VB350.
      b. Raven Industries, Vapor Block 10 or 15.
      c. Reef Industries, Inc., Vaporguard.
      d. Stego Industries, Stego Wrap Vapor Barrier 15 mil.

2. Accessories:
    a. Seam tape: High density polyethylene tape with pressure sensitive adhesive, minimum 4 inches wide.
    b. Pipe boots: Constructed from vapor barrier membrane and seam tape.

2.13 CONCRETE MIXING

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.

B. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94, with exceptions specified herein, and ASTM C 1116 where fibers are used, and furnish batch ticket information.
    1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

C. Admixtures: Use approved admixtures according to manufacturer's written instructions.
    1. Use chemical admixtures in concrete, as required, for placement, workability, durability, and controlled set time.

D. Air Content: Do not allow air content of hard-troweled finished floors to exceed 3 percent.

E. Concrete Slump Limits: Measured according to ASTM C 143 at point of placement.
    1. 4 inches without water reducing admixtures
    2. 5 inches after addition of WRA or MWRA.
    3. 7 inches after addition of HRWRA.
    4. A tolerance of up to one inch above indicated maximum will be allowed for one batch in any five consecutive batches tested.
    5. If the maximum water-cement ratio is not exceeded, concrete arriving at the jobsite within 60 minutes of the initial batching that has a slump less than the maximum allowed may have water added when accepted by the project inspector.
    6. Water reducing admixtures may be added to increase the slump when water can not be added and additional slump is necessary for workability when accepted by the project inspector.
    7. Water shall not be added to the mix after any supplemental water reducing admixtures have been dosed into the mixer.

2.14 CONCRETE MIXTURES FOR BUILDING ELEMENTS

A. Proportion normal-weight concrete mixture as follows:

Item	Requirements
Compressive Strength at 28 days (min), f'c	As noted in construction documents
Maximum water/cementitious materials ratio, w/cm	As noted in construction documents
Maximum Top Size Aggregate	3/4 inch typical; 1 1/2 inch in footings and concrete fill
Air Content (at point of placement) for concrete exposed to freezing and thawing	5.5% (± 1.5%)

B. Miscellaneous Concrete Items: Concrete stair pan fill, curbs, housekeeping pads, etc. Proportion normal-weight concrete mixture as follows:

Item	Requirements
Compressive Strength at 28 days (min), f'c	4000 psi
Maximum water/cementitious materials ratio, w/cm	0.45

Maximum Top Size Aggregate	1/2 inch

PART 3 EXECUTION

3.01 GENERAL

A. Work shall conform to ACI 117 and ACI 301, except as modified by requirements of these Contract Documents.

3.02 REFERENCE STANDARDS

A. ASTM A108 - Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished; 2018.

B. ASTM C618 - Standard Specification for Coal Ash and Raw or Calcined Natural Pozzolan for Use in Concrete; 2023, with Editorial Revision.

C. ASTM C1315 - Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete; 2019.

D. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Asphalt Types); 2023.

E. ASTM E1643 - Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs; 2018a.

F. ASTM E1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs; 2017 (Reapproved 2023).

G. PS 1 - Structural Plywood; 2023.

3.03 PREPARATION

A. Verify actual locations of existing structure, new work previously placed and other construction to which the new work must fit by accurate field measurements before submittal of related shop drawings or fabrication; show recorded measurements on shop drawings submitted for review. Coordinate fabrication schedule with construction progress to avoid delay of Work. Where work will be connected to existing masonry or concrete, contractor shall engage a testing agency to pre-locate hidden embeds and reinforcing steel prior to submittal of shop drawings. Provide templates and dimensions to fabricator for accurate alignment with existing conditions. Show field conditions impacting the work on the shop drawings, prior to submittal.

3.04 FORMWORK

A. Design, erect, shore, brace, and maintain formwork, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads. Contractor’s licensed specialty structural engineer shall design formwork to satisfy applicable codes and all imposed loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated.

C. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
   1. Class C, 1/2 inch for rough-formed finished surfaces.

D. Construct forms tight enough to prevent loss of concrete mortar.

E. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.

F. Chamfer exterior corners and edges of permanently exposed concrete.

G. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.05 REMOVING AND REUSING FORMS

A. General: Formwork for sides of footings, foundation walls, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 12 hours after placing concrete, if concrete is hard enough to not be damaged by form-removal operations and curing and protection operations are maintained.

B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.

C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.06 EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."

3.07 REINFORCEMENT INSTALLATION

A. General: Comply with CRSI's "Manual of Standard Practice" and accepted shop drawings for placing reinforcement.

B. Underfloor Vapor Retarders: When chairing reinforcement on top of underfloor vapor retarders, use only supports with integral sand plates.
   1. Do not cut or puncture vapor retarder.
   2. Repair damage and reseal cuts or punctures in vapor retarder before placing concrete.

C. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.

D. Accurately position, support, and secure reinforcement against displacement by formwork, construction, or concrete placement operations. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

E. Provide bar supports in sufficient number and heavy enough to carry steel they support. Place no bar more than 2 inches beyond last leg of continuous bar support. Do not use bar supports to support runways for concrete buggies, or similar loads.
   1. Maximum support bar spacing shall not exceed 48 inches.

F. Maximum bolster spacing shall not exceed 36 inches for #4 support bar or 48 inches for #5 support bar.

G. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

H. Steel reinforcement partially embedded in concrete shall not be field bent, except as indicated or permitted by Structural Engineer.

I. For walls reinforced on both faces, provide spreader bars and chairs to surfaces of forms on each side at spacings not to exceed 8 feet in either direction. For walls with single layer of reinforcing, provide chairs each side at spacings not to exceed 8 feet in either direction.

J. Install welded wire reinforcement in longest practicable lengths. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

K. Install diamond plate dowels in concrete slab-on-grade joints where shown. Install diamond plate dowels per manufacturer’s written instructions.

3.08 REINFORCEMENT PROTECTION AND REPAIR

A. Install additional bar supports at locations where reinforcement position is not maintained due to collapsed chairs or construction activity from time of original placement.

B. Epoxy-Coated Reinforcement: Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963. Use epoxy-coated steel wire ties to fasten epoxy-coated steel reinforcement.

3.09 MIXING

A. Add fiber reinforcement to concrete mixture in accordance with manufacturer's instructions and approved mix designs.

B. Mix fiber reinforcement in concrete mixer in accordance with mixing time and speed of ASTM C 94 and minimum 75 rotations at full mixing speed to ensure uniform distribution and random orientation of fibers throughout concrete.

3.10 JOINTS

A. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect and Engineer.
   1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints, unless otherwise indicated.
   2. Form joints with keyways and/or dowels as detailed. Embed keys at least 1-1/2 inches into concrete.
   3. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
   4. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

B. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows where not specifically shown on Drawings:
   1. Interior Slabs:
      a. Spacing shall not exceed 36 times slab thickness; 15 feet on center, maximum.
      b. Short: long side ratio not less than 2:3.
   2. Interior Slabs with Carpeting:
      a. Spacing shall not exceed 48 times slab thickness; 20 feet on center, maximum.
      b. Short: long side ratio not less than 2:3
   3. Sawed Joints: Form contraction joints with early-entry dry-cut power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.
      a. Install cuts 0 to 2 hours after final finishing and prior to final set.
      b. Install joint protector at saw-cut intersections prior to cross cut.
   4. Provide cleanly cut, straight joints in toppings over joints in base slab.

C. Isolation Joints in Slabs-on-Grade: After removing formwork, install expansion joint material at slab junctions with vertical surfaces, such as column pedestals, foundation walls, and other locations, as indicated.
   1. Extend expansion joint material full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated.
   2. Terminate full-width expansion joint material not less than 1/2 inch or more than 1 inch below finished concrete surface where joint sealants.
   3. Install expansion joint material in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

D. Install diamond plate dowels in concrete slab-on-grade joints where shown. Install diamond plate dowels per manufacturer's written instructions.

E. Sidewalks: Unless noted or detailed otherwise provide for expansion joints in sidewalks at intervals not to exceed 40 feet on centers and where walks abut curbs, stoops, walls or other fixed objects. Expansion joints shall be 1/2 inch wide using expansion joint materials. Provide tooled weak plane joints across sidewalks, one inch deep by 1/4 inch at 5 feet intervals, unless otherwise noted. Tool edges of joints to 1/8 inch radius.

F. Curbs: Provide control joints in poured in place concrete curbs 10 feet o.c. maximum spacings with expansion joints not over 40 feet o.c. Make control joints by cutting approximately 1/8 inch wide by one inch to 1-1/2 inch deep into exposed surfaces. Expansion joints shall be 1/2 inch wide with expansion joint material. At curbs adjacent to sidewalks, align joints in curb and sidewalk.

3.11 INSTALLING UNDER SLAB VAPOR RETARDER

A. Install according to membrane manufacturer's current published instructions and ASTM E1643.

B. Install over level granular base and under reinforcing and slabs on grade.

C. Lap over footings and seal to foundation walls.

D. Overlap membrane joints minimum 6 inches and seal continuously with seam tape.

E. Seal penetrations and pipes with pipe boot fashioned from membrane and sealed with seam tape.

F. Repair damaged membrane with patches of membrane overlapping damage minimum 6 inches and sealing completely with seam tape.

3.12 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

B. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.
   1. Do not add water to concrete after adding water-reducing admixtures to mixture.

C. Clean forms, reinforcing and accessories and lubricate forms prior to placing concrete.

D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
   1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
   2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
   3. Do not allow concrete to drop freely more than 4 feet.
   4. Use approved chutes equipped with suitable hoppers for placing where required.
   5. Place at rate that concrete is always plastic and flows readily into every space.

E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
   1. Before concrete slabs on grade are placed, verify that granular base is level and compacted.
   2. Sprinkle base to eliminate suction of water from concrete.
   3. Allow no freestanding water.
   4. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
   5. Maintain reinforcement in position on chairs during concrete placement.

6. Do not insert vibrators to bottom of slabs-on-grade with underfloor vapor retarders to avoid damaging this membrane.
7. Screed slab surfaces with a straightedge and strike off to correct elevations.
8. Slope surfaces uniformly to drains where required.
9. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

F. Do not use concrete that has partially hardened or been contaminated by foreign materials, nor concrete that has been retempered or remixed after initial set.

G. Before depositing new concrete on or against concrete that has set at construction joints, clean, wet and apply bonding agent to existing surfaces. Tighten forms prior to resuming pouring.

H. Exercise care to prevent splashing of forms or reinforcing with concrete above level of concrete being placed.

I. Clean reinforcement projecting above or out of concrete immediately after completion of particular unit of pour.

J. Do not place concrete under adverse weather conditions unless adequate protection is provided. Refer to ACI 301, for weather restrictions and placing temperatures.

3.13 COLD WEATHER CONCRETING

A. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
1. When average high and low temperature is expected to fall below 40 deg F, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
4. Ensure minimum temperatures are maintained for the duration of the curing period in accordance with ACI 306.1.
5. Concrete shall be allowed to dry for at least 12 hours before removing temperature protection for water cured or moisture retention cured concrete.

3.14 HOT WEATHER CONCRETING

A. Hot-Weather Placement: Comply with ACI 305 and as follows:
1. When high temperature, measured on jobsite at concrete placement area, is expected to rise above 90 degrees Fahrenheit, maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. When temperature of steel reinforcement, embeds, subgrade, or forms is greater than 120 degrees Fahrenheit, fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.
3. Protect concrete from wind and direct sunlight to avoid rapid drying.
4. Apply evaporation retarder to unformed concrete surfaces if the air temperature exceeds 80 degrees Fahrenheit, the wind speed exceeds 10 mph, or the relative humidity is less than 40%. Apply according to manufacturer's written instructions immediately after placing and screeding.
5. Apply moisture retaining covers or wet cure in accordance with concrete curing and protection methods as specified.

3.15 FINISHING FLOORS AND SLABS

A. Finish bare concrete floors (adjacent to floors with other surfacing) so concrete surface is level with other finishes, unless otherwise noted.

B. At areas to receive floor covering, grind joints smooth between slabs on grade and structural slabs and between existing and new surfaces to eliminate unevenness and to provide smooth, level surface across joints.

C. Wetting the concrete surface during finishing operations is prohibited.

D. Protect finished surfaces from damage. Keep free of abrasive materials.

E. In areas where water will be present (interior and exterior) place and finish slabs so areas will drain and water will not stand in puddles. Conform to slopes shown. Where elevations and slopes are not indicated, generally slope floors 1/8 inch per foot uniformly to drains, unless otherwise directed by Architect.

F. Finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding, 10-foot-long straightedge resting on 2 high spots and placed anywhere on the surface does not exceed 1/8-inch.

G. General Finishing Requirements: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces as appropriate to attain slab finish specified.
   1. Utilize wet-screed guides, dry-screed guides, and/or edge forms for initial strikeoff set with optical or laser instruments as appropriate to attain specified Floor Profile Number. Check elevation after initial strikeoff and repeat as necessary.
   2. Smooth and restraighten surface using 8 to 10 foot wide bull float, darby, or modified highway straightedge.
   3. Wait until bleed water sheen has disappeared and concrete can sustain finishing operations employed without digging in or disrupting the levelness of the surface.
   4. Float surface with one or more passes using a power float (float shoe blades or pans) or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.

H. CONC FIN-1: Float Finish.
   1. Follow General Finishing Requirements for initial procedures.

I. CONC FIN-2: Light Trowel Finish.
   1. Follow General Finishing Requirements for initial procedures.
   2. Restraighten surface if required following paste-generating float passes using 10-foot wide highway straightedge.
   3. Consolidate concrete surface, uniform in texture and appearance, with one to two passes using power trowel. Hand trowel areas inaccessible by power trowel.

J. CONC FIN-3: Medium Trowel Finish.
   1. Follow General Finishing Requirements for initial procedures.
   2. Restraighten surface if required following paste-generating float passes using 10-foot wide highway straightedge. Apply in two directions at 45 degree angle to strip. Use supplementary material to fill low spots.
   3. Consolidate concrete surface, uniform in texture and appearance, with two to three passes using power trowel. Hand trowel areas inaccessible by power trowel.

K. CONC FIN-4: Hard Trowel Finish.
   1. Follow General Finishing Requirements for initial procedures.
   2. Restraighten surface if required following paste-generating float passes using 10-foot wide highway straightedge. Apply in two directions at 45 degree angle to strip. Use supplementary material to fill low spots.

3. Consolidate concrete surface, uniform in texture and appearance, with three or more passes using power trowel. Hand trowel areas inaccessible by power trowel.

L. CONC FIN-5: Trowel and Fine Broom Finish.
1. Follow General Finishing Requirements for initial procedures.
2. Consolidate concrete surface, with one pass using a power trowel.
3. Slightly scarify surface with soft bristled broom while concrete is still plastic.

M. CONC FIN-8: Broom Finish.
1. Follow General Finishing Requirements, steps 1 through 3, for initial procedures.
2. Scarify surface with a transverse scored texture using a medium bristled broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.
3. Finish Tolerance: Surface shall not vary by more than □1/2 inch anywhere from elevation noted on Drawings.
4. Finish all concrete slabs to proper elevations to insure that all surface moisture will drain freely, and that no puddles exist. Contractor must bear cost of any corrections to provide positive drainage and repairing poorly finished surface areas.

N. Coordinate final slab texture requirements with requirements of final flooring materials.

O. Summary Slab Finish Schedule:

SLAB USE	SLAB FINISH
Sand-bed terrazzo	CONC FIN-1 Float Finish
Carpet or raised access floor	CONC FIN-2 Light Trowel Finish
Thin set resilient flooring; paint; or other thin film-finish coating system	CONC FIN-3 Medium Trowel Finish
Exposed to view with light foot traffic	CONC FIN-4 Hard Trowel Finish
Thin set ceramic or quarry tile; stone flooring; epoxy terrazzo	CONC FIN-5 Trowel and Fine Broom Finish

P. Measurement of Floor Tolerance:
1. Frequency: Conduct floor tolerance or measurements only if slab appears to be out of tolerance.
2. Floor slab tolerances provided for localized areas shall apply to sections maximum one bay in length and minimum one-half bay.
3. Conduct measurement of floor tolerance utilizing Dip Stick Floor Profiler.

3.16 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
1. Apply to formed concrete surfaces unless indicated otherwise.

B. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.17 MISCELLANEOUS CONCRETE ITEMS

A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.

3.18 CONCRETE PROTECTING AND CURING

A. General: Concrete shall be maintained above 50-degrees F and in a moist condition for at least the first seven days after placement. Provide curing and protection immediately after placement in accordance with ACI 301 using materials as specified herein.

B. Formed Surfaces: Cure formed concrete surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.

C. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, and other surfaces.

D. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
   1. Wet Curing: Keep surfaces continuously wet for not less than three days with the following materials:
      a. Water.
      b. Continuous water-fog spray.
      c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
      d. Protect surface from rapid loss of moisture upon termination of wet curing by covering with moisture-retaining covers for the remainder of the curing period.
   2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
   3. Curing and Sealing Compound: Apply uniformly to floors and slabs in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

E. Wet cure or use moisture-retaining covers on all concrete surfaces for first 24 hours, minimum.
   1. Continue curing in this manner for as long as Hot Weather Concreting conditions persist.

F. Curing and Sealing Compounds shall not be used on concrete surfaces to receive adhered coverings without prior manufacturer certification that it will not interfere with bonding of floor covering and warranties of flooring installer are validated.

G. Moisture Condition of Slabs – Following placement of concrete and climatization of building, check to see that any specified tests for moisture emission have been made and a written report submitted prior to floor covering or coating installation.

3.19 JOINT SEALING

A. When concrete has cured 30 to 90 days, and space has assumed its normal operating temperature, rake out loose debris and clean joint with compressed air.

B. Install backer rod and sealant according to manufacturer’s published recommendations.

C. Protect joint completely from traffic for 24 hours.

3.20 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval and in accordance with ACI 301. Repair methods for defects affecting the concrete’s structural performance shall be closely coordinated between Contractor and Engineer.

B. Patching Mortar: Submit proposed patching materials for Architect’s review and approval.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension in solid concrete, but not less than 1 inch in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
2. Repair defects on surfaces exposed to view by blending white Portland cement and standard Portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
2. After concrete has cured at least 14 days, correct high areas by grinding.
3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.21 FIELD QUALITY CONTROL

A. Contractor will assign an individual to monitor reinforcement position during concrete placement and reposition bars that are displaced due to construction activity.

B. The Owner will engage a qualified testing and inspection agency to provide special inspection and testing services and prepare reports in accordance with Division 01 “Structural Tests and Special Inspections”, and with Chapter 17 of the current IBC as adopted by the current MSBC, and the CASE/Mn Guideline for Special Structural Inspection and Testing, and other items which in the professional judgment of the Structural Engineer of Record, are critical to the integrity of the building structure.

C. Contractor will cooperate with and assist testing agency in obtaining representative concrete samples as concrete is placed for determining slump and air entrainment and casting test cylinders.
   1. Provide suitable space on site for storage for field condition test cylinders.
   2. If testing agency is not available, cast compression test cylinders as concrete is placed, determine and record slump of concrete, determine and record air content of concrete and submit cylinders and information to the testing agency.

D. General Inspections Items (Technical 1):
   1. Verification of formwork size.
   2. Verification of reinforcement.
   3. Verification of use of required design mixture.
   4. Concrete placement, including conveying and depositing.
   5. Curing procedures and maintenance of curing temperature.

E. Formwork Inspection (Technical 1) :
   1. Inspect formwork prior to concrete placement to verify resulting element width, depth and length correspond to those indicated on formwork installation drawings and Contract Documents.

F. Reinforcement Inspection (Technical 1):
   1. Inspect reinforcement in all cast-in-place concrete footings, and foundation frost walls, excluding slabs on grade, and footings without transverse reinforcement.
   2. Verify reinforcing bar grade.
   3. Verify reinforcing bars are free of dirt, excessive rust and damage.
   4. Verify reinforcing bars are adequately tied, chaired and supported to prevent displacement during concrete placement.
   5. Verify proper clear distances between bars and to surfaces of concrete.
   6. Verify reinforcing bar size and placement.
   7. Verify bar laps for proper length and stagger and bar bends for minimum diameter, slope and length.
   8. Verify epoxy coating is present at locations noted on the Contract Documents, include tie wires, chairs, bolsters, etc. Verify coating damage is repaired in accordance with the Contract Documents.
   9. Verify dosage of synthetic fiber reinforcement on all truck batch ticket reports.

G. Concrete Tests (Technical 1): Testing of composite samples of fresh concrete obtained according to ASTM C 172 - Practice for Sampling Freshly Mixed Concrete, ASTM C 31 - Practice for Making and Curing Concrete Test Specimens in the Field, and ASTM C 39 - Test Method for Compressive Strength of Cylindrical Concrete Specimens. Evaluation and acceptance of concrete shall be in accordance with ACI 318 and according to the following requirements:
   1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture where less than 50 yd3 is placed, plus one additional set for each additional 100 yd3 or fraction thereof.
      a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
   2. Slump: ASTM C 143; one test at point of discharge for each composite sample.
      a. Perform additional tests when concrete consistency appears to change.
   3. Air Content: When air content is specified, perform test in accordance with ASTM C 231, pressure method, for normal-weight concrete and ASTM C 173, volumetric method, for structural lightweight concrete.
      a. Where placement is by pump, air content shall be measured at location of placement.
      b. For concrete exposed to freezing and thawing, concrete from each truck shall be tested and concrete not meeting specified percentages shall not be placed.
      c. For interior concrete not exposed to freezing and thawing perform one test for each set of test cylinders.
      d. Concrete used in performing air content test shall not be used in fabricating test specimens
   4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
   5. Unit Weight: ASTM C 567, equilibrium unit weight of structural lightweight concrete; one test for each composite sample.
   6. Compression Test Specimens: ASTM C 31.
      a. Cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
      b. Cast and field cure one cylinder specimen for each composite sample.
         1) Store field-cured cylinders as near as possible to location of concrete represented by sample and give cylinder, insofar as practicable, same protection and curing as adjacent concrete.
      c. If additional specimens are required to verify early strength of concrete, contractor must pay for additional testing.
   7. Compressive-Strength Tests: ASTM C 39.
      a. Test one cylinder specimen at 7 days for information, and remaining two cylinder specimens at 28 days for acceptance.
      b. Deliver field-cured specimens to laboratory at 28 days and test to verify adequacy of curing and protection in field.
      c. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.

3.22 EVALUATION OF TEST RESULTS

A. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.

B. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

C. Test results shall be reported in writing to Architect, concrete supplier, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

D. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

E. Additional Tests: Testing and inspecting agency shall make additional tests of concrete at the expense of the Contractor when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42 or by other methods as directed by Architect.

F. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

G. Correct deficiencies in the Work that test reports and inspections indicate dos not comply with the Contract Documents.

H. Fill core holes with concrete specified for location.

END OF SECTION 03 30 00

END OF SECTION 033000

SECTION 051200
STRUCTURAL STEEL

PART 1 GENERAL

1.01 REFERENCE STANDARDS

A. ASTM A108 - Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished; 2018.

B. ASTM E164 - Standard Practice for Contact Ultrasonic Testing of Weldments; 2019.

C. ASTM E709 - Standard Guide for Magnetic Particle Testing; 2021.

D. ASTM F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs; 2022.

E. ASTM F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength; 2020.

F. SSPC-SP 1 - Solvent Cleaning; 2015, with Editorial Revision (2016).

G. SSPC-SP 2 - Hand Tool Cleaning; 2024.

H. SSPC-SP 3 - Power Tool Cleaning; 2024.

1.02 RELATED DOCUMENTS

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

1.03 SUMMARY

A. This Section includes the following:
   1. Structural steel framing members and all related accessories such as structural embeds, connections, bolts, welds, fasteners, threaded rods, headed studs, including fabrication, erection and all related work and accessories.
   2. Framing around openings larger than 6” in roof and floor deck systems.
   3. Connections.
   4. Temporary bracing and shoring, including related design by contractor’s specialty structural engineer.
   5. Shop applied finishes and coatings, including preparation, primers, special paint systems or galvanizing on steel exposed to exterior or aggressive environments, and bitumastic coating on steel below grade in soil.
   6. Grouting for base plates, seats and bearing areas.

B. Related Sections include the following:
   1. Division 01 Section "Structural Tests and Special Inspections" for independent testing agency procedures and administrative requirements.
   2. Division 03 Section “Concrete” for items attached to formwork, anchors and embeds to be cast in concrete.

1.04 REFERENCES

A. American Institute of Steel Construction (AISC):
   1. Code of Standard Practice for Buildings and Bridges.
   2. Manual of Steel Construction.

B. American Society for Testing and Materials (ASTM).

C. American Welding Society (AWS):
   1. AWS D1.1 - Structural Welding Code - Steel.
   2. AWS D1.3 - Structural Welding Code – Sheet Metal.

D. Council of American Structural Engineers of Minnesota (CASE/MN): Guideline for Special Structural Inspection and Testing.

E. International Building Code (IBC).

F. Minnesota State Building Code (MSBC).

G. Research Council on Structural Connections (RCSC): Specification for Structural Joints Using ASTM A 325 or A 490 Bolts.

H. The Society for Protective Coatings (SSPC):
   1. Standard Procedure for Evaluating Qualifications of Shop Painting Applicators.

I. U. S. Green Building Council (USGBC): Green Building Design and Construction Reference Guide.

1.05 DEFINITIONS

A. Structural Steel: Elements of structural steel frame, as classified by AISC's "Code of Standard Practice for Steel Buildings and Bridges," that support design loads, and as indicated on the structural contract documents.

1.06 SUBMITTALS

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

B. Shop Drawings and related submittals: Show complete information for fabrication and erection of structural-steel components.
   1. Submit shop drawings under provisions of Division 1 Section “Submittal Procedures”. Phase submittals to match sequence of actual construction to avoid delay of work. Field verify all existing conditions impacting this work and add relevant field information to shop drawings, prior to submittal of shop drawings.
   2. Indicate profiles, sizes, spacing, and locations of structural members, connections, attachments, fasteners, cambers, loads, welds, and headed studs. Cut erection details where details are cut on structural plans and add erection details as needed. Provide erection plans, erection details and member detail sheets. If partial area submittals are made, submit all related sheets and cloud related plan areas. Reference specific structural plans and details from which information is drawn or submittals will be rejected.
   3. Indicate welded connections using standard AWS welding symbols. Indicate net weld lengths and weld capacities. Indicate shop and field welds and sequence of erection.
   4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical high-strength bolted connections.
   5. Provide setting drawings, templates and directions for the installation of the anchor rods and other anchoring devices, including embedments.
   6. Welders Certificates: Submit under provisions of Division 1 Section “Submittal Procedures”. Welder’s Certificates, certifying welders employed on the Work obtained appropriate AWS qualification within the previous 12 months.

C. Qualification Data: For erector and fabricator.

D. Mill Test Reports: Submit under provisions of Division 1 Section “Submittal Procedures”. Signed by manufacturers certifying that the following products comply with requirements:
   1. Structural steel including chemical and physical properties.
   2. Bolts, nuts, and washers including mechanical properties and chemical analysis.
   3. Direct-tension indicators.
   4. Tension-control, high-strength bolt-nut-washer assemblies.
   5. Shear stud connectors.
   6. Shop primers.
   7. Non-shrink grout.
   8. Other structural elements as indicated on the documents.

1.07 QUALITY ASSURANCE

A. Installer (Erector) Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector.

B. Fabricator Qualifications: A qualified fabricator who participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant.

C. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel."

D. Comply with applicable provisions of the following specifications and documents:
   1. AISC's "Code of Standard Practice for Steel Buildings and Bridges."
   2. AISC's "Specification for Structural Steel Buildings."
   3. AISC's "Specification for the Design of Steel Hollow Structural Sections."
   4. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

E. Contractor shall assign a qualified staff member to perform quality control on their own work in the field on a daily basis, for each day work is performed. The Contractor's quality control staff shall review their own work for compliance with contract documents before the Contractor notifies the design team or others, of readiness for required inspections, tests and observations to be provided by the Owner's Representatives.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from erosion and deterioration.
   1. Store fasteners in a protected place. Clean and relubricate bolts and nuts that become dry or rusty before use.
   2. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

1.09 FIELD MEASUREMENTS

A. Verify actual locations of existing structure, new work previously placed and other construction to which the new work must fit by accurate field measurements before submittal of related shop drawings or fabrication. Show recorded measurements on shop drawings submitted for review. Coordinate fabrication schedule with construction progress to avoid delay of Work. Where work will be connected to existing masonry or concrete, contractor shall engage a testing agency to pre-locate hidden embeds and reinforcing steel prior to submittal of shop drawings. Provide templates and dimensions to fabricator for accurate alignment with existing conditions. Show field conditions impacting the work on the shop drawings, prior to submittal.

1.10 COORDINATION

A. Deliver anchor rods and other anchorage devices to be embedded in concrete or masonry construction to site in time for installation without impact on schedule. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

PART 2 PRODUCTS

2.01 STRUCTURAL-STEEL MATERIALS

A. W-Shapes: ASTM A 992, Grade 50.

B. Channels, Angles, Plate and Bar: ASTM A 36.

C. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade B, structural tubing.

D. Steel Pipe: ASTM A 53, Type E or S, Grade B, Finish.

E. Welding Electrodes: E70XX, comply with AWS requirements.

2.02 BOLTS, CONNECTORS, AND ANCHORS

A. High-Strength Bolts, Nuts, and Washers: ASTM A 325 or ASTM A 490, Type 1, heavy hex steel structural bolts; ASTM A 563 heavy hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers.
   1. Direct-Tension Indicators: ASTM F 959, Type 325 compressible-washer type.

B. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, round head steel structural bolts with splined ends; ASTM A 563 heavy hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers.

C. Shear Connectors or Headed Concrete Anchors: ASTM A108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1, Type B. The ferules shall be specifically designed for the weld-through technique.

D. Unheaded Anchor Rods: ASTM F1554, Grade 36 or as indicated on Drawings.
   1. Configuration: Straight with nut and washer, unless specifically indicated to be hooked on the drawings.
   2. Nuts: ASTM A 563 heavy hex carbon steel.
   3. Plate Washers: ASTM A 36 carbon steel.
   4. Washers: ASTM F 436 hardened carbon steel.

E. Headed Anchor Rods: ASTM F1554, Grade 36 unless otherwise indicated.
   1. Nuts: ASTM A 563 heavy hex carbon steel.
   2. Plate Washers: ASTM A 36 carbon steel.
   3. Washers: ASTM F 436 hardened carbon steel.

F. Threaded Rods: ASTM A 36.
   1. Nuts: ASTM A 563 heavy hex carbon steel.
   2. Washers: ASTM A 36 carbon steel.

G. Deformed Bar Anchors (DBA):
   1. Manufactures:
      a. Nelson Stud Welding, Inc.
   2. ASTM A496, uniform diameter with minimum tensile strength of 80ksi.

H. Expansion Bolts:
   1. Manufactures:
      a. Liebig International, Ultraplus
      b. Hilti, Kwik-Bolts II
      c. ITW Ramset/Redhead, Trubolt
      d. Wej-it Expansion Products, Inc. Wej-it Bolts
   2. If embedment length is not indicated on the drawings, provide embedment length recommended by the manufacturer to develop full strength of bolt.

I. Adhesive Anchors into Hollow Masonry:
   1. Manufacturers:
      a. Hilti, HY 200
   2. Rods: Standard rods per ASTM A36.
   3. If embedment length is not indicated on the Drawings, provide embedment length recommended by manufacturer to develop full strength of bolt.

J. Adhesive Anchors into Solid Masonry or Concrete:
   1. Manufacturers:
      a. Hilti, HIT RE 500
   2. Rods:
      a. Standard rods per ASTM A36.
      b. Super rods per ASTM A193 Grade B7.

c. Stainless steel rods per ASTM F593 Condition CW.
d. Reinforcement bar per Section 03200.

3. If embedment length is not indicated on the Drawings, provide embedment length recommended by manufacturer to develop full strength of bolt.
4. Provide rods threaded full length with 45 degree bevel cut at base.

K. Clevises and Turnbuckles: ASTM A108, Grade 1035, cold-finished carbon steel.

L. Eye Bolts and Nuts: ASTM A108, Grade 1030, cold-finished carbon steel.

M. Sleeve Nuts: ASTM A108, Grade 1018, cold-finished carbon steel.

N. Expansion Bolts for Steel to Steel Connections: Lindapter Hollo-Bolt
1. www.LindapterUSA.com

2.03 FINISH

A. All structural steel and related connectors permanently exposed to exterior environment: hot dip galvanized, or shop primed and shop or field painted in accordance with Owner's standards and specifications.

B. Steel not exposed to exterior environment: shop primed and shop or field painted, or plain in accordance with Owner's standards and specifications.

2.04 PRIMER

A. Primer:
1. Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer.
2. Color: Fabricator's standard.

B. Galvanizing Repair Paint: ASTM A 780.

C. Bituminous Protection Coating: Carboline, Bitumastic 50

2.05 GROUT

A. Nonmetallic, High Strength, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, non-staining, mixed with water to consistency suitable for application and a 30-minute working time. F'c=4000 psi minimum at 24 hours.

2.06 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC's "Specification for Structural Steel Buildings" as indicated on the documents.
1. Camber structural-steel members where indicated.
2. Identify high-strength structural steel according to ASTM A 6 and maintain markings until structural steel has been erected.
3. Mark and match-mark materials for field assembly.
4. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.

B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1.

C. Fabricate heavy shapes and connections (ASTM A6-Group 4 and 5 Rolled shapes) in accordance with AISC Manual of Steel Construction, Part 5, Paragraph A.3.C and related requirements for finishing: Accurately finish ends of columns and other members transmitting bearing loads.

D. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 1, "Solvent Cleaning or SSPC-SP 2, "Hand Tool Cleaning."

E. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer's written instructions.

F. Holes: Provide holes required for securing other work to structural steel and for passage of other work through steel framing members.
   1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
   2. Base-Plate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
   3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.07 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
   1. Joint Type: Snug tightened or as indicated on Drawings.

B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.
   1. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.
   2. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.
   3. Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable tolerances. Prevent weld show-through on exposed steel surfaces.
      a. Grind butt welds flush.
      b. Grind or fill exposed fillet welds to smooth profile. Dress exposed welds.

2.08 SHOP PRIMING

A. Shop prime steel surfaces except the following:
   1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
   2. Surfaces to be field welded.
   3. Surfaces to be high-strength bolted with slip-critical connections.
   4. Surfaces to receive sprayed fire-resistive materials.
   5. Galvanized surfaces.

B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
   1. SSPC-SP 2, "Hand Tool Cleaning."
   2. SSPC-SP 3, "Power Tool Cleaning."

C. Painting: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a dry film thickness of not less than 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
   1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
   2. Apply two coats of shop paint to inaccessible surfaces after assembly or erection. Change color of second coat to distinguish it from first

2.09 GALVANIZING

A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123.

1. Galvanize lintels and shelf angles attached to structural-steel frame and located in exterior walls.
2. Fill vent holes and grind smooth after galvanizing.

2.10 SOURCE QUALITY CONTROL

A. Owner will engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports in accordance with the quality control program indicated for Field Quality Control, unless the fabricator maintains AISC Certification.
   1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.

B. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

C. Bolted Connections: Shop-bolted connections will be inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

D. Welded Connections: In addition to visual inspection, shop-welded connections will be tested and inspected according to AWS D1.1 and the following inspection procedures, at testing agency's option:
   1. Liquid Penetrant Inspection: ASTM E 165.
   2. Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
   3. Ultrasonic Inspection: ASTM E164.
   4. Radiographic Inspection: ASTM E 94.

E. In addition to visual inspection, shop-welded shear connectors will be tested and inspected according to requirements in AWS D1.1 for stud welding and as follows:
   1. Bend tests will be performed if visual inspections reveal either a less-than- continuous 360-degree flash or welding repairs to any shear connector.
   2. Tests will be conducted on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify elevations of new and existing support surfaces and locations of anchor rods, bearing plates, and other embedments, with steel erector present, for compliance with requirements. Verify dimensions that affect the new work including gridlines, column and beam centerlines, face of wall, etc.

B. Remove and replace existing finishes, utilities and other obstructions that may impede proper access for verification of conditions and installation of new work.

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

3.02 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place, unless otherwise indicated.

3.03 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and "Specification for Structural Steel Buildings", as indicated on the drawings.

B. Base and Bearing Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting base and bearing plates. Clean bottom surface of base and bearing plates.
   1. Set base and bearing plates for structural members on wedges, shims, or setting nuts as required.
   2. Weld plate washers to top of base plate.
   3. Snug-tighten or Pretension anchor rods, as indicated on the drawings, after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of base or bearing plate before packing with grout.
   4. Promptly pack grout solidly between bearing surfaces and base and bearing plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

C. Maintain erection tolerances of structural steel and architecturally exposed structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."

D. Align and adjust various members forming part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
   1. Level and plumb individual members of structure.
   2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.

E. Splice members only where indicated.

F. Do not use thermal cutting during erection unless approved by structural engineer. Finish thermally cut sections within smoothness limits in AWS D1.1.

G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

H. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer's written instructions. The top flanges of the beams receiving stud shear connectors shall be free of any substances that might interfere with the welding operations. During welding the steel decking panels shall be free of detrimental substances and rest tightly upon the top flange of the beam.

I. No trades may field cut or alter structural members without specific approval of the Structural Engineer. Submit dimensioned plan and detail sketch of proposed modification under cover of an RFI or cloud proposed changes on shop drawings.

J. Provide deck support framing typically around openings in roof and floor deck cutting more than one deck rib. Also provide support thus where openings cutting only 1 rib occur within 24” of each other in the same deck span. Typical support detail is shown on the drawings. Not all openings are shown on the structural drawings. Fabricator shall coordinate with Mechanical, Electrical, Roofing contractors and other associated trades to include all such work in base bid and determine final locations as required.

3.04 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
   1. Joint Type: Snug tightened unless noted otherwise on Drawings.

B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.
   1. Comply with AISC's "Code of Standard Practice for Steel Buildings and Bridges" and "Specification for Structural Steel Buildings" for bearing, adequacy of temporary

connections, alignment, and removal of paint on surfaces adjacent to field welds. Contractor shall remove all weld slag using pick and brush to expose bright steel for self-verification of workmanship by the contractor and for Quality Assurance access by testing agency. This shall be done on a daily basis as welding proceeds.

2. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.
3. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.
4. Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable tolerances. Prevent weld show-through on exposed steel surfaces.
    a. Grind butt welds flush.
    b. Grind or fill exposed fillet welds to smooth profile. Dress exposed welds.

C. Tension Control Devices:
1. Install using electric power wrench as recommended by bolt manufacturer.
2. Tighten until splined end of bolt is sheared off.

D. Expansion Bolts or Adhesive Anchors: Install according to manufactures published instructions.

E. Shear Connectors:
1. Do not weld when the temperature is below 0 degrees Fahrenheit.
2. Remove standing water in deck ribs so that water is not trapped between beams and deck during welding.
3. Ensure that surfaces of steel beams to which studs are to be welded are dry and free of paint, dirt and debris and that deck bottom is in firm contact with beam.
4. Install studs after steel framing and metal decking are in place.
5. Use automatic welding equipment powered to weld studs satisfactorily under site conditions.
6. Prior to starting each day’s operations, weld at least two shear studs to determine proper generator control unit and stud welder settings.
7. Test that studs are capable of being bent 45 degrees from vertical without weld failure.
8. Weld additional trial shear studs at request of ITL.
9. Minimum projection of stud above top of deck: 1-1/2 inches.

3.05 FIELD QUALITY CONTROL

A. The Owner will engage a qualified testing and inspection agency to provide special inspection and testing services and prepare reports in accordance with Division 1, Section “Structural Tests and Special Inspections”, and with Chapter 17 of the current IBC as adopted by the current MSBC, and the CASE/Mn Guideline for Special Structural Inspection and Testing, and other items which in the professional judgement of the Structural Engineer of Record, are critical to the integrity of the building structure.

B. Special Inspection and Testing Criteria
1. General
    a. If special inspection of fabricators work is required in the shop, testing agent may test and inspect structural steel at plant before shipment. Owner and SER reserve right to reject material not complying with Contract Documents at any time before final acceptance.
2. Definitions
    a. a. Refer to Division 1, Section “Structural Tests and Special Inspections”for standard requirements.
    b. b. A.S.N.T.: The American Society for Non-destructive Testing
    c. c. N.D.E.: Non-destructive Evaluation

d. d. A.W.S./C.A.W.I.: American Welding Society / Certified Associate Weld Inspector
e. e. A.W.S./C.W.I.: American Welding Society / Certified Weld Inspector
f. f. Special Inspector – Technical: Shall be employed by a testing agency and shall be supervised by an A.W.S./C.W.I. with a minimum of 10 years experience, or an A.S.N.T. Level III with a minimum of 10 years experience. These individuals shall satisfy the following requirements:
    1) Technical I: Non-destructive Testing Technician A.S.N.T.-TC-1A Level I, and/or A.W.S. Certified Associate Weld Inspector (C.A.W.I.)
    2) Technical II: Nondestructive Testing Technician A.S.N.T.-TC-1A Level II (NDE Technician II), A.W.S./C.A.W.I. with minimum 3 years experience, or an A.W.S./C.W.I
    3) Technical III: A.S.N.T. Level III with a minimum of 10 years experience or an A.W.S./C.W.I with a minimum of 10 years experience.
g. g. Special Inspector – Structural
    1) 1) Structural I: Graduate civil/structural engineer, or other personnel acceptable to the SER, with experience in the design of structural systems of this type. Inspections shall be performed under the direct supervision of a licensed civil/structural engineer.
    2) 2) Structural II: Civil/structural engineer regularly engaged in the design of structural systems of this type, licensed in the state in which the project is located. The licensed engineer shall review and approve all inspection reports.
    3) 3) Special Inspector – Structural may be an employee of the SER.

3. Special Testing and Inspection Requirements
    a. High Strength Bolting (Field Installed).
        1) General (Technical II)
            (a) Visually inspect mating surfaces and bolt type for all slip-critical bolted connections for general conformance with the contract documents prior to bolting.
            (b) Determine the requirements for bolts, nuts, washers, paint and installation/tightening standards are met.
            (c) Observe calibration procedures when such procedures are required in the contract documents and verify that selected procedure is used to tighten bolts.
        2) Slip Critical Bolts and Tension Bolts (Technical II)
            (a) Test bolt tightening in 10% of all bolts. Test a minimum of two bolts in each connection. Verify that all plies of connected elements have been brought into contact, at 100% of connection. Verify all tips are removed from “twist-off” bolts.
        3) Bearing Bolts (Technical II)
            (a) Visually inspect to conform all plies of connected elements have been brought into contact, at 100% of connections. (Applies only to bolts designed for values not requiring exclusion of threads from failure plane, all other bolts require testing as for tension bolts.)
        4) Standard
            (a) Test High Strength bolted connections per R.C.S.C. Specifications for Structural Joints Using ASTM A325 or A490 Bolts.
    b. High Strength Bolting (Shop Installed) (Technical II)
        1) For shop fabricated work, perform tests required for field installation, except that bolt testing may be reduced of deleted, if fabrication shop satisfies AISC Quality Certification Program – Category I, or more stringent criteria, or is approved by SER.
    c. Welding (General): The Special Inspector shall perform the following (Technical II):

1) Prior to start of fabrication, determine if fabrication shop meets the criteria for exempting shop welds from inspection and confirm in writing to SER.
2) Verify qualifications of all welders as AWS certified.
3) Verify proposed welding procedures and materials.
4) Verify adequate preparation of faying surfaces.
5) Verify preheat and interpass temperature of steel, proper technique and sequence of welding, and cleaning and number of passes are provided as required.

d. Welding (Field)
1) Fillet Welds (Technical II)
(a) Visually inspect 100% of all fillet welds for size, length and quality per AWS D1.1.
2) Partial Penetration Welds (Technical II)
(a) Test 100% of all partial penetration welds exceeding 5/16 inch, using Ultrasonic Tester per AWS D1.1. Test 25% of all partial penetration welds less than 5/16 inch, using Magnetic Particle Testing per ASTM E109, performed on root pass on finished weld.
3) Full Penetration Welds (Technical II)
(a) Test 100% of all full penetration welds exceeding 5/16 inch, using Ultrasonic Tester per AWS D1.1. Test 25% of all full penetration welds less than 5/16 inch, using Magnetic Particle Testing per ASTM E109, performed on root pass on finished weld.
4) Stud Shear Connector Welds (Technical I)
(a) Visually inspect 100% of installed studs for full 360 degree flash. Test all questionable studs, not showing full 360 degree flash by bending studs 15 degrees from vertical, away from weld discontinuity, per AWS D1.1. All ceramic welding ferrules shall be removed by contractor. Randomly test all other studs by bending to 15 degrees from vertical as noted:
(1) Studs welded through deck: 15%
(2) Studs welded to bare steel: 5%
(3) Alternatively, sound 100% of installed studs, for full penetration weld, using an 8 lb. Maul. Test questionable studs as noted above. Welding ferrules need not be removed.
5) 5) Deck Welds and Fasteners (Technical I)
(a) a) Visually inspect size, location, length and burn through for 100% of puddle welds on metal deck designed as a structural element, per AWS D1.3.
(b) b) Visually inspect sidelap fasteners to meet spacing and size specified.
6) 6) Welding of Reinforcing Bars (Technical II)
(a) a) Be continuously present during welding and visually inspect 100% of all reinforcing bar welds as the welding is performed, per AWS D1.4. Verify proper joint preparation is provided and proper electrodes are used and properly store and dried.

e. Welding (Shop)
1) Perform inspections as for field welding except weld testing may be reduced or deleted, if fabrication shop satisfies AISC Quality Certification Program – Category I, or more stringent criteria, or is approved by SER.

f. Mechanical Fasteners (Misc.)
1) Fasteners (Technical I)
(a) Visually inspect specified size, spacing, embedment, and location of expansion bolts and adhesive bonded bolts in connections shown on the structural drawings.

(1) Structural Configuration

2) Submittals (Structural I)
   (a) Verify mill test reports and other submitted documentation for compliance with contract documents.
3) Materials (Technical I)
   (a) Verify materials delivered to site comply with contract documents and approved shop drawings. Materials include bolts, electrodes, mechanical fasteners and deck gauge.
4) Detail Compatibility (Structural I) On a periodic basis:
   (a) Review project documents affecting integrity of the structure, including contract documents and pertinent submittals (approved shop drawings)
   (b) Visit site, at intervals appropriate to the stage of construction, to perform review of the structure and visually confirm general compliance with the project documents.
   (c) Inspect the following to verify member orientation, configuration, type and size comply with details indicated on the contract documents and approved shop drawings:
      (1) Bracing and stiffening members.
      (2) Proper applications of joint details at connections for structural members.
      (3) Other work critical to the integrity of the building structure.

4. Conventional Testing and Inspection Requirements
   a. High Strength Bolting
      1) Bolt Material Test (Technical II)
         (a) Test a minimum of two bolts of each ASTM class specified, for bolt hardness and tensile properties.
      2) Fabrication and Erection Tolerances (Owner's Construction Manager)
         (a) Verify in-place structure satisfies specified tolerances

3.06 REPAIRS AND PROTECTION

A. If tests or inspections indicate Work does not meet specified requirements, remove work, replace and retest at no cost to Owner.

B. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

C. Touchup Painting: After installation, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted joists and accessories, bearing plates, and abutting structural steel.
   1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
   2. Apply a compatible primer of same type as shop primer used on adjacent surfaces.

END OF SECTION 051200

SECTION 053113
STEEL FLOOR DECK

PART 1 GENERAL

1.01 REFERENCE STANDARDS

A. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2022.

B. ASTM E329 - Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection; 2023.

C. SSPC-Paint 20 - Zinc-Rich Coating (Type I - Inorganic, and Type II - Organic); 2019.

1.02 RELATED DOCUMENTS

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

1.03 SUMMARY

A. This Section includes the following:
   1. Composite steel deck.
   2. Related accessories.

B. Related Requirements:
   1. Division 01 Section “Structural Testing and Special Inspections”.
   2. Division 03 Section “Cast-In-Place Concrete”.
   3. Division 05 Section “Structural Steel”.

1.04 REFERENCES

A. American Iron and Steel Institute (AISI):
   1. North American Specification for the Design of Cold-Formed Steel Structural Members.
   2. Cold-Formed Steel Framing Standards.

B. American Society for Testing and Materials (ASTM).

C. American Welding Society (AWS):
   1. AWS D1.1 - Structural Welding Code - Steel.
   2. AWS D1.3 - Structural Welding Code – Sheet Metal.

D. Steel Deck Institute (SDI): Steel Deck Institute Design Manual for Composite Decks, Form Decks, and Roof Decks - Publication No. 31.

E. The Society for Protective Coatings (SSPC): SSPC-Paint 20 - Zinc-Rich Coating.

F. U. S. Green Building Council (USGBC): Green Building Design and Construction Reference Guide.

1.05 ACTION SUBMITTALS

A. Product Data: For each type of deck, accessory, and product indicated.
   1. Include name of deck manufacturer as well as type, depth, gauge and finish of deck.

B. Shop Drawings:
   1. Show layout and types of deck panels, anchorage details, attachment patterns, field welding requirements, side lap fastenings, pans, cut deck openings, special jointing, closure plates, tabs or holes for ceiling hangers, trench headers, preset service fittings, prepunched holes for fittings, accessories, and attachments to other construction required for complete installation of decking.

C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that each of the following complies with requirements:
   1. Powder-actuated mechanical fasteners.

a. Substitute for deck welds at contractor's option. Product data and test reports shall demonstrate fasteners have equal or greater capacity than welds indicated and are suitable for attachment to base material.

1.06 INFORMATIONAL SUBMITTALS

A. Submittal Schedule for all action submittal items.

B. Product Certificates: For each type of steel deck, signed by product manufacturer certifying that products furnished comply with the requirements.

C. Welding certificates.

D. Research/Evaluation Reports: For steel deck.

1.07 QUALITY ASSURANCE

A. Manufacturer Qualifications: Fabricate panels to comply with dimensional parameters as defined in "Design Manual for Composite Decks, Form Decks, and Roof Decks" in SDI Publication No. 31. Section properties shall be based in accordance with the AISI Specification for the Design of Cold-Formed Steel Structural Members.

B. Installer Qualifications: An experienced installer who has completed steel deck similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1 and D1.3 Structural Welding Codes.

D. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM E329 for testing indicated, as documented according to ASTME 548.

E. Fire-Test-Response Characteristics: Where indicated, provide steel deck units identical to those tested for fire resistance per ASTM E119 by a testing and inspecting agency acceptable to authorities having jurisdiction.
   1. Fire-Resistance Ratings: Indicated by design designations of applicable testing and inspecting agency.
   2. Steel deck units shall be identified with appropriate markings of applicable testing and inspecting agency.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

C. Keep construction loads and stored materials, including other decking, off steel deck until it is permanently fastened and inspected.

D. Do not overload deck beyond 75 percent of rated normal capacity with stored materials or equipment.

1.09 COORDINATION

A. Provide decking to receive spray-applied fire-resistive materials (SFRM) free of amounts of lubricant or other contaminants which would significantly impair adhesion of sprayed materials.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
2. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.02 COMPOSITE STEEL DECK

A. Available Products:
   1. Nucor Corp.; Vulcraft Division: Type VLI.
   2. Canam Steel Corp.; Lok-Floor

B. Fabricate panels, with integrally embossed or raised pattern ribs, and interlocking side laps to comply with dimensional parameters as defined in “Design Manual for Composite Decks, Form Decks, and Roof Decks” in SDI Publication No. 31. Section properties shall be based in accordance with the AISI Specification for the Design of Cold-Formed Steel Structural Members.

C. Galvanized Steel Sheet: ASTM A 653, Structural Steel (SS), Grade 50, G60 zinc coating.

D. Galvanized and Shop-Primed Steel Sheet: ASTM A 653, Structural Steel (SS), Grade 50, G60 zinc coating; with unpainted top surface and cleaned and pretreated bottom surface primed with manufacturer's standard baked-on, rust-inhibitive primer.

E. Section Properties: Deck profile, depth, design uncoated steel thickness, and finish shall be as indicated on Drawings.

F. Span Condition: As indicated on drawings.

2.03 ACCESSORIES

A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.

B. Mechanical Fasteners: Corrosion-resistant, low-velocity, powder-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.

C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 minimum diameter.

D. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

E. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi, of same material and finish as deck, and of thickness and profile indicated.

F. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck, unless otherwise indicated.

G. Galvanizing Repair Paint: ASTM A 780.

H. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

3.02 INSTALLATION, GENERAL

A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 31, manufacturer's written instructions, and requirements in this Section.

B. Install temporary shoring before placing deck panels, if required to meet deflection limitations.

C. Locate deck bundles to prevent overloading of supporting members.

D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.
   1. Align cellular deck panels over full length of cell runs and align cells at ends of abutting panels.

E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.

F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.

G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.

H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

I. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions.

3.03 FLOOR-DECK INSTALLATION

A. Fasten floor-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated and as follows:
   1. Weld Diameter: 3/4 inch, nominal.
   2. Weld Spacing: Weld edge ribs of panels at each support. Space additional welds an average of 12 inches apart, but not more than 18 inches apart.
   3. Weld Spacing: Space and locate welds as indicated.

B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports as indicated on the drawings and as follows:
   1. Mechanically fasten with self-drilling, No. 10 diameter or larger, carbon-steel screws.
   2. Fasten with a minimum of 1-1/2-inch- long welds.

C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches, with end joints as follows:
   1. End Joints: Butted.

D. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure according to SDI recommendations, unless otherwise indicated.

E. Floor-Deck Closures: Weld steel sheet column closures, cell closures, and Z-closures to deck, according to SDI recommendations, to provide tight-fitting closures at open ends of ribs and sides of deck.

F. Install piercing hanger tabs at 14 inches apart in both directions, within 9 inches of walls at ends, and not more than 12 inches from walls at sides, unless otherwise indicated.

3.04 PROTECTION AND REPAIR

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Repair Painting: Wire brush and clean rust spots, welds, and abraded areas on bottom surface of prime-painted deck exposed to view immediately after installation and apply repair paint of same color as adjacent shop-primed deck.
   1. Wire brushing, cleaning, and repair painting of bottom deck surfaces as indicated in Division 09.

C. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Substantial Completion.

D. No hangers, fasteners or loads shall be hung from the underside of the deck unless specifically indicated thus on the structural drawings. Such items as mechanical/electrical equipment, utility lines, architectural bulkheads, ceilings, signage, etc, shall have their own sub-framing designed, supplied and installed by their related trade, as required span to adjacent beams, joists or walls for any support needed.

3.05 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage a qualified special inspector and independent testing and inspecting agency to perform field tests and inspections and prepare test reports in accordance with Division 01 Section “Structural Testing and Special Inspections”.

B. Inspections:
   1. Visually inspect size, location, length and burn-through for 100% of puddle welds on metal deck, per AWS D1.3, Section 6. (Technical I).
   2. Visually inspect size, location, and seating for 100% of powder-actuated or pneumatically driven fasteners on metal deck, per AWS D1.3, Section 6. (Technical I).
   3. Report inspection results promptly and in writing to Contractor and Architect.

C. Deck panels shall be clean, dry, and in firm contact with substrate prior to welding.

D. Remove and replace work that does not comply with specified requirements.

E. Additional inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

END OF SECTION 05 31 13

END OF SECTION 053113

SECTION 055000
METAL FABRICATIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Shop fabricated steel items.

1.02 REFERENCE STANDARDS

A. ASTM A276/A276M - Standard Specification for Stainless Steel Bars and Shapes; 2024.

B. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.

C. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2022.

D. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.

E. ASTM A283/A283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates; 2018.

F. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength; 2021.

G. ASTM A501/A501M - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing; 2021.

H. ASTM A554 - Standard Specification for Welded Stainless Steel Mechanical Tubing; 2021.

I. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2023.

J. 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; 2023.

K. ASTM F3125/F3125M - Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength; 2023.

L. AWS B2.1/B2.1M - Specification for Welding Procedure and Performance Qualification; 2021, with Errata (2023).

M. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2020, with Errata (2023).

N. AWS D1.2/D1.2M - Structural Welding Code - Aluminum; 2014, with Errata (2020).

O. SSPC-Paint 15 - Steel Joist Shop Primer/Metal Building Primer; 2004.

P. SSPC-Paint 20 - Zinc-Rich Coating (Type I - Inorganic, and Type II - Organic); 2019.

Q. SSPC-SP 2 - Hand Tool Cleaning; 2024.

1.03 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable.

C. Welders' Qualification Statement: Welders' certificates in accordance with AWS B2.1/B2.1M and dated no more than 12 months before start of scheduled welding work.

1.04 QUALITY ASSURANCE

A. Welder Qualifications: Welding processes and welding operators qualified in accordance with AWS D1.1/D1.1M and AWS D1.2/D1.2M and dated no more than 12 months before start of scheduled welding work.

PART 2 PRODUCTS

2.01 MATERIALS - STEEL

A. Steel Sections: ASTM A36/A36M.

B. Steel Tubing: ASTM A501/A501M hot-formed structural tubing.

C. Plates: ASTM A283/A283M.

D. Pipe: ASTM A53/A53M, Grade B Schedule 40, black finish.

E. Stainless Steel, General: ASTM A666, Type 304.

F. Stainless Steel Tubing: ASTM A554, Type 304, 16 gauge, 0.0625 inch minimum metal thickness, 1-1/2 inch diameter.

G. Stainless Steel Bars, Shapes and Moldings: ASTM A276/A276M, Type 304.

H. Slotted Channel Fittings: ASTM A1011/A1011M.

I. Mechanical Fasteners: Same material as or compatible with materials being fastened; type consistent with design and specified quality level.

J. Bolts, Nuts, and Washers: ASTM A307, Grade A, plain.

K. Bolts, Nuts, and Washers: ASTM F3125/F3125M, Type 1, plain.

L. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.

M. Shop and Touch-Up Primer: SSPC-Paint 15, complying with VOC limitations of authorities having jurisdiction.

N. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20, Type I - Inorganic, complying with VOC limitations of authorities having jurisdiction.

2.02 FABRICATION

A. Fit and shop assemble items in largest practical sections, for delivery to site.

B. Fabricate items with joints tightly fitted and secured.

C. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.

D. Furnish components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

2.03 FABRICATED ITEMS

A. Bumper Posts and Guard Rails: As detailed; prime paint finish.

B. Bollards: Steel pipe, concrete filled, crowned cap, as detailed; prime paint finish.

C. Joist Hangers: Strap anchors, fabricated with sheet steel, 18 gauge, 0.0478 inch minimum base metal thickness; galvanized finish.

D. Ledge Angles, Shelf Angles, Channels, and Plates Not Attached to Structural Framing: For support of metal decking; prime paint finish.

E. Lintels: As detailed; prime paint finish.

2.04 FINISHES - STEEL

A. Prime paint steel items.

1. Exceptions: Galvanize items to be embedded in concrete and items to be embedded in masonry.
2. Exceptions: Do not prime surfaces in direct contact with concrete, where field welding is required, and items to be covered with sprayed fireproofing.

B. Prepare surfaces to be primed in accordance with SSPC-SP2.

C. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.

D. Prime Painting: One coat.

E. Galvanizing of Structural Steel Members: Galvanize after fabrication to ASTM A123/A123M requirements. Provide minimum 1.7 oz/sq ft galvanized coating.

F. Galvanizing of Non-structural Items: Galvanize after fabrication to ASTM A123/A123M requirements.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field conditions are acceptable and are ready to receive work.

3.02 PREPARATION

A. Clean and strip primed steel items to bare metal where site welding is required.

3.03 INSTALLATION

A. Install items plumb and level, accurately fitted, free from distortion or defects.

B. Provide for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.

C. Perform field welding in accordance with AWS D1.1/D1.1M.

D. Obtain approval prior to site cutting or making adjustments not scheduled.

E. After erection, prime welds, abrasions, and surfaces not shop primed or galvanized , except surfaces to be in contact with concrete.

END OF SECTION 055000

SECTION 230500
COMMON WORK RESULTS FOR HVAC

PART 1 GENERAL

1.01 SUMMARY

A. This section includes the following:
   1. Piping materials and installation instructions common to most piping systems.
   2. Transition fittings.
   3. Grout.
   4. Equipment installation requirements common to equipment sections.
   5. Painting and finishing.
   6. Concrete bases.
   7. Supports and anchorages.

1.02 BASIS-OF-DESIGN

A. Equipment manufacturers listed on the equipment schedules are the basis-of-design. Manufacturers listed in the specification other than the basis-of design manufacturer are acceptable substitutions. Equipment schedules are on the drawings. Refer to specifications for unscheduled equipment.

1.03 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.04 SUBMITTALS

A. Product Data: For the following:
   1. Transition fittings.
   2. Dielectric fittings.
   3. Escutcheons.

B. Welding certificates.

C. Coordination Drawings: Submit one copy for the engineers use. Division 23 coordination drawings will not be returned.
   1. Detail major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Indicate if sequence and coordination of installations are important to efficient flow of the Work. Include the following:
      a. Planned piping layout, including valve and specialty locations and valve-stem movement.
      b. Planned piping hanger layout including building attachments and building structural coordination.
      c. Clearances for installing and maintaining insulation.

d. Clearances for servicing and maintaining equipment, accessories, and specialties, including space for disassembly required for periodic maintenance.
e. Equipment and accessory service connections and support details
f. Exterior wall and foundation penetrations.
g. Fire- and smoke-rated wall and floor penetration.
h. Sizes and locations of required concrete equipment curbs and bases.
i. Scheduling, sequencing, movement, and positioning of large equipment into building during construction.
j. Floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
k. Access door and panel locations.
l. Reflected ceiling plans to coordinate and integrate installation of air outlets and inlets, light fixtures, communication system components, sprinklers, and other ceiling-mounted items.

D. Equipment startup reports.
1. Reports will indicate equipment was started and tested according to the manufacturers recommendations and is operating as specified. Include test data.

1.05 QUALITY ASSURANCE

A. Comply with ASHRAE Guideline 4 – 2008 Preparation of operating and maintenance documentation for building systems.

B. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

C. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

D. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.06 GUIDELINES, CODES, AND STANDARDS

A. Refer to the most recently published edition for references to guidelines, and standards (examples: ASHRAE, NFPA, AWWA, ASTM) unless a specific edition is listed.

B. Installation and materials shall comply with applicable national, state, and local codes and ordinances.

1.07 DELIVERY, STORAGE, AND HANDLING

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

B. Materials and equipment stored on site shall have a protective covering; open ends on equipment connections and ducts shall be covered. Duct liner shall be encapsulated.

1.08 COORDINATION

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

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.02 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.03 JOINING MATERIALS

A. Refer to individual Division 23 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
      a. Full-Face Type: For flat-face, Class 150, cast-iron and cast-bronze flanges.
      b. Narrow-Face Type: For raised-face, Class 300, cast-iron and steel flanges.
   2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

PART 3 EXECUTION

3.01 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.

B. 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.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Install ¾" vents at all local high points where air could be trapped.

L. Install ¾" vents close to valves where piping is isolated and drained for maintenance, such as at coils, boilers, chillers, pump drops where strainers are located to facilitate venting when refilling isolated sections of pipe.

M. Install drain valves at low points, on equipment having drain ports, and in sections of pipe to be removed for maintenance such as strainer removal or tube cleaning.

N. Select system components with pressure rating equal to or greater than system operating pressure.

O. Sleeves are not required for core-drilled holes through walls.

P. Verify final equipment locations for roughing-in.

Q. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.02 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. 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.

E. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

F. 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 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:
   1. Install unions, in steel piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
   2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.04 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install HVAC equipment according to the equipment manufacturer's installation instructions and as indicated on the drawings. Resolve conflicting instructions, with the architect before mounting equipment.

B. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated.

C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

D. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

E. Install equipment to allow right of way for piping installed at required slope.

F. Refer to equipment shop drawings for rough in locations; do not scale drawings.

3.05 PAINTING

A. Painting of HVAC systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

END OF SECTION 230500

SECTION 230513
ELECTRIC MOTORS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Basic requirements for electrical equipment, materials and installation furnished as part of a packaged equipment assembly specified elsewhere in the Contract Documents.

1.02 RELATED REQUIREMENTS

A.

1.03 REFERENCE STANDARDS

A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.

B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.

C. NEMA MG 00001 - Motors and Generators; 2024.

1.04 SUBMITTALS

A. Include evidence of NRTL listing and labeling per paragraph 1.02

B. Include the following electrical data with equipment submittals for Engineer review:
   1. Nominal voltage, phase, frequency and peak and continuous current requirements for all required electrical supply connections.
   2. Interrupting and short circuit withstand ratings of fuses, circuit breakers, motor control equipment and control panels.
   3. Schematic and wiring diagrams.
   4. Termination information for all field wiring connections.
   5. Bill of materials and recommended spare parts list.

C. Motor Data:
   1. Manufacturer’s motor data sheet.
   2. Dimensioned drawings with mounting provisions, connection locations, and accessories clearly identified.
   3. Schematics and wiring diagrams for motor, and accessories such as RTDs, winding heaters, etc.
   4. Complete motor data sheet including all nameplate data and electrical ratings of all accessories.
   5. Motors over 200 HP:
      a. Complete thermal damage criteria including hot and cold safe stall times, running and stopped cooling times and stator current versus time curves.
      b. Maximum starting frequency.
      c. Unbalanced current versus time curve at rated temperature.
      d. Acceleration times and plots of motor torque, load torque, and current versus RPM based on the specific driven equipment at nominal voltage and at the specified minimum starting voltage.
   6. Motors over 600V:
      a. Dimensioned drawings of motor terminal enclosure including internal layout of terminals and components.
      b. Manufacturer’s catalog data and specifications for surge protection components.

1.05 QUALITY ASSURANCE

A. All materials and equipment shall be listed and labeled by a Nationally Recognized Testing Laboratory (NRTL) or other agency acceptable to the Authority Having Jurisdiction.

B. All materials and equipment shall comply with the applicable requirements of the latest edition of the standards of the following agencies:
   1. American National Standards Association (ANSI)
   2. ASTM International (ASTM)
   3. Electrical Testing Laboratories (ETL)
   4. Institute of Electrical and Electronic Engineers (IEEE)
   5. National Electrical Manufacturer's Association (NEMA)
   6. National Fire Protection Association (NFPA)
      a. 70 – National Electrical Code
   7. National Electrical Contractors Association (NECA)
   8. Underwriter's Laboratories (UL)

C. All equipment and materials shall be new and of the quality represented by the manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Provide all equipment and components of a similar type by the same manufacturer.

2.02 SUPPORT MATERIALS

A. Structural Shapes and Strut:
   1. Galvanized Steel: ASTM A123/A123M or ASTM A153/A153M
   2. Stainless Steel: AISI Type 316
   3. Aluminum: AA Type 6063-T6

B. Mounting Hardware:
   1. Galvanized steel
   2. Stainless steel

C. Field repair of galvanized structures:
   1. Zinc-rich primer, 30 mils minimum

2.03 ELECTRIC MOTORS (LOW VOLTAGE)

A. These requirements apply to all motors furnished with equipment unless the motor is custom-designed as an integral part of the driven equipment such as in submersible pumps or hermetic compressors. In such cases, motors shall comply with all of the listed requirements that are not precluded by the requirements of the driven equipment design. Preferred-supplier arrangements for standard motors are not grounds for exception to this specification.

B. Acceptable Manufacturers:
   1. Siemens
   2. Toshiba
   3. ABB
   4. TECO

C. General Requirements
   1. Comply with NEMA MG 00001
   2. Premium efficiency
   3. ½ HP and below: 115V, 1-PH
   4. Over ½ HP: 460V, 3-PH
   5. Enclosure: Cast iron frame and end bells.
   6. Windings: Copper
   7. Terminal boxes:

a. Oversized, gasketed, rotatable in 90 degree increments.
b. Provide two conduit entries on motors over 200 HP.

8. Service Factor: 1.15, minimum
   a. BHP requirement of the driven equipment over its full operating range shall not exceed the motor HP rating without including use of the service factor.
9. Insulation Temperature Rating: Class F
10. Design Temperature Rise: Class B
11. NEMA Design B unless other torque characteristic is required for operation.
12. NEMA standard frame sizes and mounting dimensions unless a custom design is required for operation.

D. Indoor Motors:
   1. Wet, damp, hazardous and corrosive locations: TEFC, TEAO or TENV enclosure.

E. Outdoor motors and motors located in outside air streams:
   1. TEFC or TEAO enclosure with drain-breather and 120V winding heater.

F. Starting Methods:
   1. All motors shall be designed for across-the-line starting unless indicated or specified otherwise.
   2. Motors for across-the-line starting shall be capable of safely starting and accelerating the driven equipment with a minimum terminal voltage of 85% of rated.
   3. Motors for reduced voltage starting shall be capable of safely starting and accelerating the driven equipment with the specified minimum terminal voltage or starting method.

G. Variable Frequency Drive Application:
   1. Comply with NEMA MG 00001 Part 31.
   2. Provide an insulated or ceramic drive-end bearing and a shaft grounding brush on the non-drive-end of the shaft.
   3. Utilize insulating coupling between the motor and driven equipment shafts.

2.04 MOTOR CONTROLLERS

A. Motor controllers provided as part of an equipment assembly or furnished by the equipment supplier for separate installation shall comply with the requirements of the applicable specification sections.

B. Section 262913 - Enclosed Controllers

C. Section 262923 - Variable-Frequency Motor Controllers

PART 3 EXECUTION

3.01 SUPPLY VOLTAGES

A. Design equipment for the following nominal system voltages at 60 Hz (+/- 10% operating range):
   1. 4160V 3-PH supplied from an {effectively-grounded} {low-resistance-grounded} wye-connected transformer for large motor loads only.
   2. 480V 3-PH or 1-PH, supplied from an effectively-grounded wye-connected transformer; service is 3-wire; no neutral is available.
   3. 208/120V 3-PH or 1-PH, supplied from an effectively-grounded wye-connected transformer; both 3-wire and 4-wire service is available.
   4. Maximum load at 120V 1-PH: 1500W
   5. 220V, 240V and 277V nominal voltages are not available at the site.

3.02 SHORT CIRCUIT RATINGS

A. Equipment shall be designed for the following minimum short circuit current interrupting and withstand ratings, unless indicated or specified otherwise:
   1. 208V and 120V: 10 kA RMS SYM

2. 480V: 65 kA RMS SYM
3. 4160V: 25 kA RMS SYM

3.03 WIRING METHODS

A. All line voltage (Over 50 VAC or 50 VDC) circuits shall be installed in raceways and enclosures.

B. Class 2 or other low-voltage and low-energy circuits installed outside of raceways shall be segregated from line voltage circuits within control panels and enclosures.

C. Conduit: Rigid metal conduit (RMC), Intermediate Metal Conduit (IMC).

D. Flexible liquid-tight metallic conduit (FLEX-LT).
   1. May be used for flexible connections to motors and instruments only.
   2. Maximum length: 18 inches for instrument connections; 36 inches for motor connections.

E. Outlet and Junction Boxes: Cast with threaded hubs and gasketed covers.

F. Support all conduits within 18 inches of boxes and enclosures and at minimum intervals per UL or NEC requirements.

G. Conductors:
   1. Line voltage control panel and motor controller internal wiring shall be Type SIS or MTW, with fine-stranded copper conductors and 600V rated insulation.
   2. Line voltage wiring to field devices shall be Type XHHW-2 with stranded copper conductors and 600V insulation.
   3. All terminations shall be made with compression-type ring terminal or spade lugs.

H. Include an insulated equipment grounding conductor in all line voltage circuits; metallic raceways and/or connections to equipment frame or structure shall not be relied upon for grounding.

I. Provide a ground bus or terminal screw at each external power supply connection location, bonded to the enclosure, for connection of an insulated equipment grounding conductor sized per NEC Table 250.122.

J. Control panels, terminal enclosures and pull and junction boxes:
   1. Indoors: NEMA 12
   2. Outdoors: NEMA 4

K. Label all conductors at both ends with machine-printed sleeve-type permanent wire markers to correspond to wire numbers or other designations on the drawings. Adhesive labels are not acceptable.

L. Provide labeling of all components with descriptions and identification matching the drawings. Labels on control panel doors shall be weatherproof engraved phenolic or engraved and filled corrosion-resistant metal, mechanically attached to the equipment. Adhesive mounting is not acceptable.

M. Equipment shall fit within the space indicated on the drawings without reducing required working clearances or access space. Oversized equipment will be rejected.

END OF SECTION 230513

SECTION 230517
SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Sleeves.
   2. Stack-sleeve fittings.
   3. Sleeve-seal systems.
   4. Grout.

1.02 ACTION SUBMITTALS

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

PART 2 PRODUCTS

2.01 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

C. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

2.02 STACK-SLEEVE FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Smith, Jay R. Mfg. Co.
   2. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.

B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.
   1. Underdeck Clamp: Clamping ring with setscrews.

2.03 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Metraflex Company (The).
   2. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
   1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   2. Pressure Plates: Carbon steel, Plastic, or Stainless steel.
   3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating or Stainless steel of length required to secure pressure plates to sealing elements.

2.04 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 EXECUTION

3.01 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch (25-mm) annular clear space between piping and concrete slabs and walls.
   1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
   1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
   2. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level.
   3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.
   1. Cut sleeves to length for mounting flush with both surfaces.
   2. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
   3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07 Section "Joint Sealants."

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping."

3.02 STACK-SLEEVE-FITTING INSTALLATION

A. Install stack-sleeve fittings in new slabs as slabs are constructed.
   1. Install fittings that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
   2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Division 07 Section "Sheet Metal Flashing and Trim."
   3. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level.
   4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
   5. Using grout, seal the space around outside of stack-sleeve fittings.

B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping."

3.03 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.04 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:
   1. Exterior Concrete Walls above Grade:
      a. Piping Smaller Than NPS 6 (DN 150): Cast-iron wall sleeves.
      b. Piping NPS 6 (DN 150) and Larger: Cast-iron wall sleeves.
   2. Exterior Concrete Walls below Grade:
      a. Piping Smaller Than NPS 6 (DN 150): Cast-iron wall sleeves with sleeve-seal system.
         1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
      b. Piping NPS 6 (DN 150) and Larger: Cast-iron wall sleeves with sleeve-seal system.
         1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
   3. Concrete Slabs-on-Grade:
      a. Piping Smaller Than NPS 6 (DN 150): Cast-iron wall sleeves with sleeve-seal system.
         1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
      b. Piping NPS 6 (DN 150) and Larger: Cast-iron wall sleeves with sleeve-seal system.
         1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
   4. Concrete Slabs above Grade:
      a. Piping Smaller Than NPS 6 (DN 150): Galvanized-steel pipe sleeves, Stack-sleeve fittings, or Sleeve-seal fittings.
      b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel pipe sleeves or Stack-sleeve fittings.
   5. Interior Partitions:
      a. Piping Smaller Than NPS 6 (DN 150): Galvanized-steel-pipe sleeves.
      b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 230517

SECTION 230519
METERS AND GAGES FOR HVAC PIPING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Bimetallic-actuated thermometers.
   2. Liquid-in-glass thermometers.
   3. Light-activated thermometers.
   4. Thermowells.
   5. Dial-type pressure gages.
   6. Gage attachments.
   7. Test plugs.
   8. Test-plug kits.
   9. Sight flow indicators.

1.02 ACTION SUBMITTALS

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

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

1.03 INFORMATIONAL SUBMITTALS

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

1.04 CLOSEOUT SUBMITTALS

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

PART 2 PRODUCTS

2.01 BIMETALLIC-ACTUATED THERMOMETERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Trerice, H. O. Co.
   2. Weiss Instruments, Inc.
   3. WIKA Instrument Corporation - USA.

B. Standard: ASME B40.200.

C. Case: Liquid-filled and sealed type(s); stainless steel with 3-inch nominal diameter.

D. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F.

E. Connector Type(s): Union joint, adjustable angle, with unified-inch screw threads.

F. Connector Size: 1/2 inch, with ASME B1.1 screw threads.

G. Stem: 0.25 or 0.375 inch in diameter; stainless steel.

H. Window: Plain glass.

I. Ring: Stainless steel.

J. Element: Bimetal coil.

K. Pointer: Dark-colored metal.

L. Accuracy: Plus or minus 1 percent of scale range.

2.02 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.

2.03 LIGHT-ACTIVATED THERMOMETERS

A. Direct-Mounted, Light-Activated 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. WIKA Instrument Corporation - USA.
2. Case: Metal; 7-inch nominal size unless otherwise indicated.
3. Scale(s): Deg F.
4. Case Form: Adjustable angle.
5. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
6. Stem: Aluminum and of length to suit installation.
    a. Design for Air-Duct Installation: With ventilated shroud.
    b. Design for Thermowell Installation: Bare stem.
7. Display: Digital.
8. Accuracy: Plus or minus 2 deg F.

2.04 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.

2.05 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.

2.06 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: Stainless steel ball, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

2.07 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 °F.

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

2.08 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 °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 °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.

2.09 SIGHT FLOW INDICATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Dwyer Instruments, Inc.
   2. Emerson Process Management; Brooks Instrument.
   3. Ernst Co., John C., Inc.
   4. Ernst Flow Industries.

B. Description: Piping inline-installation device for visual verification of flow.

C. Construction: Bronze or stainless-steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends.

D. Minimum Pressure Rating: Shall be confirmed based on the process requirements.

E. Minimum Temperature Rating: Shall be confirmed based on the process requirements.

F. End Connections for NPS 2 and Smaller: Threaded.

G. End Connections for NPS 2-1/2 and Larger: Flanged.

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

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

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

I. Install test plugs in piping tees.

J. Install elements in accessible positions in piping systems, accessible from the floor without the use of a ladder..

K. Install wafer-orifice flowmeter elements between pipe flanges.

L. Install connection fittings in accessible locations for attachment to portable indicators.

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

N. 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. After installation, calibrate meters according to manufacturer's written instructions.

B. 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 Steam and Steam-Condensate Piping: 50 to 400 °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 Low Pressure Steam Piping: 30 in. Hg to 15 psi.

B. Scale Range for Steam Piping: 0 to 300 psi.

END OF SECTION 230519

SECTION 230523
GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Globe valves.

B. Ball valves.

C. Butterfly valves.

D. Check valves.

E. Chainwheels.

1.02 ABBREVIATIONS AND ACRONYMS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

D. NRS: Nonrising stem.

E. OS&Y: Outside screw and yoke.

F. PTFE: Polytetrafluoroethylene.

G. RS: Rising stem.

H. TFE: Tetrafluoroethylene.

I. WOG: Water, oil, and gas.

1.03 REFERENCE STANDARDS

A. ASME B1.20.1 - Pipe Threads, General Purpose, Inch; 2013 (Reaffirmed 2018).

B. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; 2020.

C. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard; 2020.

D. ASME B16.10 - Face-to-Face and End-to-End Dimensions of Valves; 2022, with Errata (2023).

E. ASME B16.34 - Valves — Flanged, Threaded, and Welding End; 2020.

F. ASME B31.1 - Power Piping; 2024.

G. ASME B31.9 - Building Services Piping; 2020.

H. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings; 2004 (Reapproved 2023).

I. ASTM A216/A216M - Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service; 2021.

J. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings; 2017.

K. MSS SP-45 - Drain and Bypass Connections; 2020.

L. MSS SP-68 - High Pressure Butterfly Valves with Offset Design; 2021.

M. MSS SP-72 - Ball Valves with Flanged or Butt-Welding Ends for General Service; 2010a.

N. MSS SP-80 - Bronze Gate, Globe, Angle, and Check Valves; 2019.

O. MSS SP-85 - Gray Iron Globe and Angle Valves, Flanged and Threaded Ends; 2011.

P. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010, with Errata .

Q. MSS SP-125 - Check Valves: Gray Iron and Ductile Iron, In-Line, Spring-Loaded, Center-Guided; 2018.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data on valves including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.

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

1.05 QUALITY ASSURANCE

A. Manufacturer:
   1. Obtain valves for each valve type from single manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Minimize exposure of operable surfaces by setting plug and ball valves to open position.
   2. Protect valve parts exposed to piped medium against rust and corrosion.
   3. Protect valve piping connections such as grooves, weld ends, threads, and flange faces.
   4. Adjust globe, gate, and angle valves to the closed position to avoid clattering.
   5. Secure check valves in either the closed position or open position.
   6. Adjust butterfly valves to closed or partially closed position.

B. Use the following precautions during storage:
   1. Maintain valve end protection and protect flanges and specialties from dirt.
      a. Provide temporary inlet and outlet caps.
      b. Maintain caps in place until installation.
   2. Store valves in shipping containers and maintain in place until installation.
      a. Store valves indoors in dry environment.
      b. Store valves off the ground in watertight enclosures when indoor storage is not an option.

C. Exercise the following precautions for handling:
   1. Handle large valves with sling, modified to avoid damage to exposed parts.
   2. Avoid the use of operating handles or stems as rigging or lifting points.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Valve Pressure and Temperature Ratings: No less than rating indicated; as required for system pressures and temperatures.

B. Valve Sizes: Match upstream piping unless otherwise indicated.

C. Valve Actuator Types:
   1. Gear Actuator: Quarter-turn valves 8 inch and larger.
   2. Handwheel: Valves other than quarter-turn types.
   3. Hand Lever: Quarter-turn valves 6 inch and smaller.
   4. Wrench: Plug valves with square heads.
   5. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator, of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

D. Valves in Insulated Piping: Provide 2 inch stem extensions and the following features:
   1. Ball Valves: Extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
   2. Butterfly Valves: Extended neck.

E. Valve-End Connections:
   1. Threaded End Valves: ASME B1.20.1.
   2. Flanges on Iron Valves: ASME B16.1 for flanges on iron valves.
   3. Pipe Flanges and Flanged Fittings 1/2 inch through 24 inch: ASME B16.5.

F. General ASME Compliance:
   1. Ferrous Valve Dimensions and Design Criteria: ASME B16.10 and ASME B16.34.
   2. Power Piping Valves: ASME B31.1.
   3. Building Services Piping Valves: ASME B31.9.

G. Valve Bypass and Drain Connections: MSS SP-45.

H. Source Limitations: Obtain each valve type from a single manufacturer.

2.02 BRONZE, GLOBE VALVES

A. Ratings for Class 300:
   1. Class 300: CWP Rating; 600 psi.
   2. Comply with MSS SP-80, Type 1.
   3. Body: ASTM B62, bronze with integral seat and screw-in bonnet.
   4. End Connections: Threaded.
   5. Bonnet: NRS; Nonrising Stem.
   6. Nonrising Stem: Bronze.
   7. Disc: Bronze.
   8. Packing: Asbestos free.
   9. Handwheel Operator: Malleable iron or aluminum.
   10. Manufacturers:
      a. Crane Co.; Crane Valve Group; Crane Valves.
      b. Crane Co.; Crane Valve Group; Stockham Division.
      c. NIBCO INC.
      d. Or approved substitution.

2.03 IRON, GLOBE VALVES

A. CWP Ratings: Class 250: 500 psi:
   1. Comply with MSS SP-85, Type I.
   2. Body: Gray iron; ASTM A126, with bolted bonnet.
   3. Ends: Flanged.
   4. Trim: Bronze.
   5. Packing and Gasket: Asbestos free.
   6. Operator: Handwheel or chainwheel.
   7. Manufacturers:
      a. Apollo Valves; _____: www.apollovalves.com/#sle.
      b. Bonney Forge.
      c. Crane Co.; Crane Valve Group; Stockham Division.
      d. Hammond Valve.
      e. Milwaukee Valve Company.
      f. NIBCO INC.
      g. Or approved substitution.

2.04 CARBON STEEL, GLOBE VALVES

A. Class 300:
   1. Body: ASTM A216/A216M.
   2. CWP Rating: 725 psi.
   3. Bonnet: NRS; Nonrising Stem.
   4. End Connections: Flanged.

5. Packing and Gasket: Asbestos free.
6. Operator: Malleable iron handwheel.
7. Pressure and Temperature Rating: ASME B16.34.
8. Manufacturers:
    a. Apollo Valves
    b. Bonney Forge.
    c. Crane Co.; Crane Valve Group; Stockham Division.
    d. Hammond Valve.
    e. Milwaukee Valve Company.
    f. NIBCO INC.
    g. Or approved substitution.

2.05 BRONZE, BALL VALVES

A. General:
1. Fabricate from dezincification resistant material.
2. Copper alloys containing more than 15 percent zinc are not permitted.

B. Two Piece, Full Port with Stainless Steel Trim:
1. Comply with MSS SP-110.
2. WSP Rating: 150 psi.
3. CWP Rating: 600 psi.
4. Body: Forged bronze.
5. End Connections: Pipe thread or solder.
6. Seats: PTFE or TFE.
7. Stem: Stainless steel.
8. Ball: Stainless steel, vented.
9. Operator: Provide lockable handle and stem extension.
10. Manufacturers:
    a. Apollo Valves.
    b. Crane Co.
    c. Hammond Valve.
    d. Milwaukee Valve Company
    e. NIBCO INC.
    f. Or approved substitution.

2.06 CARBON STEEL, BALL VALVES

A. Class 300, Full Port, Stainless Steel Trim, Flanged:
1. Comply with MSS SP-72.
2. WOG Rating: 700 psi.
3. Body: Carbon steel, ASTM A216/A216M, Type WCB.
4. Seats: PTFE.
5. Stem: Stainless steel.
6. Ball: Stainless steel, vented.
7. Size: 1/2 to 12 inches.
8. Manufacturers:
    a. Apollo Valves.
    b. Crane Co.; Crane Valve Group; Crane Valves.
    c. Milwaukee Valve Company.
    d. NIBCO INC.
    e. Or approved substitution.

B. Two Piece, Full Port with Stainless Steel Trim:
1. Comply with MSS SP-110.

2. WSP Rating: 250 psi.
3. CWP Rating: 1,000 psi.
4. Seats: TFM.
5. Stem: Stainless steel, blowout proof.
6. Ball: Stainless steel, vented.
7. End Connections: Threaded or socket weld.
8. Operator: Lockable handle.
9. Pressure and Temperature Rating: ASME B16.34.
10. Manufacturers:
    a. Apollo Valves.
    b. Crane Co.; Crane Valve Group; Crane Valves.
    c. Milwaukee Valve Company.
    d. NIBCO INC.
    e. Or approved substitution.

2.07 HIGH-PERFORMANCE BUTTERFLY VALVES

A. Lug type; Bidirectional dead end service without downstream flange:
1. Comply with MSS SP-68.
2. Class 300: CWP Rating: 720 psi at 100 degrees F.
3. Body: Provide carbon steel or stainless steel.
4. Seat: Metal or reinforced PTFE.
5. Offset stem: Stainless steel.
6. Disc: 316 stainless steel.
7. Manufacturers:
    a. Bray International.
    b. Velan
    c. Dezurik Water Controls.
    d. Milwaukee Valve Company.
    e. Or approved substitution.

2.08 BRONZE, SWING CHECK VALVES

A. Class 300:
1. Pressure and Temperature Rating: MSS SP-80, Type 3.
2. Design: Y-pattern, horizontal or vertical flow.
3. CWP Rating: 300 psi.
4. Body: Bronze, ASTM B62.
5. End Connections: Threaded.
6. Disc: Bronze.
7. Manufacturers:
    a. American Valve, Incorporated..
    b. Crane Co.
    c. Kitz Corporation.
    d. Milwaukee Valve Company.
    e. NIBCO INC.
    f. Or approved substitution.

2.09 IRON, FLANGED END SWING CHECK VALVES

A. Class 250:
1. 300 psi with metal seats.
2. 500 psi with metal seats.

B. Standard: MSS SP-71, Type I.

C. Body Design: Clear of full waterway.

D. Body Material: ASTM A 126, gray iron with bolted bonnet.

E. Trim: Bronze.

F. Gasket: Asbestos free.

G. Manufacturers:
   1. Crane Co..
   2. Hammond Valve.
   3. Milwaukee Valve Company.
   4. NIBCO INC.
   5. Watts Regulator Co.
   6. Or approved substitution.

2.10 IRON, CENTER-GUIDED CHECK VALVES

A. Class 250, Compact-Wafer:
   1. Comply with MSS SP-125.
   2. Sizes 2-1/2 to 12 inch: CWP Rating; 400 psi.
   3. Body Material: ASTM A126, gray iron.
   4. Style: Spring loaded.
   5. Resilient Seat: EPDM.
   6. Manufacturers:
      a. Flo Fab Incorporated.
      b. Hammond Valve.
      c. Milwaukee Valve Company.
      d. NIBCO INC.
      e. Sure Flow Equipment Incorporated.
      f. Val-Matic Valve & Manufacturing Corporation.
      g. Or approved substitution.

2.11 CHAINWHEELS

A. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
   1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
   2. Attachment: For connection to ball, butterfly, and plug valve stems.
   3. Sprocket Rim with Chain Guides: Ductile iron include zinc coating.
   4. Chain: Hot-dip galvanized steel. Sized to fit sprocket rim.

B. Manufacturers:
   1. Babbit Steam Specialty Co..
   2. Roto Hammer Industries..
   3. Trumbull Industries..
   4. Or approved substitution.

PART 3 EXECUTION

3.01 EXAMINATION

A. Discard all packing materials and verify that valve interior, including threads and flanges, are completely clean without signs of damage or degradation that could result in leakage.

B. Verify valve parts to be fully operational in all positions from closed to fully open.

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.

E. Confirm gasket material to be suitable for the service, to be of correct size, and without defects that could compromise effectiveness.

F. Should valve be determined to be defective, replace with new valve. Do not attempt to repair.

3.02 INSTALLATION

A. Provide unions or flanges with valves to facilitate equipment removal and maintenance while maintaining system operation and full accessibility for servicing.

B. Provide separate valve support as required and locate valve with stem at or above center of piping, maintaining unimpeded stem movement.

C. Install valve in horizontal piping with stem at or above center of pipe.

D. Where valve support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc-rich primer to welds.

E. Install check valves where necessary to maintain direction of flow as follows:
   1. Lift Check: Install with stem plumb and vertical.
   2. Swing Check: Install horizontal maintaining hinge pin level.

F. Provide chainwheels on operators for valves 4 NPS and larger where located 84 inches or more above finished floor, terminating 60 inches above finished floor.

END OF SECTION 230523

SECTION 230529
HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 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 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
   2. Division 23 Section "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.

1.02 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.03 ACTION SUBMITTALS

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

1.04 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.05 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. Stainless-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
   2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
   3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

C. 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.

D. Variable Spring Hanger Assembly
   1. Type 51 variable spring, with Type 3 pipe clamp or Type 1 clevis. Type 53 variable spring trapeze may also be used. Locate Type 51 variable spring withing 1 foot above pipe attachment. Attach rod to top of variable spring with Type 14 clevis.
   2. Typical features of variable spring hangers include spring rates under 150 lb./in. enclosed spring, load and travel indicator, sizes available with load capabilities ranging from 50 lb to multiples of 10,000 lb.

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 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. Unistrut Corporation; Tyco International, Ltd.
   2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
   3. Standard: MFMA-4.
   4. Channels: Continuous slotted steel channel with inturned lips.
   5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
   6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
   7. Metallic Coating: Hot-dipped galvanized.

2.04 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 Cold Piping: 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 and vapor barrier.

C. 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.

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

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

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

2.05 FASTENER SYSTEMS

A. Power-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated or 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.

2.06 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.

2.07 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.08 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. Attachments to metal roof decks not utilizing structure concrete will not be permitted.

B. 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.

C. 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.

D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

E. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

F. Fastener System Installation:
   1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs greater than 4-inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by power-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
   2. Install mechanical fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured.
   3. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

G. 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.

H. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

I. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

J. 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.

K. Install lateral bracing with pipe hangers and supports to prevent swaying.

L. 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.

M. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

N. 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.

O. 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. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
    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.
4. 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.
    e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
5. Pipes NPS 8 and Larger: Include reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. 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 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 stainless-steel pipe hangers, fiberglass pipe hangers, and figerglass strut systems and stainless-steel or corrosion-resistant attachments for hostile environment applications.

G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

H. Use padded hangers for piping that is subject to scratching.

I. Use thermal-hanger shield inserts for insulated piping and tubing.

J. 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. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
   4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
   5. 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.
   6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
   7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
   8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
   9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
   10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
   11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
   12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
   13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
   14. 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.

15. 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.
16. 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.
17. 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.
18. 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.
19. 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.
20. 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.
21. 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.

K. 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.

L. 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.

M. 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.

N. 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.

O. 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.

P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

R. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 230529

SECTION 230553
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Equipment labels.
   2. Warning signs and labels.
   3. Pipe labels.
   4. Duct labels.
   5. Valve tags.
   6. Warning tags.

1.02 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.

1.03 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 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: White.

C. Background Color: Red.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. 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.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.03 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.

2.04 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.

2.05 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: Approximately 4 by 7 inches.
2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Color: Yellow background with black lettering.

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. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

D. All pipes 1" and larger shall also have size identification at same locations as service identification markers.

E. Pipe Marker Sizing Guide: (Outside pipe diameter including cover)
   1. NPS 3/4 to 1-1/4-inches: Minimum label length 8-inches; minimum letter height 1/2-inch.
   2. NPS 1-1/2 to 2-inches: Minimum label length 8-inches; minimum letter height 3/4-inch.
   3. NPS 2-1/2 to 6-inches: Minimum label length 12-inches; minimum letter height 1-1/4-inches.
   4. NPS 8 to 10-inches: Minimum label length 24-inches; minimum letter height 2-1/2-inches.
   5. NPS over 10-inches: Minimum label length 32-inches; minimum letter height 3-1/2-inches.

F. Pipe Label Color Schedule:
   1. Low-Pressure Steam Piping:

a. Background Color: Yellow.
b. Letter Color: Black.

2. High-Pressure Steam Piping:
   a. Background Color: Yellow.
   b. Letter Color: Black.
3. Steam Condensate Piping:
   a. Background Color: Yellow.
   b. Letter Color: Black.
4. Natural Gas Piping (Internal):
   a. Background Color: Yellow.
   b. Letter Color: Black.
5. Fuel Oil Piping:
   a. Background Color: Yellow.
   b. Letter Color: Black.
6. Compressed Air
   a. Background Color: Blue.
   b. Letter Color: White.

G. Do not use plastic pipe labels or plastic tapes for bare pipes conveying fluids at temperatures of 125 degrees F or higher. In these instances, stenciling shall be used.

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. Gas: 1-1/2 inches, round.
      b. Fuel Oil: 1-1/2 inches, round.
      c. Low-Pressure Steam: 1-1/2 inches, round.
      d. High-Pressure Steam: 1-1/2 inches, round.
      e. Steam Condensate: 1-1/2 inches, round.
   2. Valve-Tag Color:
      a. Gas: Yellow.
      b. Fuel Oil: Brown.
      c. Low-Pressure Steam: Yellow.
      d. High-Pressure Steam: Yellow.
      e. Steam Condensate: Green.
   3. Letter Color:
      a. Gas: Black.
      b. Fuel Oil: White.
      c. Low-Pressure Steam: Black.
      d. High-Pressure Steam: Black.
      e. Steam Condensate: White.

3.05 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 230553

SECTION 230719
HVAC PIPING INSULATION

PART 1 GENERAL

1.01 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 C547 - Standard Specification for Mineral Fiber Pipe Insulation; 2015.

J. ASTM C585 - Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing; 2010.

K. ASTM C591 - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation; 2015.

L. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel; 2008 (Reapproved 2013).

M. ASTM D2842 - Standard Test Method for Water Absorption of Rigid Cellular Plastics; 2012.

N. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.

O. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials; 2014.

P. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.02 SUMMARY

A. Section includes insulating the following HVAC piping systems:
   1. Indoor steam and steam condensate piping.
   2. Outdoor Fuel oil supply and return 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.

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 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.

B. 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. 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. 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. 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.

G. Mineral-Fiber, Pipe Insulation Wicking System:
1. Preformed pipe insulation complying with ASTM C 547, Type I, Grade A, with absorbent cloth factory-applied to the entire inside surface of preformed pipe insulation and extended through the longitudinal joint to outside surface of insulation under insulation jacket. Factory apply a white, polymer, vapor-retarder jacket with self-sealing adhesive tape seam and evaporation holes running continuously along the longitudinal seam, exposing the absorbent cloth.
2. Products: Subject to compliance with requirements, provide one of the following:
   a. Knauf Insulation; Permawick Pipe Insulation.
   b. Owens Corning; VaporWick Pipe Insulation.
3. Insulation: ASTM C547; rigid molded, noncombustible
   a. 'K' Value: ASTM C177, 0.24 at 75° F
   b. Maximum service temperature: 850° F
   c. Maximum moisture absorption: 0.2% by volume
4. Wicking Material
   a. Insulation shall be lined with vapor 'wicking' material to draw moisture or vapor away from the pipe, valves, and fittings. Wicking material shall extend continuously to outside of vapor retarder.
   b. Exposed evaporator area shall not be less than 0.1 sq. ft. / linear ft.
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.
   c. Vapor retarder shall extend not less than 98% of the circumference of the product.
6. Tie Wire: 0.048" stainless steel with twisted ends on maximum
   a. 12" centers.
7. Vapor Barrier Lap Adhesive:
   a. Compatible with insulation.

H. Polyisocyanurate: Unfaced, preformed, rigid cellular polyisocyanurate material intended for use as thermal insulation.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Dow Chemical Company (The); Trymer 2000 XP.
   b. Duna USA Inc.; Corafoam.

c. Dyplast Products; ISO-25.
d. Elliott Company of Indianapolis; Elfoam.

2. Comply with ASTM C 591, Type I or Type IV, except thermal conductivity (k-value) shall not exceed 0.19 Btu x in./h x sq. ft. x deg F at 75° F after 180 days of aging.
   a. Dimension: Comply with requirements of ASTM C 585.
   b. 'K' value: 0.19 at 75 degrees F, when tested in accordance with ASTM C 518
   c. Minimum Service Temperature: -40° F.
   d. Maximum Service Temperature: 250° F.
   e. Water Absorption: 0.5 percent by volume, maximum, when tested in accordance with ASTM D 2842.
   f. Moisture Vapor Transmission: 4.0 perm in.
   g. Connection: Waterproof vapor barrier adhesive.
3. Fittings
   a. Custom manufactured fittings
   b. Fittings, such as valves, strainers, flanges, 90 degree and 45 degree elbows, tees, etc., shall be insulated with two piece flycut or routed as the preferred fabrication methods. For diameters too large for flycutting or routing, the pieces shall be fabricated in two halves with each half made up of mitered sections. Both methods shall be in accordance with ASTM C-450 and C-585.
4. Flame-spread index shall be 25 or less, and smoke-developed index shall be 50 or less for thickness up to 1 inch as tested by ASTM E 84.
5. Fabricate shapes according to ASTM C 450 and ASTM C 585.
6. 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, provide the following:
      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. 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. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
   1. Products: Subject to compliance with requirements, provide one of 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 indoor use on below-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-30.
      b. Eagle Bridges - Marathon Industries; 501.
      c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-35.
      d. Mon-Eco Industries, Inc.; 55-10.
   2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
   3. Service Temperature Range: 0 to 180° F.

4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
5. Color: White.

D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-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; 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° F.
4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
5. Color: White.

E. 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° F.
4. Solids Content: 60 percent by volume and 66 percent by weight.
5. Color: White.

2.05 SEALANTS

A. Joint Sealants:
1. Joint Sealants for Cellular-Glass, Phenolic, and Polyisocyanurate 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-76.
b. Eagle Bridges - Marathon Industries; 405.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
d. Mon-Eco Industries, Inc.; 44-05.
e. Pittsburgh Corning Corporation; Pittseal 444.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: Minus 100 to plus 300° F.
5. Color: White or gray.
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."

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° 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 FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in. for covering pipe and pipe fittings.
   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; Chil-Glas Number 10.

B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for pipe.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Mast-A-Fab.
      b. Vimasco Corporation; Elastafab 894.

2.08 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd..
   1. Products: Subject to compliance with requirements, provide the following:
      a. Alpha Associates, Inc.; Alpha-Maritex 84215 and 84217/9485RW, Luben 59.

2.09 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.
   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.

C. Metal Jacket:
   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; Metal Jacketing Systems.
      b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
      c. RPR Products, Inc.; Insul-Mate.
   2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
      a. Sheet and roll stock ready for shop or field sizing.
      b. Finish and thickness are indicated in field-applied jacket schedules.
      c. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
      d. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
      e. Factory-Fabricated Fitting Covers:
         1) Same material, finish, and thickness as jacket.
         2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
         3) Tee covers.
         4) Flange and union covers.
         5) End caps.
         6) Beveled collars.
         7) Valve covers.
         8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.10 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.

C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, provide one of 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.

2.11 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. 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 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.

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

C. 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.

D. 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. 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 INSTALLATION OF POLYISOCYANURATE INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of insulation to pipe with tape or bands and tighten without deforming insulation materials. Orient longitudinal joints between half sections in 3- and 9-o'clock positions on the pipe.
2. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
3. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.

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, same thickness of adjacent pipe insulation, not to exceed 1-1/2-inch thickness.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyisocyanurate block insulation of same thickness as pipe insulation.

C. Insulation Installation on Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed sections of polyisocyanurate 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.

3.08 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.

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

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

3.10 FIELD QUALITY CONTROL

A. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.11 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.
   1. Insulation on the hydronic pipe is required behind the IDUs. Due to limited space the thickness of the insulation can be reduced to 1".

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.

3.12 INDOOR PIPING INSULATION SCHEDULE

A. Steam, High Pressure
   1. Insulation shall have the following:
      a. 3/4" pipe size and below - Minneral-Fiber, Preformed Pipe, Type I: 4.5-inches thick.

b. 1" pipe sizes and above - Minneral-Fiber, Preformed Pipe, Type I: 5-inches thick.

2. Install stucco embossed aluminum jacket over insulation material. For insulation with factory-applied jacket, install teh field applied jacket of the factory-applied jacket.

B. Steam Condensate:

1. Insulation shall be the following:
   a. 3/4" pipe size and below - Minneral-Fiber, Preformed Pipe, Type I: 3-inches thick.
   b. 1" pipe size ato 1-1/4" pipe size - Minneral-Fiber, Preformed Pipe, Type I: 4-inches thick.
   c. 1-1/2" pipe size and above - Minneral-Fiber, Preformed Pipe, Type I: 4.5-inches thick.
2. Install stucco embossed aluminum jacket over insulation material. For insulation with factory-applied jacket, install teh field applied jacket of the factory-applied jacket.

3.13 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Fuel oil supply and return piping:

1. Insulation shall be the following:
   a. Insulate exterior fuel oil supply and return piping with 2" closed-cell polysiocyanurate insulation with ASJ and covered with stucco finished aluminum outer jacket.
   b. Insulation at supports shall have a mimimum compressive strength of 130 PSI.

END OF SECTION 230719

SECTION 230910
FIELD DEVICES

(BURNER VENDOR)

PART 1 GENERAL

2.01 REFERENCE STANDARDS

A. ASME B31.1 - Power Piping; 2024.

B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2020.

C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

D. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

E. UL 486A-486B - Wire Connectors; Current Edition, Including All Revisions.

2.02 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.
   1. ASME INTERNATIONAL (ASME)
   2. ASME B31.1 (2012) Power Piping ASTM INTERNATIONAL (ASTM)
   3. ASTM A269 (2010) Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
   4. NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)
   5. NEMA 250 (2008) Enclosures for Electrical Equipment (1000 Volts Maximum)
   6. NEMA WC 57 (2004) Standard for Control, Thermocouple Extension, and Instrumentation Cable
   7. NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)
   8. NFPA 70 (2011; Errata 2 2012) National Electrical Code
   9. NFPA 85 (2011; Errata 2011) Boiler and Combustion Systems Hazards Code
   10. UNDERWRITERS LABORATORIES (UL)
   11. UL 467 (2007) Grounding and Bonding Equipment
   12. UL 486A-486B (2003; Reprint Feb 2010) Wire Connectors

2.03 RELATED REQUIREMENTS

A. Refer to SECTION 23 05 19 for Burner Meters and Gauges. Refer to SECTION 23 09 10.20 for BURNER Steam Plant PLC. Refer to SECTION 23 09 10.48 for Steam Plant Logic.

2.04 SUMMARY

A. This SECTION includes specifications for field devices and accessories including, but not limited to control valves, transmitters, regulators, control tubing, etc. This SECTION includes burner train and drum level related devices.

B. There are 28 existing Siemens 353 loop controllers located in the plant control room. These controllers are used for boiler Combustion Controls, Plant Master, and Steam Pressure Control. The Controls shall be migrated to the new system.
   1. These combustion controls shall be migrated to the local boiler control panel for each boiler. The conduit shall be re routed to the new panel and new wire pulled.
   2. The Plant Master and Steam Pressure Control shall be migrated to the existing balance of plant PLC.

2.05 SUBMITTALS

A. DES approval/acceptance is required for submittals with a “DES” designation, submittals not having a designation are for information only. Submit the following in accordance with SECTION 01 30 00 SUBMITTAL PROCEDURES:

1. Shop Drawings
    a. Wiring Diagrams; DES
    b. P&ID for Each Boiler; DES
    c. IO List and IO Plan; DES
2. Product Data
    a. Boiler Drum Water Column and Gauge Glass; DES
    b. Boiler Drum Level Auxiliary Low Water Cutoff; DES
    c. Pressure and Temperature Transmitters; DES
    d. Ignition Transformer; DES
    e. Current-to-Pressure (I/P) Transducers; DES
    f. Flame Scanners; DES
    g. Pressure Switches; DES
    h. Control Valves; DES
    i. Safety Shut-Off and Vent Valves; DES
    j. Pressure Regulating Valves; DES
    k. Actuators for FD Fans, Windbox Dampers; DES
    l. Solenoid Valves; DES
    m. Control Tubing; DES
3. Operation and Maintenance Data
    a. Operation and Maintenance Manuals; DES

B. IO List
1. Vendor shall prepare an IO list that includes all instruments and controls for each boiler. The IO list shall include information related to each device including but not limited to tag number, description, range, setpoint, alarm points, termination point in PLC, installed location, etc.
2. IO List shall be coordinated with Vendor furnished P&ID.

C. IO plan
1. Vendor shall furnish an IO plan with elevation locating each device in plant.

D. Pressure/Differential Pressure/Level Transmitters
1. Manufacturer's product data for each type of device including but not limited to construction, type, connections, range, accuracy, turndown, electrical characteristics and process connections. Clearly indicate the entire model number for each transmitter and sensor assembly provided to determine compliance with the Contract Specifications. The Contractor shall provide dP span calculations for the expected nominal design condition. Completed ISA data sheets shall be submitted for each device. Provide factory calibration certificate for each transmitter.

E. Temperature Transmitters
1. Manufacturer's product data for each type of device including but not limited to construction, type, connections, range, accuracy, turndown, electrical characteristics and process connections. ISA data sheets shall be provided for each device. Clearly indicate the entire model number for each transmitter and sensor assembly provided. Provide manufacturer’s information regarding the entire temperature sensor assembly. Sufficient information shall be provided to determine compliance with the Contract Specifications. Provide factory calibration certificate for each transmitter.

F. Pressure Switches
1. Provide manufacturer's product data for each type of switch including but not limited to construction, type, connections, range, accuracy turndown electrical characteristics and process connections.

G. Control Valves
1. Manufacturer's product data for each valve including design, materials, and dimensions.

2. Completed ISA S20 form or the equivalent for each valve which displays calculated design characteristics for the valve, actuator, and positioner. Identify each by device ID number as indicated on the Vendor furnished P&ID.

H. Safety Shut-Off and Vent Valves
   1. Manufacturer's product data for each valve including design, materials, and dimensions.
   2. Electrical requirements for each valve.

I. Pressure Regulating Valves
   1. Manufacturer's product data for each valve including design, materials, and dimensions.
   2. Completed ISA S20 form or the equivalent for each valve which displays calculated design characteristics for the valve and related devices. Identify each by the device ID number as indicated on the Vendor furnished P&ID.

J. Actuators for FD Fans and Windbox Dampers
   1. Manufacturer's product data indicating model, type, construction, etc.
   2. Damper actuator drawing indicating dimensions, weights, installation instructions, and materials of construction.
   3. Recommended spare parts list.

K. Control Tubing
   1. Provide manufacturer’s product data for all tubing.

L. Wiring Diagrams
   1. Wiring diagrams detailing wiring for power, signal, and control systems and differentiating clearly between manufacturer-installed and field-installed wiring.

M. Operation and Maintenance Manuals
   1. Submit the following operation and maintenance information in a manual.
   2. General:
      a. Operation and Maintenance Manual shall clearly identify the operational and functional features of each component. The manual shall include operating instructions and recommended maintenance schedules and procedures. A complete bill of materials and manufacturer's bulletins, general information drawings and installation drawings shall be provided. Provide name, address, and phone number for manufacturer’s representative responsible for aftermarket equipment support.
   3. Scope: Operation and Maintenance Manuals shall include the following:
      a. Maintenance instructions and spare parts lists for each type of device.
      b. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
      c. Calibration records, list of set points, and calibration interval.

2.06 QUALITY ASSURANCE

A. Multiple Quantities
   1. All multiple quantities of the same item, whether of the same size or differing sizes shall be by the same manufacturer unless otherwise specified and, where applicable, the same model number. Devices that must remain similar include pressure and temperature transmitters, switches, and control valve positioners, sensors, gauges, etc.

B. Identification Tags
   1. Provide an aluminum identification tag indicating device number as specified in SECTION 23 05 53 for all field devices including pressure transmitters, temperature transmitters, pressure switches, temperature switches, level switches, control valves (including positioners), pressure regulating valves, etc.

C. Code Work
   1. The Contractor performing any boiler external piping related work must possess an active ASME "PP" stamp. The Contractor must maintain the "PP" stamp throughout the duration

of the related work. The Contractor will be required to maintain, file, and submit all required paper work. The Contractor will be required to stamp the piping.

D. Applicable Codes
   1. All work shall be in accordance with the ASME Boiler and Pressure Vessel Code Sections I and VIII, ASME B31.1 Power Piping Code, and the National Board Inspector's Code. The Contractor shall refer to the Authorized Inspector for direction for any discrepancies with boiler external versus boiler non-external piping.
   2. All devices related to the burner management shall be in compliance with NFPA 85.
   3. Comply with applicable portions of the Instrumentation, Systems, and Automation Society (ISA) standards pertaining to construction and installation of field devices.

E. Existing Conditions
   1. Check existing pipe sizes before ordering field devices.

2.07 DELIVERY, STORAGE, AND HANDLING

A. General
   1. It shall be the responsibility of the Contractor to receive and store all instrument hardware items. Contractor shall visually inspect each item for damage and compliance with the specification.
   2. Store equipment and materials inside and protected from weather.

B. Factory-Mounted Components
   1. Where control devices specified in this SECTION are indicated to be factory mounted on equipment, arrange for shipping control devices to unit manufacturer.

PART 2 PRODUCTS

3.01 PRESSURE AND TEMPERATURE TRANSMITTERS

A. Pressure/Differential/Temperature Transmitters
   1. General
      a. Provide transmitters as suitable for use with specified operating conditions. Provide transmitters from Rosemount or as indicated in approved equipment/device list.
      b. Preferred instruments are Rosemount 2088 pressure transmitters, Rosemount 3051 differential pressure transmitters, and Rosemount 248 temperature transmitter with 4 wire RTD.
      c. All transmitters shall have local display.
   2. Construction
      a. Construction shall be rugged type, designed for industrial applications with low sensitivity to vibration and shock. All process wetted parts (isolating diaphragm, drain/vent valves, process flanges, and adapters) shall be 316 stainless steel. Wetted O-rings shall be Viton. The electronics housing shall be a low copper aluminum NEMA 4X enclosure. Cover O-rings shall be Buna-N. Bolts shall be austenitic 316 stainless steel.
   3. Electrical Design
      a. The transmitter shall operate with regulated DC power of 24 volts. Current requirements shall be a maximum of 25 mA.
      b. Transmitters shall have a load resistance effect less than plus or minus 0.10 percent of span per 1,000 ohm of load.
      c. Output signal shall be 4 to 20 mA with Hart digital protocol. Output signal shall be analagous to pressure or differential pressure range.
      d. Transmitter housing shall have 4 digit loop powered display which indicates process condition in units (i.e. 30 PSIG pressure, 30,000 PPH flow, 30 inch drum level, etc.) Display option shall also include percent and milliamps. Display accuracy shall be +/- 0.5 percent of calibrated span.
   4. Performance

a. Accuracy (including combined effects of linearity, hysteresis, and repeatability) shall be as follows.
b. Boiler Air Flow: Within plus or minus 0.075 percent of span.
c. Boiler steam flow, drum level, feedwater flow, gas flow, draft pressures: 0.1 percent of span.
d. Boiler steam drum and natural gas pressures: 0.25 percent of span.
e. Steam and feedwater header pressures: 0.25 percent of span.
f. All other transmitters not indicated above: 0.25 percent of span.
g. Linearity within plus or minus 0.1 percent of calibrated span.
h. Hysteresis within plus or minus 0.05 percent of calibrated span.
i. Repeatability within plus or minus 0.05 percent of calibrated span.
j. Drift within plus or minus 0.2 percent of upper range limit per year.
k. Calibration: All transmitters shall be factory calibrated.

5. Connections
   a. Process connections shall be 1/2-inch NPT. Provide side drain and vent. Electrical connection shall be 1/2-inch NPT with screw terminals and integral test jacks.
6. Smart Technology
   a. All pressure, differential pressure, and level transmitters supplied under this project shall be "Smart" via the Hart protocol. Communication shall allow identification of measured variables, tag number, range and span settings, device information, and diagnostics, and shall allow respanning, calibration, and maintenance between a handheld device or computer and the transmitter. Communication shall occur via a digital signal along the 4 to 20 mA signal and shall not interfere with the 4 to 20 mA signal.
7. Accessories
   a. Provide three valve manifold for all differential pressure transmitters. Manifold shall be constructed with a Type 316 stainless steel body and stem. Handwheel and barrel shall be Type 304SS. Packing and seals shall be Teflon. Nominal rating of manifold shall be 3000 psi at 392 degrees Fahrenheit. Provide connections required to connect test equipment for instrument calibration and adjustment.
8. Mounting Brackets
   a. Provide a bracket for mounting each transmitter on a 2-inch pipe. Bracket shall be constructed of carbon steel with carbon steel U-bolt. Bracket shall be coated with polyurethane paint. Provide bolts and nuts for flanges and adapters.
9. Tagging
   a. Transmitter Tag No. as indicated on Contract Documents shall be permanently stamped on the transmitter nameplate. Tag shall be permanently attached to the transmitter. In addition, provide aluminum identification tag per SECTION 23 05 53.

B. Temperature Transmitters
1. General
   a. Temperature transmitters shall be provided complete with sensor assembly and all required accessories. Sensor assembly and transmitter shall be manufactured and supplied by the same entity.
2. Construction
   a. Construction shall be rugged type, designed for industrial applications with low sensitivity to vibration and shock. The electronics housing shall be a low copper aluminum NEMA 4X enclosure. Cover O-rings shall be Buna-N. Electrical connection shall be 1/2-inch NPT. Transmitter shall be compatible with a variety of temperature sensors, including 2, 3, and 4 wire RTD's, thermocouples, and other resistance and millivolt inputs.
3. Electrical Design

a. The transmitter shall operate with regulated DC power of 24 volts. Current requirements shall be a maximum of 25 mA.
b. Transmitters shall have a load resistance effect less than plus or minus 0.10 percent of span per 1,000 ohm of load.
c. Output signal shall be 4 to 20 mA with Hart digital protocol. Output signal shall be analagous to temperature range.
d. Transmitter shall be equipped with a 5 digit loop powered LCD display. Display options shall include engineering units in degrees F and milliamps. Display accuracy shall be +/- 0.5 percent calibrated span.

4. Performance Specifications
   a. Transmitter accuracy shall be minimum of +/- 0.25 degrees Fahrenheit including combined effects of linearity, hysteresis, and repeatability. Stability shall remain within plus or minus 0.1 percent of span for 24 months. All transmitters shall be factory calibrated.
5. Mounting
   a. Provide a bracket for mounting each transmitter on a 2 inch pipe. Bracket shall be constructed of carbon steel with carbon steel U-bolt. Bracket shall be coated with polyurethane paint. Provide bolts and nuts for flanges and adapters.
6. Tagging
   a. Transmitter Tag No. as indicated on Contract Documents shall be permanently stamped on the transmitter nameplate. Tag shall permanently be attached to the transmitter. In addition, provide aluminum identification tag per SECTION 23 05 53 for element and transmitter.
7. Sensor Assembly
   a. Provide platinum, four wire 100 ohm RTDs. RTDs shall have a terminal block and shall be spring loaded. The protective sheath shall be 304 stainless steel; the sheath and element with protective head shall screw into the thermowell. Provide threaded, tapered thermowells constructed of 304 stainless steel. Immersion length of each thermowell shall be a minimum of 1/3 to 1/2 into to process stream.
8. Smart Technology
   a. All temperature transmitters supplied under this project shall be "Smart" via the Hart protocol. Communication shall allow identification of measured variables, tag number, range and span settings, device information, and diagnostics, and shall allow respanning, calibration, and maintenance between the PLC and the transmitter. Communication shall occur via a digital signal along the 4 to 20 mA signal and shall not interfere with the 4 to 20 mA signal.

3.02 CURRENT-TO-PRESSURE (I/P) TRANSDUCERS

A. General
   1. Refer to control valves specification paragraph for control valve positioner specification.

B. Construction
   1. Construction shall be rugged type, designed for industrial applications, with low sensitivity to vibration and shock. Electronics housing shall be low copper aluminum with a NEMA 4X rating and painted with epoxy polyester or polyurethane paint. Provide inlet and outlet air gauges.

C. Design
   1. The I/P transducer shall convert a 4 to 20 mA DC current input to a proportional output of pressure range required. If required, a split range input of 4 to 12 mA or 12 to 20 mA shall be provided. Maximum air consumption shall be 0.20 SCFM at 30 PSIG supply pressure. Operating temperature limits shall be -40 to 185 degrees Fahrenheit.

D. Smart Technology

1. All I/P transducers supplied under this project shall be "Smart" via the Hart protocol. Communication shall allow identification of measured variables, tag number, range and span settings, device information, and diagnostics, and shall allow respanning, calibration, and maintenance between the PLC and the transducer. Communication shall occur via a digital signal along the 4 to 20 mA signal and shall not interfere with the 4 to 20 mA signal.

E. Air Filter
   1. Provide an air filter upstream of each I/P device.

F. Pressure Regulator
   1. Provide regulator where required upstream of each I/P device.

3.03 PRESSURE SWITCHES

A. General
   1. All pressure switches provided with the new burners shall be provided by the burner manufacturer.

B. Natural Gas and Pilot Gas Pressure Switches (BMS Interlock)
   1. Gas pressure switches shall have NEMA 4 housing, Viton O-ring, and Type 316L or 17-7PH stainless steel diaphragm. Switch shall have single pole, double throw contacts rated for a minimum of 15 amperes at 120/240 volts alternating current. The switch shall be UL listed.

C. Instrument Air Pressure Switch (BMS Interlock for Instrument Air and Other Non-Draft Air Switch Services)
   1. Air pressure switch shall be operated by a type 316 stainless steel Bourdon tube actuating a snap-switch. Switch shall have a dead band adjustable up to a maximum of 100 percent of switch range. The switch shall have a calibrated dial and two pointers indicating set and reset points. Switch shall have visible on/off indication. The switch shall be provided with and mounted on a pigtail siphon suitable for operating pressures of 250 PSIG. The air pressure switch shall have a weather resistant housing.
   2. Pressure switch connection shall be 1/4 inch N.P.T. Switch shall have single-pole, double-throw contacts rated for a minimum of 15 amperes at 120/240 volts alternating current. Switch shall be provided with manufacturer's standard off-surface mounting bracket. The switch shall be UL listed.

D. Draft Pressure Switches (Burner Manager System - Proof of Flow Interlocks)
   1. Static pressure air switches shall be diaphragm operated to activate two independent double-pole, double-throw snap switches. Motion of the diaphragm shall be restrained by a calibrated spring which can be adjusted to set the exact pressure differential at which the electrical switch shall be actuated. The motion of the diaphragm shall be transmitted to the switch button by means of a direct mechanical linkage. Switch range shall be subject to field verification by the Contractor prior to final selection and installation. Switches shall have a minimum rated pressure of 50 inches of water column and a maximum surge pressure of two pounds per square inch Gauge. Pressure connections shall be 1/8 inch N.P.T. type.
   2. Diaphragm shall be silicone rubber with aluminum support plate and calibration spring shall be stainless steel. Housing shall be 16 Gauge weatherproof type with gasketed cover. Contacts shall be rated for a minimum of 15 amperes at 120 volts alternating current. The switch shall be UL listed.

E. Differential Pressure Indicating Flow Switch
   1. General
      a. Switch shall be mechanical snap acting and shall have NEMA 4 housing with die-cast aluminum case. Switch shall have single pole, double throw contacts rated for minimum of 15 amps at 120/240 VAC. Switch shall be adjustable from 5% to 95% of factory calibrated scale. The switch shall be UL Listed. Dial size shall be 6 inches.

Accuracy of indication shall be +/- 1% of full scale differential pressure. The body of the switch shall be rated for 600 PSIG. Differential pressure scale shall be sized in accordance with the orifice plate.

3.04 BOILER DRUM WATER COLUMN AND GAUGE GLASS

A. Scope
   1. Install new level control system to match Boiler 2 and 3, QTS Level-Trac LT-40-01 water column with QTS Level-Trac LT-210-10 remote reading control unit mounted at the operating floor and a remote level indicator in the control room.
   2. Remove steam whistle and cap.
   3. Remote water column indicator in control room and at blowdown switch.
   4. Provide auxiliary low level switch.
   5. Provide blowdown switch and valves at operating level.

B. Probes
   1. Provide a QTS unit to match existing Boiler 2&3 unit. Probes shall be high water alarm, low water alarm, and low water cutoff grounding probe. Low water alarm point shall be higher than low-low water cutoffs. Switches shall be automatic reset.
   2. Provide momentary contact push button station to short-circuit probe-type unit and auxiliary low water cutoff when they are being blown down. Locate pushbutton at operating level within reach of drain valves of column. Provide separate lights for probe low water cut-off and float switch low water cut-off that light when the Operator blows down the device and the switch is open - this shall allow the Operator know that the device is giving a low water condition and is functioning properly, and it also indicates to him to keep the button pressed because releasing the button will trip the boiler on low water.
   3. Provide sufficient length of flexible conduit to allow removal of probe assembly without disconnecting wiring.
   4. Provide a three-relay control unit. The three-relay control unit shall serve as the termination of the conductors from the probe. The output from the relay control unit shall interface as required with the Burner Management System.

3.05 BOILER DRUM LEVEL AUXILIARY LOW WATER CUTOFF

A. General
   1. For BLR-1,2,3,4 provide an auxiliary low-low level cutoff switch. Connect to new shunt switch for water column blowdown.

B. Design
   1. Shall be designed for 425 PSIG, saturated steam. Shall be UL listed and have Factory Mutual approval.

3.06 FLAME SCANNERS

A. Scope Description
   1. For BLR-1 and 4, provide new flame scanners for boilers.

B. Flame Scanners Specification
   1. Match existing flame scanners as a minimum. A burner mounted flame detector shall have a dual cell scanner to detect the presence of a flame by being sensitive to emissions of light energy in the ultra-violet and infrared range. Provide Fireye Insight II, Type 9SDSS3 flame scanners. The flame detector shall be rated to detect the flame from combustion of natural gas and number 2 fuel oil. The flame detector shall have a NEMA 4X, enclosure with a fused silica window in the connection for viewing the flame. The flame detector shall have electronic "self checking", which shall use no moving parts. The flame scanner shall have two internal flame relays (independently adjustable, selected to operate from the UV sensor, IR sensor, or both) with adjustable on/off thresholds and two 4-20 mA analog outputs with no requirement for a remote flame amplifier or flame switch

module. The flame scanner shall be UL listed and approved by Factory Mutual. A flame detector shall be provided for each burner complete with mounting to permit alignment, an insulating nipple, and connection to a source of clean, dry cooling air to prevent combustion products condensing on the window. Compressed air shall be used as required in small quantities. Installation of the flame detector shall be coordinated to provide a suitable viewing angle and piping for the air. The flame detector wiring and air piping connections shall incorporate quick disconnects to permit opening the burner register for access to the boiler furnace. The flame detector shall be installed and adjusted in a manner that identifies a natural gas igniter flame capable of igniting the natural gas from the main burner and detect an adequate igniter flame. The flame detector shall be provided with cable directly supplied by the flame scanner manufacturer and the cable for each flame scanner shall be routed in a separate conduit back to the field control panel to avoid cross interference.

C. Flame Amplifier
   1. Not expected to be necessary with the scanner type specified. If required furnish matched amplifier from the same OEM as the scanner.

3.07 IGNITION TRANSFORMER

A. 2.7.1 General
   1. For BLR-1, 2, 3, 4 provide ignition transformers and ignitors for each burner.

3.08 CONTROL VALVES

A. Control Valves
   1. Provide all control valves as necessary for burner retrofit.
   2. Preferred manufacturer is Fisher.

B. Control Valve General Specifications The following applies to new control valves:
   1. Each item identified with a tag number on the data sheets shall have a permanently attached stainless steel tag containing the stated tag number of the device per SECTION 23 05 53.
   2. Positioners shall be provided on all modulating actuators. Provide electronic to pneumatic positioners.
   3. Construction: Construction shall be rugged type, designed for industrial applications, with low sensitivity to vibration and shock. Electronics housing shall be low copper aluminum with a NEMA 4X rating and painted with epoxy polyester or polyurethane paint. Provide inlet and outlet air gauges.
   4. Design: The positioner shall convert a 4 to 20 mA DC current input signal to a proportional range as required to operate the control valve.
   5. Smart Technology and Diagnostics Package: All positioners shall be Hart protocol "Smart" digital valve communicating controllers which provide feedback of the valve travel position. Communication shall allow identification of tag number and device information. The controller shall allow loop check on-line and automatically calibrate travel. In addition, the position indication for all valves in terms of percent open shall be relayed and indicated to PLC. Provide separate device if necessary to provide this feature. Communication shall occur via a digital signal along the 4 to 20 mA signal and shall not interfere with the 4 to 20 mA signal.
   6. Diaphragm operated globe and angle valves shall have stem travel indicator with scale.
   7. The control valve manufacturer shall design control valve actuators to operate against the differential pressure shutoff specified on the data sheets. No credit is to be allowed for flowing medium assistance. Actuators shall be sized to fully hold the valve against the "maximum process differential pressure" and spring rate with air to the actuator. If not explicitly stated, maximum process differential pressure is to be determined at an upstream pressure 10 percent above the maximum inlet pressure and the downstream pressure at atmospheric.

8. Air supply tubing for on-off valves shall be 3/8 inch stainless.
9. Piston operators (where provided) shall be sized to operate on a minimum of 60 PSIG. Control valves with piston operators shall be furnished with trip valves and volume tanks of suitable size completely piped and mounted, including all fittings and accessories that are required for proper operation.
10. Combination Pressure Reducing Valve/Filter Assembly: Combination air filter-regulators shall be provided for each device utilizing instrument air and/or as indicated and shall have one common inlet/outlet for both filter and regulator, a calibrated pressure gauge, and five micron-rated reusable element. The standard pressure range shall be 5 to 125 PSIG. The regulator portion shall be of balanced valve design, diaphragm operated and self-relieving. The filter-regulators shall have 1/4-inch Gauge ports and automatic drains.
11. All accessories shall be yoke-mounted and completely tubed.
12. Unless otherwise specified, weld-on flanges are not acceptable and all valve flange face to face dimensions must conform to ANSI Standards.
13. All control valves shall be fully assembled with all accessories and functionally tested at the factory. This consists of connecting air and electricity, if required, and stroking the valve, pressurizing the control pneumatics, and checking proper operation of accessories such as positioners, solenoid valves, bypass valves, etc.
14. The following guidelines shall be used when sizing throttling control valves:
    a. Maximum Flow at ???85 percent Open
    b. Normal flow at 40 - 70 percent Open
    c. Minimum Flow at ???15 percent Open
15. All electrical accessories shall have NEMA 4 housing, minimum, unless otherwise specified.
16. Solenoid valves, when specified, shall be rated for continuous duty, epoxy molded coil, 120 VAC operated, standard material rated for the service conditions unless otherwise specified on the data sheet.
17. Flow direction shall be permanently shown on valve body.
18. Unless explicitly specified, the manufacturer shall select the valve trim characteristic based on the individual service requirement for each valve.
19. Valves subjected to temperatures in excess of 450 degrees Fahrenheit shall be equipped with cooling fins unless specially designed bonnet does not required them, and with grafoil packing.
20. Body sizes of 5 inches shall not be used.
21. Limit switches shall be snap acting, with 2 SPDT isolated contact or DPDT, rated for 10 amp/120 VAC-60 Hz. The switches shall be furnished with NEMA 4 or explosion proof housing, as specified.
22. The manufacturer shall calculate and submit the Cv, Cs or Cg required for each control valve based upon the given process conditions.
23. Each valve shall be furnished with a stainless steel nameplate showing:
    a. Manufacturer's Name
    b. Pressure Rating
    c. Type
    d. Serial Number
    e. Inner Valve Size and Type
    f. Valve Action
    g. Valve Travel
    h. Control Signal Pressure
    i. Valve Tag Number

C. Control Valve Actuators
1. Control valve actuators shall be provided with the control valve as an entire package therefore keeping responsibility in the hands of the control valve supplier. The control

valve manufacturer does not have to be the manufacturer of the actuator. Control valves shall arrive on-site with actuators already installed on the control valves. It is the responsibility of the control valve supplier to provide an accurately sized actuator.

2. Actuators shall be linear or rotary to suit the control valve style. Actuators shall be directly mounted on valve bodies. No three-bar linkages should be provided. The actuator shall have a visual position indicator.
3. Provide actuators that shall be sized to have a continuous torque as required by the application based on available 60 PSIG power air supply and operable without damage up to 150 PSIG air supply.
4. Provide position switch for all fuel valves for low fire.

3.09 SAFETY-SHUTOFF VALVES

A. General
   1. All safety shut-off valves shall be provided by the burner manufacturer for BLR-1 and 4.
   2. All valves shall be rated for maximum inlet pressure of 60 PSIG.
   3. Normal natural gas operating pressure is 30 psig.
   4. All safety shutoff valves shall be provided with a means to test valve leakage rate by opening a small side valve.

B. Burner Gas Safety Shut-Off Valves
   1. Valves shall be normally-closed rising stem type shut-off valve. Valve actuator shall indicate "open" or "shut" position of valve. Valves shall have ASTM A159 cast iron body, stainless steel seat, ductile iron disc, nickel plated low-carbon steel follow ring, and Buna N seat o-rings. Valves shall have ANSI Class 125 flanges and shall be suitable for natural gas at a maximum operating and differential pressure of 30 PSIG. Class VI leakage rate. Valves shall have automatic reset feature, NEMA 250, Type 1 electrical enclosure, and integral double pole double throw "proof of closing" switch. Valve electrical characteristics shall be suitable for operation with BMS. Valves shall be UL, FM, and CGA approved.

C. Burner Gas Vent Valve
   1. Valves shall be normally-open rising stem type shut-off valve. Valve actuator shall indicate "open" or "shut" position of valve. Valves shall have ASTM A159 cast iron body, stainless steel seat, ductile iron disc, nickel plated low-carbon steel follow ring, and Buna N seat o-rings. Valves shall have threaded ends and shall be suitable for natural gas at a maximum operating and differential pressure of 30 PSIG. Class VI leakage rate. Valves shall have automatic reset feature, NEMA 250, Type 1 electrical enclosure, and integral double pole double throw "proof of closing" switch. Valve electrical characteristics shall be suitable for operation with BMS. Valve shall be UL, FM, and CGA approved.

D. Pilot Gas Safety Shut-Off Valve
   1. Valve shall be solenoid normally closed type. Valve shall be UL listed and CSA certified. Valve shall have aluminum body with Buna-N seals, diaphragm, and disc. Valve shall be rated for natural gas service suitable for minimum and maximum operating differential pressure of zero and 30 PSIG respectively. Solenoid valve shall be rated NEMA 4 and shall operate on alternating current, 60 hertz power, and 120 VAC.

E. Pilot Gas Vent Valves
   1. Valve shall be solenoid, normally-open type. Valve shall be UL listed and CSA certified for natural gas service. Valve shall have aluminum body with Buna-N seal, diaphragm, and disc. Valve shall be rated for natural gas service suitable for minimum and maximum operating differential pressure of zero and 30 PSIG respectively. Solenoid valve shall be rated NEMA 4, and shall operate on alternating current, 60 hertz power, and of a voltage suitable for matching the requirements of the BMS.

3.10 PRESSURE REGULATING VALVES

A. General

1. Valves shall be located in such a manner as to be easily accessible for maintenance.
2. Main Natural Gas Service Pressure is provided to plant at 30 PSIG nominal. Pressure varies during operation from 36 psig to 26 psig.

B. Air Pressure Regulating Valve
1. Valve shall be direct operated type suitable for gaseous fluid control. Body and spring case shall be cast iron, and major metal internal parts shall be brass or stainless steel. Valve shall be rated for 125 PSIG air service. Valve plug seating surfaces and diaphragm shall be neoprene. Valve shall have inlet and outlet ranges suitable for the specific application. Valve outlet pressure shall be adjustable.

C. Pilot Gas Pressure Regulating Valve
1. Provide direct operated pressure reducing regulator suitable for operation with natural gas. Valve body shall be ductile iron. Spring case and diaphragm case shall be ductile iron. Seat ring shall be aluminum or stainless steel and O-rings and diaphragm shall be nitrile. Valve shall have NPT screwed connections. The outlet pressure shall be adjustable via an adjusting screw. The valve shall be provided with a vented diaphragm piped to a vent line to the exterior of the building.

D. Burner Natural Gas Regulating Valve
1. Provide direct operated pressure reducing valve suitable for operation with natural gas. Valve body shall be ductile iron. Spring case and diaphragm case shall be ductile iron. Seat ring shall be aluminum or stainless steel and o-rings and diaphragm shall be nitrile. Valve shall have flanged connections. Outlet pressure range shall be selected by the burner manufacturer. The valve shall be supplied with Class 125 flanged ends. The outlet pressure shall be adjustable. Valve shall be Fisher 1098 EGR or approved equal.

E. Combination Pressure Reducing Valve/Filter Assembly
1. Combination air filter-regulators shall be provided for each device utilizing instrument air and/or as indicated and shall have one common inlet/outlet for both filter and regulator, a calibrated pressure Gauge, and five micron-rated reusable element. The standard pressure range shall be 5 to 125 PSIG. The regulator portion shall be of balanced valve design, diaphragm operated and self-relieving. The filter-regulators shall have 1/4 inch Gauge ports and automatic drains.

3.11 ACTUATORS FOR FD FANS, WINDBOX DAMPERS, AND ID FANS

A. Actuator Make and Model
1. The actuator for dampers shall be an ABB Model UP and match other actuators in plant. General
2. Provide actuators for FD fan variable vane inlet dampers, and windbox dampers to satisfy all operational requirements for a functional, safe control system.

B. Actuators for FD Fans, Windbox Dampers, and ID Fans Control
1. The unit shall be designed for modulating control using electric power. The drive unit shall be sized to have a continuous available torque as required by the application. It is the responsibility of the Contractor to ensure that adequate torque and speed is provided for each positioner.
2. The drive unit shall have a repeatability of 0.5 of full scale and a sensitivity of 0.5 percent of full scale. Speed of response shall allow good combustion control. Speed shall be 5 percent to 95 percent of full stroke in 10 seconds at full rated torque.
3. All units shall be suitable for indoor installation with continuous operation in an ambient temperature range of 40 degrees Fahrenheit to 140 degrees Fahrenheit, a heater element is not required.
4. Units shall have "Smart" positioner and shall be provided to receive 4 to 20 mA input signal. Unit shall function with actual available instrument air of 60 PSIG to 125 PSIG. The "Smart" positioner shall allow digital communication via Hart which shall allow diagnostics, characterization, and easy addressability.

5. Rotary drive units shall include an angular position indicator. A manual hand crank shall be provided to permit manual positioning of the control valve damper under full load conditions. A manual lock shall be provided. Integral shaft position transmitters shall be provided with 4 to 20 mA output signal. This signal shall be through Hart digital signal over 4 to 20 mA.
6. Two auxiliary position switches shall be provided with each device. Switch shall be SPDT 120/240 VAC. They shall fully adjustable from minimum to maximum drive lever stoke.
7. Provide new supports for all actuators.
8. Provide an integral controller to control the unit. Provide air filter and inlet and outlet air pressure Gauges.
9. Materials: The frame and output shaft shall be carbon steel. The enclosure shall be NEMA 3R or better.

C. Linkage
1. Provide all new metal linkages needed to make field devices control through the entire control range.

3.12 SOLENOID VALVES

A. 3-Way Solenoid Valves
1. General
a. This specification is for 3-way solenoid valves.
2. Specification
a. Solenoid valves shall be rated for continuous duty, epoxy molded coil, 120VAC operated, standard material for the service conditions. Valves shall be rated for instrument air service to 125 PSIG. Valves shall be 3 way in the following manner - when "open" the outlet to atmosphere shall be closed and the instrument air signal shall pass through to the diaphragm valve; when "closed" the outlet to atmosphere shall be open from the valve side there-by allowing air to bleed from the spring return diaphragm and the instrument air signal from the supply source shall be closed. For some cases, the valve shall be electric to open and spring (or fail to close); in other cases it will be the opposite.

B. 4-Way Solenoid Valves
1. General
a. Provide for double acting valves as necessary for equipment.
2. Specification
a. Shall be the same as 3-way solenoid valves except these valves shall have air release on both sides. There is no spring return on the valves these supply instrument air to, so the solenoid valve position dictates the open/close valve position.

3.13 INSTRUMENT AIR LINES

A. General
1. Instrument air branch lines from main instrument air headers shall be field run to control devices. The initial horizontal run shall be a minimum half inch diameter line (with root valve) terminating with a plugged tee and having drop lines from it, sizes as follows:

No. of Instruments Supplied From One Branch Line	Branch Line Size
1 to 2	1/4 inch NPS Pipe or 3/8 inch OD Tube
Up to 5	3/8 inch NPS Pipe or 1/2 inch OD Tube
Up to 15	1/2 inch NPS Pipe or 5/8 inch OD Tube
Over 15 Instruments	1 inch NPS Pipe or 1-1/8 inch OD Tube

NO. OF CONTROL VALVES SUPPLIED FROM ONE BRANCH LINE	**BRANCH LINE SIZE**

DIAPHRAGM	PISTON	
1	1	1/4 INCH NPS PIPE OR 3/8 INCH OD TUBE
3	2	3/8 INCH NPS PIPE OR 1/2 INCH OD TUBE
UP TO 6	4	1/4 INCH NPS PIPE OR 3/8 INCH OD TUBE

2. Instrument air subheaders from root valves to individual supplies shall be 1 inch or greater.
3. All control tubing 7/8 inch and smaller shall be in accordance with Paragraph "CONTROL TUBING" specified in this SECTION.
4. Branch lines shall be connected to the supply headers at the top of the pipe.
5. Individual air filters, air pressure reducing valves with built in relief valve, and pressure Gauges shall be supplied by the Contractor for each instrument.
6. Main and branch air supply headers shall have blowdown lines and valves at every low point, with a minimum of one blowdown per building elevation. These are to be 1/2 inch nominal pipe with ball valves 36-48 inches above the floor.

3.14 CONTROL TUBING

A. General
1. All tubing shall be seamless, fully annealed, stainless steel tubing conforming to ASTM A269, Grade TP 316. The ends shall be plugged before shipment. Outside diameter and wall thickness shall be as follows:
   a. 1/4-Inch Outside Diameter by 0.028 Inch Wall
   b. 3/8-Inch Outside Diameter by 0.032 Inch Wall
   c. 1/2-Inch Outside Diameter by 0.035 Inch Wall
   d. 5/8-Inch Outside Diameter by 0.042 Inch Wall
   e. 3/4-Inch Outside Diameter by 0.049 Inch Wall
   f. 7/8-Inch Outside Diameter by 0.058 Inch Wall
2. Fittings shall be flareless compression Type 316 stainless steel. Approved fittings are as follows:
   a. CPI by Park-Hannifin
   b. SWAGELOK by Swagelock
   c. TYLOK by Tylok International
3. Joints shall be made up in strict accordance with manufacturer's instruction.

3.15 CONTROL AND INSTRUMENTATION WIRE AND CABLE

A. General
1. Field control and instrumentation wire and cable shall be provided as specified below. Refer to the "Miscellaneous Field Panels" paragraph below and SECTION 23 09 10.20 - STEAM PLANT PLC for that required in any control panels. All conduit shall be in accordance with SECTION 26 00 00 - ELECTRICAL and as described in of this SECTION. All installation requirements for control and instrumentation wire and cable shall be in accordance with that SECTION, except do not install any wiring of 4-20mA signals in the same conduit as for any other type of wiring.

B. Manufacturer’s
1. Belden Wire and Cable Co.
2. General Cable Co., Inc.
3. Houston Wire and Cable Company
4. Okonite Co.
5. Control Wire

C. Control Wiring
   1. 600V type XHHW-2 insulated stranded copper conductors in conduit, minimum size #14 AWG, UL listed and suitable for installation in conduit.

D. Power-Limited Tray Cable, In Cable Tray
   1. Multi-conductor type XHHW-2, minimum size #14 AWG. UL listed and suitable for installation in conduit and cable tray.

E. Instrumentation Cable for 4-20 mA DC Circuits
   1. Polyethylene insulated #18 AWG stranded tinned copper twisted pair, with #20 AWG or larger stranded tinned copper drain wire, overall aluminum-on-mylar shield, with PVC outer jacket. UL listed and suitable for installation in conduit and cable tray.

F. Instrumentation Cable for RTDs
   1. UL listed polyethylene insulated #18 AWG stranded tinned copper twisted triple or quad, with #20 AWG or larger stranded tinned copper drain wire, overall aluminum-on-mylar shield, with outer jacket rated for raceway. UL listed and suitable for installation in conduit and cable tray.

3.16 INSTRUMENT SUPPORTS

A. Transmitters
   1. Instrument stands shall be provided for all transmitters.
   2. Transmitters shall be ganged together when possible.

3.17 FIELD PANELS (BMS)

A. General
   1. BMS Field panels are required for Boiler 1 through 4.

B. Field Panels
   1. Each control panel shall be a wall or floor-mounted, NEMA 12 rated, electrical enclosure. The panel shall be constructed of 10 Gauge thick steel with adequate structural steel framework to provide a rigid unit. The panel shall be constructed with one door opening from the front. The panels shall have gasketed hinged doors with latches. Proper latching equipment and hardware shall be provided. Provide a lock and key as part of the door hardware. The doors shall latch with heavy duty metal plates that lock into the top and bottom (not side) of the cabinet frame. The panel exterior shall be finished with manufacturer's standard grey enamel finish coating, and the interior shall be painted white. The panel shall be firmly mounted to the floor or on the wall with Uni-strut with the use of mounting screws. The NEMA rating of the enclosure shall not be jeopardized by the mounting feature. The controls and instrumentation shall be mounted flush on the panel as far as practical. Engraved laminated plastic nameplates shall identify all controls and instruments, and shall be secured fastened to the panel. Characters shall be a minimum 0.375 inch high. There shall be no manufacturer's nameplate listed on the front of the panel that is intended for advertisement of any kind (It may be located inside the panel only.) All necessary piping or electrical connections and all necessary devices for a complete operating installation shall be provided. All components as specified and/or as required shall be panel-mounted and tested at the factory. No high-pressure lines will be allowed to enter any panel. The control equipment shall include the necessary pushbuttons, switches, indicating lights, annunciation, etc. as indicated.

C. Panel Piping and Wiring
   1. No piping shall be routed in the panels. All electric wiring shall be run to a terminal block located on the inside of the panel. Wiring shall be terminated at an identified terminal strip. All wiring shall be suitable for boiler room requirements and installed according to NFPA 70.

D. Terminations and Wiring

1. All I/O will be pre-wired to cabinet mounted terminal strips. All wiring shall be in accordance with applicable NEC and UL listings. Internal wiring of control panels shall be at least #18 AWG stranded copper conductor, NEC type SIS or XHHW-2. Minimum control wiring size internal to the cabinets shall be #16 AWG for digital I/O and #18 for analog I/O. Minimum power wiring internal to cabinets shall be #12 AWG. All internal wiring shall be installed in a neat, professional manner with covered plastic, Panduit type, and wireways. Field terminal strips shall be designed to accept a #14 AWG wire. Termination of field wiring shall be by the installing contractor. Interposing relays will be mounted on rails in close proximity to the Field Terminal Strips.
2. All terminal blocks shall be identified. Each wire shall be marked with device tag numbers and terminal designation at both ends with shrink-on wire markers. Spare wires, whether or not connected at terminals shall be labeled spare. Not more that two wires shall be connected to a single terminal.
3. Terminal Blocks shall be mounted on channels with a minimum of 1 inch spacing between channel and the mounting surface. Separation between terminal blocks shall be a minimum of 4 inches for terminal strips up to two feet in length. Separation shall be 6 inches for longer rows. Terminal strips shall have a minimum of 4 inches clearance between terminal blocks and enclosure sidewalls. Terminal strips shall be mounted such that all installed internal wiring and field wiring can be installed to meet all minimum bending radius requirements of the NEC and the wire or cable manufacturer.

E. Power Supply Units
1. If necessary, a power supply unit shall be provided for the panel. Each unit shall convert 120 VAC, 60 Hz line voltage to the power required by the plant control station equipment and field instruments. Each power supply unit shall be compatible with the equipment supplied.
2. Preferred Power supply is Allen Bradley 1606 XL- 24 VDC with redundant modules.

3.18 PANEL MOUNTED DEVICES

A. Selector Switches
1. Selector switches shall be NEMA Type 4/13, watertight/oil-tight devices, non-illuminated knob shall be black with white line in center aligning with option selected. Selection shall be identified with identification plates affixed to the panel adjacent to each selection in a prominent location.
2. Selector switches shall be maintain-in-position unless otherwise required.
3. Allen Bradley 800 series is preferred.

B. Panel View
1. Control shall be with a panel mounted Allen Bradley Panel View Plus with a minimum of 12-inch screen.

PART 3 EXECUTION

4.01 GENERAL

A. Installation
1. All controls, control devices, control wiring, and control piping shall be installed in accordance with the Vendor Drawings and manufacturer's recommendations. The Contractor shall install all control wiring and piping from field devices to I/O panels to provide a fully operational system in accordance with the requirements of this SECTION. All control wiring and conduit shall be field routed.
2. The Contractor shall be responsible for all control sequences, both pneumatic and electronic. Critical safety interlocks such as these for the BMS, shall be directly connected, so as not to depend on any digital control system "Sequence of Operation" to perform their safety function.
3. All conduit, wiring, etc., to accomplish the sequence of operations shall be provided in accordance with this SECTION.

4. Arrangement: Arrange the work in a neat and orderly manner so that minimum storage of equipment and material is required at the project site. Install the equipment and material in accordance with the best commercial practices. All systems shall be neat in appearance, compact, workmanlike in construction and assembly, and installed for continuous service. All parts shall be readily accessible for inspection, repair, and renewal.

4.02 INSTRUMENT INSTALLATION

A. General
   1. All personnel shall be skilled in the work to which they are assigned and all work shall be performed under the direct supervision of an experienced and competent foreman. Calibration sheets shall be filled out for each piece of equipment that is calibrated and a copy turned over to the DES Project Coordinator for DES records.
   2. Vendor shall generate a location plan for all field mounted instruments, controls and control panels. The final location shall be verified by the Contractor in the field and prior to any work, the Contractor shall verify the final location of field mounted instruments with the DES Project Coordinator.

B. Scope of Supply
   1. The Contractor shall furnish all instruments including pipe, tubing, manual valves, supports, pipe and tube fittings, wire, conduit, tray, terminators, racks, mounting stands, mounting plates, etc., to complete a working and operable plant in accordance with these specifications.

C. Workmanship
   1. All work shall be constructed plumb, square, level and true to building lines and surfaces. Work shall be neat, substantial workmanlike so as to properly serve the intended purpose.

D. Manufacturer's Recommendations
   1. All instruments and instrument materials shall be installed in strict accordance with the manufacturer's recommendations and the applicable ASME, ISA or IEEE standards. Copies of manufacturer's instructions shall be shipped with each instrument for the Contractor's use.

E. Support of Field Mounted Instruments
   1. Devices shall be securely supported on stands, plates or heavy brackets heavy enough not to vibrate or move excessively. Instrument supports shall not be mounted on or connected to handrails, stairways, machine bases, plant piping or any component subject to severe vibration, sway, or movement under load. All instruments unless specifically noted on Contract Drawings, shall be located in a manner and at an elevation that permits convenient access for calibration and maintenance (approximately 4 feet- 0 inch. above finished floor).
   2. Instruments shall be mounted in such a way to prevent interferences with equipment, equipment maintenance, building structure, passageways, etc.

F. Holes and Openings
   1. Where holes are necessary in floors, walls, and siding, the Contractor shall neatly and carefully cut holes or openings of sizes approved by the DES Project Coordinator. Where concrete slabs are already inplace, cutting shall be performed in a manner not producing spalling of masonry or over break. Openings in walls and siding shall be sealed by the Contractor after piping and tubing is in place.

G. Installation Verification
   1. The Contractor shall visually inspect all instrumentation to determine that each piece has been installed in accordance with the contract documents and manufacturer's recommendations. The following shall be inspected:
      a. Instrument Mounting
      b. Air Supply

c. Signal Tubing
d. Wiring
e. Piping

2. Upon completion of this inspection, the Contractor shall submit to the DES Project Coordinator a letter indicating that all of the instrumentation has been installed with the Contract Documents.

4.03 CALIBRATION AND LOOP CHECKING

A. General

1. The Contractor shall provide all labor supervision, services, tools, special equipment, and consumable supplies required to perform a bench checkout of all instrumentation, both new and existing. The purpose is to provide initial recorded data that can be used as a bench mark for future routine maintenance and trouble shooting. The anticipated result is to ensure minimal instrument and control related start-up problems. All loops shall be checked for proper operation and documented from field device to PLC, and from PLC to the MMI in control room to verify proper operation and ranging of field devices.

B. Calibration Scope

1. The Contractor shall calibrate all instruments (existing and new) over the full operational range and prove instruments to be within the specified accuracy. The instruments shall be calibrated individually and where applicable as a system. A minimum of five points shall be checked during calibration (0, 25, 50, 75 and 100 percent range).

C. Failure Procedure

1. The Contractor shall advise the DES Project Coordinator in writing upon failure of any equipment or material to pass the test performed by the Contractor, or to properly function, as intended, or to meet the calibration accuracy required. The DES Project Coordinator shall direct the Contractor in taking the necessary steps to correct the failure. All equipment and materials provided by the Contractor requiring correction shall be corrected at his expense.

D. Calibration Records

1. After the instrument has been calibrated, all pertinent valves and switches shall be positioned and tagged as needed for protection, and a distinctive tag or label shall be affixed to the instrument to indicate that it has been calibrated.

E. Documentation

1. The Contractor shall be responsible for preparation and distribution of certified copies of forms recording and documenting the results of all calibrations. The Contractor shall maintain a current record of calibration and loop checkout in order to permit informing the DES Project Coordinator, upon request, of exact status of the calibration and checkout.

F. Personnel Qualification

1. The Contractor shall perform the work with technicians skilled in this particular type of work and with supervision thoroughly knowledgeable in calibration and loop checking of instruments in large industrial facilities.

G. Compatibility of Calibration Medium

1. All fluids introduced to instrument bodies and attached piping for purpose of calibration, or any other purpose, shall be compatible with the fluid in which instrument and piping will be filled during normal operation, and shall be free of system contaminants.

H. Loop Checkout

1. The Contractor shall provide all labor and supervision for the pre-operational tests of each control loop and of each control system. Loop checkout shall be completed from MMI to field device to verify proper operation and ranging of all devices. Upon completion of the loop checkout, the Contractor shall submit to the DES Project Coordinator a check list indicating that all of the control loops have been checked and operate as required by the

contract documents. At a minimum, the check list shall include the Loop No., date checked, and initials of person performing loop check.

2. All control loops shall be individually operated before start-up. Permissive interlocks shall be actuated or positioned temporarily to prove the proper operation of each control loop. Actual signals must be introduced into the normal loop sensors unless specifically waived by the DES Project Coordinator in favor of mechanical movement of such devices. Prior to energization of instrument loops, the Contractor shall ensure that all power, control, and signal circuits containing fuses are checked for the presence of fuses of the proper type and size.

4.04 CALIBRATION AND ADJUSTMENT OF CONTROL DEVICES TO BE RE-USED

A. All control devices and instruments on the existing Boiler 1 and 4 shall be replaced by Vendor including but not limited to transmitters, switches, gauges, sensors, etc. All devices to be connected to the new BMS and the existing Boiler combustion control system are included in the scope.

B. All control devices and instruments on the existing Boiler 2 and 3 shall be inspected and confirmed operational by Vendor including but not limited to transmitters, switches, gauges, sensors, etc. All devices to be connected to the new BMS and the existing Boiler combustion control system are included in the scope. Existing devices shall be calibrated to confirm correct operation of new BMS and CCS.

C. The Contractor shall provide a fully operational combustion control system and burner management system in accordance with the operational requirements and included in SECTION 23 09 10.48 - STEAM PLANT LOGIC. The installing Contractor, or his agent, shall generate and provide to the DES Project Coordinator a complete record of the calibration and adjustment of all controls and instruments to form a permanent record of that data. The Contractor shall demonstrate to the satisfaction of the DES Project Coordinator, which the installation complies with the specified requirements.

4.05 REMOVAL OF CONTROL DEVICES TO BE RE-USED

A. There are 28 Siemens 353 Controllers installed in the plant control room. These devices are used for Boiler 1-4 Combustion Controls (26 controllers), Plant Master (1 controller), and Steam Pressure Controller (1 controller). These controllers will not be reused and should be removed. The Contractor shall remove and dispose of existing control devices and blind off panel front.

B. Existing control devices on the Boilers that are determined by Vendor to be satisfactory for reuse after Calibration by Vendor shall be protected during construction or removed and reinstalled by Vendor.

4.06 ELECTRICAL WIRING AND CONNECTIONS

A. The Contractor shall be responsible for field wiring of all field devices. Install cable trays, raceways, boxes, and cabinets according to Division 26. Install building wire and cable according to Division 26.

B. Install signal and communication cable according to Division 26.
   1. Install all cable in cable tray or raceway.
   2. Bundle and harness multi-conductor instrument cable in place of single cables where a number of cables follow a common path.
   3. Fasten flexible conductors, bridging cabinets and doors, neatly along hinge side; protect against abrasion. Tie and support conductors neatly.
   4. Number-code conductors for future identification and servicing of control system.
   5. Do not install 4-20 mA signal wiring in the same conduit or cable tray component as any other signal or power wire or cable.
   6. Connect electrical components to wiring systems and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment

connectors. Where manufacturer's torqueing requirements are not indicated, tighten connectors and terminals according to tightening requirements specified in UL 486A-486B.

7. LOCAL/OFF/REMOTE (LR) selector switches shall override automatic controls when switch is in LOCAL position. For all LR switches, provide hand position feedback to PLC and provide indication that switch is in "LOCAL".

4.07 BOILER ACCESSORIES

A. Burner Access (Main and Ignitor)
   1. Arrange fuel trains, controls and other devices to permit removal of burner parts, including register, without removing valves or other components.

B. Arrangement of Fuel Trains
   1. All devices shall be accessible from operating floor for maintenance or replacement without removal of other devices.
   2. Do not mount any piping or devices within two feet of boiler side and top casings, and do not attach any piping or field devices to boiler side and top casings.

END OF SECTION 230910

SECTION 230910.20
STEAM PLANT PLC

PART 1 GENERAL

1.01 REFERENCE STANDARDS

A. IEC 61131-3 - Programmable Controllers - Part 3: Programming Languages; 2013.

B. ISA-5.1 - Instrumentation and Control Symbols and Identification; 2024.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2020.

D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

E. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

F. UL 486A-486B - Wire Connectors; Current Edition, Including All Revisions.

1.02 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.
   1. ISA - INTERNATIONAL SOCIETY OF AUTOMATION (ISA)
   2. ANSI/ISA-5.1 Instrumentation Symbols and Identification
   3. ISA 5.2 Binary Logic Diagrams for Process Operations
   4. ISA 5.3 Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic, and Computer Systems
   5. ISA 5.5 Graphic Symbols for Process Displays
   6. ISA RP60.9 Piping Guide for Control Centers INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)
   7. IEC 61131-3 Programmable Controllers - : Programming Languages; Ed 2.0
   8. NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)
   9. NFPA 70 National Electrical Code
   10. NFPA 85 Boiler and Combustion Systems Hazards Code
   11. NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATION (NEMA)
   12. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum)
   13. NEMA WC 57 Standard for Control, Thermocouple Extension, and Instrumentation Cable
   14. UNDERWRITERS LABORATORIES (UL)
   15. UL 467 Grounding and Bonding Equipment
   16. UL 486A-486B Wire Connectors

1.03 RELATED REQUIREMENTS

A. Refer to SECTION 23 09 10.48 for Steam Plant Logic.

1.04 DESCRIPTION OF WORK

A. General
   1. This SECTION covers the functional and minimum requirements for the integration of the Boiler Burner Retrofit and all related control and instruments into the existing balance plant (BOP) control system. The Vendor shall be responsible for integrating all controls into the existing control system. This includes programming changes, HMI screens, check out and startup. This will integrate the existing plant control system with Contractor supplied components and provide an operational system.
   2. Contractor shall program Plant Master in Balance of Plant PLC and Local BOP Panel HMI and Control Room HMI and fully integrate new boilers into front end HMI.
   3. All alarms from each boiler shall be routed back to Control Room.
   4. All boilers shall be able to be started and stopped from the Control Room in addition to from local boiler control panel.

B. Existing Controllers and Software
   1. BOP PLC:
      a. ControlLogix L81 with Flex IO.
   2. Front End:
      a. PC1 Local BOP HMI, Factory Talkview SE Standalone.
      b. PC2 Dells in Control Room, Factory Talkview SE Standalone.

C. Scope of Supply
   1. The Vendor shall provide all hardware, software, and engineering services required to meet the intent of this SECTION. Equipment and services to be provided include but are not limited to the following:
      a. Shop assembled and tested Burner Management System for Boiler 1 – Boiler 4. One system shall be provided for each boiler. BMS cabinets ("field panels" or "PLC panels") shall be furnished complete with power supplies, control processors (redundant where specified), communication modules, touchscreens, alarm horns, input and output (I/O) modules, and termination hardware.
      b. Integrate New BMS and Burner system into existing plant SCADA system. Combustion Control system (CCS) for new burners shall be completed in the existing Ovation system.
      c. Engineering and configuration services for implementation and configuration of the sequences of operation for new burner system in existing the Ovation system.
      d. Engineering and configuration services for all graphic displays.
      e. Engineering and configuration services for all system database, historian, logging, and reporting functions.
      f. All PLC and HMI programs shall be furnished with annotations to DES.
      g. System hardware, software, and maintenance documentation.
      h. Engineering support for Factory Acceptance Test.
      i. Field Engineering Support for system inspection, testing, and start-up.
      j. Factory and on-site training.

1.05 SUBMITTALS

A. DES approval/acceptance is required for submittals with a “DES” designation; submittals not having a designation are for information only. Submit the following in accordance with SECTION 01 30 00 SUBMITTAL PROCEDURES:
   1. Shop Drawings
      a. System Architecture Drawings; DES
      b. General Arrangement Drawings; DES
      c. Bill of Materials; DES
      d. Electrical Connection Drawings; DES
      e. Enclosure Layout Drawings; DES
      f. Graphic Displays; DES
   2. Product Data
      a. Hardware Components; DES
      b. Training Scope; DES
   3. Test Reports
      a. Factory Acceptance Test Plan; DES
      b. Factory Acceptance Test Results; DES
   4. Certificates
      a. List of Similar Installations; DES
   5. Operation and Maintenance Data Manufacturer's Instructions; DES
      a. Final I/O List; DES
      b. O&M Manuals; DES
      c. As-Built Documentation; DES

1.06 SUBMITTAL REQUIREMENTS

A. Shop Drawings and Product Data
   1. All control submittals shall include the identification number of devices as indicated on P&IDs.

B. Hardware Components
   1. Provide catalog information listing performance and features of all equipment to verify compliance with the specification.

C. System Architecture Drawings
   1. Provide system architecture drawings that clearly identify the major control system components existing and new and the communication highways that connect them. The drawings shall have sufficient detail to include as a minimum the workstations, SCADA server, printers, data highway, control processors, equipment cabinets, and I/O Racks. Communication protocols, cable installation requirements, connectors, data conversion hardware, copper to fiber converters and other interface requirements specific to this project. Provide data highway cable installation instruction specifications, including a complete communication test protocol to verify integrity of highway prior to use.

D. General Arrangement Drawings
   1. Provide general arrangement drawings that provide an overview of the equipment arrangement or layout in plan view. Drawings shall show clearance dimensions required for enclosure door openings, cooling air circulation, cable and conduit penetrations, equipment maintenance and component replacement. Drawings shall show dimensions of all major components.

E. Bill of Materials
   1. Provide a complete bill of materials to include a complete list of all equipment and material being supplied. The list shall provide a complete description of each item supplied including specific hardware and software for each assembled operating console, server, workstation, etc. Items shipped loose for installation by the Contractor or PLC supplier's field engineer shall be clearly identified.

F. Final I/O List
   1. Provide As-built I/O list at END OF Project. For each point, indicate PLC controller number, termination number (+-, -, and shield). Indicate PLC I/O cabinet and module. Update all I/O information that has changed from the original issue. Use Microsoft Excel to establish the database.

G. Electrical Connection Drawings
   1. Provide electrical connection drawings that show all PLC/Contractor interface points. The drawings shall clearly identify all purchaser connection points including power, grounding, network, and signal wire termination. All terminal blocks, terminals, ground bars, etc, shall be uniquely numbered and labeled. PLC system supplier shall provide a complete set of drawings for all wiring connections in accordance with ANSI/IEEE standard symbols. 120 VAC power requirements shall be specified.

H. Enclosure Layout Drawings
   1. Provide enclosure layout drawings that clearly identify all cabinet internal components including racks, power supplies, modules, I/O terminal points, power feed terminations, ground bus, and wireways.

I. Graphic Displays
   1. Provide color print out of graphics.

J. Factory Acceptance Test Plan
   1. Provide a detailed factory acceptance test plan.

K. Factory Acceptance Test

1. Provide results.

L. Storage Instructions
1. Provide complete storage and receiving instructions.

M. O&M Manuals
1. Submit complete O&M manual set. The O&M Manual shall not be submitted loose. Assemble information such that each O&M Manual binder does not exceed 3-inches.

N. As-built Documentation
1. Provide as-built documentation for controls.

O. Shop Test Reports
1. Provide all shop test reports in accordance with this specification.

1.07 QUALITY ASSURANCE

A. Coordination
1. The Contractor shall be responsible for coordinating and scheduling control associated work. The Contractor shall coordinate the interfacing of controls with the PLC equipment.

B. List of Similar Installations
1. The Supplier of the PLC shall have provided the same PLC system as the supplier proposes to provide for this project for a minimum of 3 similar projects in the last 5 years. All of the projects listed shall be for steam plants with a minimum combined output of 50,000 PPH of steam or HW plants with a minimum combined energy output of 10 million BTU/HR. Of the five projects, at least one project shall have included a multiple burner (minimum of 2 burners) boiler. The boiler installations shall include combustion controls and burner management systems, including draft and drum level.
2. The list of similar installations shall include location of installation, PLC equipment system and scope, steam capacity of boilers, type of combustion control system, types of fuels, and name, address, and phone number of contact person. This person shall be contacted so make sure the person still works there and the phone number is correct.
3. Suppliers who do not demonstrate the required past experience may be disqualified at the discretion of DES.

C. Codes and Standards
1. All work shall be in accordance with NFPA 70 and NFPA 85.
2. All control documentation, programming, and assembly shall be in accordance with ANSI/ISA-5.1, ISA 5.2, ISA 5.3, ISA 5.5.

1.08 DELIVERY, STORAGE, AND HANDLING

A. General
1. Equipment shall be shipped as completely assembled as practical in the least number of factory fabricated and assembled sections. All equipment and components shall be identified and/or match marked to assist field assembly and erection.
2. The equipment shall be carefully packed for loading and shipment at the supplier's facility. Packing shall prevent the entrance of moisture during shipping or on-site storage to all components susceptible to damage be water.
3. All equipment and attachments shall be secured to withstand rough handling in transit. Adequate blocking, bracing, and lifting eyes shall be provided.

1.09 EXTENDED SERVICE REQUIREMENTS

A. General
1. The PLC Supplier and the PLC Integrator (programmer) shall provide support until up to one year after the entire project is accepted by DES. This shall include software upgrades to the most current version, hardware replacement of failed devices, and two visits to the DES plant after project acceptance to perform loop checks and tuning, and review and address problems identified by the DES instrument supervisor.

1.10 CUSTOMER SUPPORT

A. Type of Support
   1. The manufacturer shall have customer support and service representatives available to provide assistance upon project completion. Customer Support shall be offered by the manufacturer's technicians for questions and problems regarding the operation of the PLC. All service support shall be offered by the manufacturer's certified technicians or by technicians at service facilities operated by a sub-contractor that is authorized and certified by the manufacturer.

B. Access to Support
   1. Normal service and customer support shall be accessed during regular business hours. Emergency service support shall be accessed 24 hours a day, 7 days a week.

C. Cost
   1. There shall be no cost for warranty service.
   2. There shall be no cost for customer support during the warranty period.

PART 2 PRODUCTS

2.01 ACCEPTABLE PLC SYSTEM MANUFACTURER'S

1. Compact Logix series packaged by Rockwell Automation consisting of 1769-L32 Series controllers with RS Logix 5000 Software with Ethernet communications to existing SCADA and MMI system.
2. ControlLogix L81.

2.02 PERFORMANCE REQUIREMENTS

A. Availability
   1. The PLC shall be designed to ensure maximum availability by the inclusion of built-in redundancy for both hardware and software. This shall include, where specified, redundant controllers, data highway, and power supplies with automatic change over to the standby unit upon detection of a fault or failure of the operating unit. The failure of any single element shall not affect the operation of any item of the operating plant.

B. Power Supply Source
   1. One source of 120V power shall be provided.
   2. Sub-distribution panels consisting of circuit breaker panelboards with separate 1-pole circuit breakers for the PLC, field instruments, and network communications devices, shall be mounted inside each PLC controller cabinet.

C. Interference Protection
   1. Standard UHF, VHF and BC hand-held radios (5 watts nominal output power) will be operated within 3 feet of the PLC, and shall cause no adverse effects to PLC operation.

2.03 DESIGN/FABRICATION

A. Enclosures
   1. The PLCs, I/O modules, communication modules, and power supplies shall be rack mounted in NEMA 250, Type 12 enclosures, designed for industrial Steam Plants. Panels shall be constructed of 10 Gauge thick steel with adequate structural steel framework to provide a rigid unit. Panels shall have gasketed hinged doors with latches. Proper latching equipment and hardware shall be provided. Provide a lock and key as part of the door hardware. The doors shall latch with heavy duty metal plates that lock into the top and bottom (not side) of the cabinet frame. A single ceiling light shall be provided in the interior of the panel enclosure with its on/off switch located inside the panel and clearly marked. An on/off switch for the control power shall be provided inside the panel and clearly marked. The panel exterior shall be finished with manufacturer's standard grey enamel finish coating (two coats), and the interior shall be painted white. The panel shall be firmly mounted on the floor with the use of mounting screws. The NEMA rating of the enclosure

shall not be jeopardized by the mounting design and installation. The indicated controls and instrumentation shall be mounted flush on the panel as far as practical. Engraved laminated plastic nameplates shall identify all controls and instruments. Nameplates shall be securely fastened to the panel. Characters shall be a minimum 0.375 inch high. A plug-in strip shall be provided on the rear of the panel for any required plug-in electrical connections of the instruments with a minimum additional 2 plugs available for spare capacity. All necessary piping or electrical connections and all necessary devices for a complete operating installation shall be provided. All components as specified and/or as required shall be panel-mounted and tested at the factory. No high-pressure lines will be allowed to enter any panel. The control equipment shall include the necessary switches, indicating lights, annunciation, etc. as indicated. The enclosures shall be located in unconditioned spaces where temperatures can reach 110 degrees Fahrenheit. The air is dusty. Initially, due to phasing, it includes coal dust. All components in the PLC cabinets shall be rated for the service including heat gain from all components in the panel. Calculations, equipment ratings, and a letter shall be included in the submittal indicating all items are rated for the temperature including the calculated heat gain from an unventilated panel. Note that if during operation problems are encountered with overheating within 1 full year of service, the Contractor shall provide larger panels with more surface area for heat loss at no additional charge to DES. Touch screen and some interface buttons shall be installed in the front door. Provide plenty of cable with support to prevent pinching of cable. All components shall be installed in a neat, professional manner and shall be plumb, square, and securely fastened.

B. Architecture
   1. The PLC system shall have a client/server architecture comprised of a group of controllers, networked by redundant Ethernet data highways to the existing SCADA server. Comprehensive online system diagnostics and tracking shall be incorporated to assist in maintenance and troubleshooting. Diagnostics shall detect failure of the data highway and failure of equipment connected to the data highway down to the board level. Diagnostics shall include status of power supplies, status of redundant processor modules (where applicable), and analog input quality. Trouble alarms generated by the system diagnostics shall be displayed for operator information and action.

C. Controller Redundancy
   1. The PLC shall have the capability to have redundant I/O, however, this is not required for this project unless code requires. Failure of a controller shall be immediately detected and alarmed. The controllers shall support conventional analog and digital I/O segments. The system shall be designed with sufficient redundancy to preclude a single device failure from impacting overall plant control and operation.
   2. The system design shall also incorporate failsafe philosophy to ensure process security in the event of power loss to the system or controllers. I/O shall fail in a predefined state upon a power loss. Upon restoration of power, PID control modes and I/O shall assume a pre-defined state.

D. Watch Dog Requirement
   1. Controllers are going to be used for burner management systems for steam boilers, and therefore shall be in compliance with NFPA 85. The controllers shall incorporate watch-dog features whereby the controller itself and the input and output are continuously monitored for safety.

E. Common Interface
   1. The PLC system shall provide a single operator interface, integrating all monitored independent subsystems into a common real time database, including data and alarms.

F. Controller Capabilities
   1. All components as indicated in the sequence of operations shall be controlled from the PLC. The controllers shall be capable of multiple programming languages including relay

ladder, structured text, function block, and sequential functional charts. The controllers shall be capable of performing complex continuous control algorithms, Boolean logic, and control drive logic. Extensive use of PID controllers, cascade loops, function generators, and calculation algorithms is required. PID controller algorithms shall not be based on the parallel or non-interacting algorithms, nor shall velocity implementation be utilized. All control loops shall be capable of automatic self-tuning or automatic loop performance analysis. Provide software to perform these functions.

2. Controllers shall be sized such that the loading shall not exceed 75 percent of the manufacturer's recommended maximum when the unit ships.

G. Alarms
   1. All plant and system generated alarms shall be prioritized, logged, and displayed by the PLC/SCADA.
   2. There shall be a dedicated display which shall show all the plant alarms or group of alarms, and which contains a link to lead the Operator to graphic or control displays where corrective action may be taken. The PLC/SCADA system shall provide a first-in/first-out alarm tracking system to allow immediate and historical indication of what caused a trip.

H. Upgradeable Software
   1. The software shall be upgradeable without taking the entire plant's PLC/SCADA system out of service. Control operations must continue at all times for active boilers. Changes to programming and testing shall be done without taking the PLC out of service. Where there is redundancy, applying changes to one controller shall automatically be transferred to the redundant controller.

I. I/O Modules
   1. The PLC system supplier shall provide I/O modules as required to interface with all equipment. The I/O types shall include but not be limited to those listed below.
      a. Analog Input: 4 to 20 mA powered by the PLC.
      b. Analog Input: 4 to 20 mA powered by the field instrument.
      c. Analog Output: 4 to 20 mA powered by the PLC.
      d. RTD Input: 100 OHM Platinum 3 or 4 wire.
      e. Thermocouple Input: Type K and E.
      f. 120 VAC Discrete Input: Dry Field contact wetted by PLC.
      g. 120 VAC Discrete Input: Relay input wetted by motor control circuit.
      h. 120 VAC Discrete Output: ??? 1/2 amp 120 VAC powered from PLC.
      i. 120 VAC Discrete output with interposing relays.
   2. Each I/O card shall be individually isolated.
   3. Digital I/O shall have LED status indication.
   4. The PLC system supplier shall include at the time of shipment 20 percent spare I/O capacity of each type, to include I/O modules with spare I/O points pre-wired out to spare terminal strips.

J. Communication Modules
   1. The PLC system supplier shall provide the appropriate communication modules to interface the I/O to the controllers and the controllers to the operator workstations, touchscreen, and to the SCADA server. The communication modules shall support the redundancy requirements specified. The PLC system supplier shall provide the appropriate communication port to interface with the existing PLC controllers as specified herein.

K. Terminations and Wiring
   1. All I/O will be pre-wired to cabinet mounted terminal strips. All wiring shall be in accordance with applicable NEC and UL listings. Internal wiring of control panels shall be at least #18 AWG stranded copper conductor, NEC type SIS or XHHW-2. Minimum control wiring size internal to the PLC cabinets shall be #16 AWG for digital I/O and #18

for analog I/O. Minimum power wiring internal to PLC cabinets shall be #12 AWG. All internal wiring shall be installed in a neat, professional manner with covered plastic, Panduit type, and wireways. Termination of field wiring shall be by the installing contractor. Interposing relays will be mounted on rails in close proximity to the Field Terminal and Strips.

2. All terminal blocks shall be identified. Each wire shall be marked with device tag numbers and terminal designation at both ends with shrink-on wire markers. Spare I/O points shall be wired out to the terminal strips.
3. Terminal Blocks shall be mounted on channels with a minimum of 1 inch spacing between channel and the mounting surface. Separation between terminal blocks shall be a minimum of 4 inches for terminal strips up to two feet in length. Separation shall be 6 inches for longer rows. Terminal strips shall have a minimum of 4 inches clearance between terminal blocks and enclosure sidewalls. Terminal strips shall be mounted such that all installed internal wiring and field wiring can be installed to meet all minimum bending radius requirements of the NEC and the wire or cable manufacturer.

L. Operator Workstations (Field Touchscreens)
1. The standard operator interface shall have downward compatibility whereby all new module designs can be interchanged with all similar modules in an effort to reduce obsolescence.
2. The standard operator interface hardware shall function continuously in:
   a. Operating Temperature of range of 0 degrees to plus 60 degrees C (140 degrees Fahrenheit)
   b. Storage Temperature range of minus 20 degrees to plus 158 degrees Fahrenheit
   c. Humidity range of 5 to 95 percent non-condensing
3. The standard operator interface system shall be UL listed and cUL certified, CE marked for all applicable directives, North American Hazardous Locations Class I, Division II, Groups A,B,C,D.
4. The standard operator interface system shall be designed and tested to operate in the high electrical noise environment of an industrial plant.
5. The standard operator interface shall have redundant dedicated ports, which supports communications to the controller via an industrial communications network or RS232 serial connection utilizing industrial secure protocols.
6. A configuration mode on the terminal shall be provided to adjust display characteristics, memory card (if used), terminal preset, terminal information, data and time and printer setup on demand and be available from run mode if required.
7. The standard terminal shall be designed to provide for free air flow convection cooling without a fan.
8. The standard terminal back panel shall include indicators showing the following status information:
   a. Status of the CPU
   b. Communications status for the controller channel
9. Run mode object (button) shall be available to place the standard terminal in Run mode on demand from the configuration mode.
10. Non-volatile memory shall store the operating system information to protect against loss in the case of power loss or system shut-down. New terminal firmware can be downloaded into the terminal on demand to utilize feature upgrades via PCMCIA card or by serial communications.
11. Touchscreen operator terminals shall have the entire screen available for object usage and not be limited by specific templates or function keys.

M. Selection
1. The operator interface shall interface with the programmable logic controller.

N. Programming

1. A major consideration of the standard operator interface terminal shall be its programming software, which shall allow development, modification and maintenance of the application program in the standard operator interface terminal. The programming software shall be compatible with the logic controller programming software, the communications systems driver software, be tested to run on Microsoft operating systems including Windows and be a 64 bit based product. The capability shall exist to allow for expansion of the system by the addition of hardware and/or user software.
2. A single programming package shall be capable of programming the family of specified graphical operator interface.
3. The software package shall include the following minimum operator devices.
    a. Push buttons and selectors
    b. ASCII entry devices
    c. Diagnostic indicators
    d. Message displays
    e. Embedded numeric and ASCII variable displays
    f. Analog and digital gauges
    g. The software package shall offer such features as cut, copy, paste, and tag import / export capabilities in and between various application files.

O. Programming Techniques
1. The programming format shall involve the placement of input and output objects via the offline programming and configuration package.
2. Input and Output objects shall be linked to the logic controller via "tags" Tags will contain the addressing information to access the data in the logic controller.
3. The capability shall exist to change an input object from normally open to normally closed, add instructions, change addresses, offline and then download the application to the terminal.
4. A real time clock shall be included within the standard terminal. Access to the time and date shall be from the user program, or message or alarm generation.
5. The standard terminal shall have a user configurable alarm system capable of popping up an alarm banner on a user screen and presenting information that is critical to the user and of immediate use.
6. The Alarm banner shall be configurable to include "Clear Alarm", "Acknowledge Alarm", "Clear Alarm List" and "Acknowledge All Alarms" buttons.
7. The standard terminal shall have solid state RAM memory to store the application program, process data, and alarm status. This memory shall have both capacitor and battery backup in the event that input power to the processor is lost.
8. Memory shall contain battery back-up capable of retaining all stored program data through a continuous power outage for 24 months under worst case conditions.

P. Graphical Operator Interface - Fifteen Inch Display:
1. The operator interface panel shall be a Color Flat Panel.
2. Specifications
    a. Allen Bradley Panel View Plus is preferred.
    b. The display type shall be color flat panel.
    c. The minimum display size shall be 12.0 inches wide by 9.0 inches high.
    d. The operator input shall be touch screen with 384 touch cells.
    e. The standard memory shall be 1MB Flash memory.
    f. Provide PCMCIA Memory. Card Selected and sized based upon memory requirements with a 2MB minimum.
    g. The unit shall include a battery-backed clock and shall timestamp critical data.
    h. Agency approvals shall include UL, cUL approved; CE marked.

Q. Identification Tags

1. Provide identification tags for all cabinets, enclosures, workstations, UPS, and major pieces of equipment in accordance with 23 05 53, "Identification for HVAC PIPING AND EQUIPMENT".

2.04 STEAM PLANT PLC ARCHITECTURE

A. Cabinet and Controllers for Steam Plant
   1. Provide the following cabinets that include the controllers and I/O.
      a. PLC Cabinet 1 - BLR-1 (Controller 1): burner management system (BMS).
      b. PLC Cabinet 2 - BLR-2 (Controller 2): BMS.
      c. PLC Cabinet 3 - BLR-3 (Controller 3): BMS.
      d. PLC Cabinet 4 - BLR-4 (Controller 4): BMS.

B. Field Located Operator Workstations
   1. Each cabinet shall have an Operator Workstation(OWS) touchscreen which shall allow an Operator to control that particular boiler at all times and when the data highway link is lost to any and all other cabinets and/or if the SCADA server and/or workstations are out of service.

C. Burner Management System Wiring
   1. All devices connected to the Burner Management System (BMS) controllers shall be hardwired to the I/O in the cabinet.
   2. BMS devices, nor any devices, shall not be connected in any way by a bus network.

D. External Access
   1. The PLC/SCADA systems shall only be connected to the plant SCADA system. There shall be no access to the PLC/SCADA system from any outside location, via Internet, wireless, or anything else. This means no outside monitoring or diagnostics is allowed.

2.05 STEAM PLANT PLC SPECIAL REQUIREMENTS

A. Graphical Interface
   1. To the greatest extent practical, the System Integrator shall copy the existing screen for layouts for existing plant maintain continuity. Existing color formats and indications shall be mimicked to the greatest extent practical.
   2. Information shall be displayed as part of an easy to understand representation of the process.
   3. Operation and representation of the boiler BMS and CCS shall be installed on local operator panel. It shall be possible to start and stop boiler from local panel in addition to the control room.
   4. An alarm screen shall be on one screen at all times in the operator control room. These alarms shall include those from the boilers' burner management systems, field device alarms, alarms programmed in the PLC, and any other hardwired alarms.
   5. Pictorial "screens" identified below shall be provided. Additional "screens" shall be provided to effectively communicate all information to an Operator.
   6. Boiler Screens: Provide one of the following for each boiler.
      a. Fuel: Flows, Pressures, Valve Positions.
      b. Air: Draft Pressures, Air Flows, Damper and Register Positions, and Fan Speeds.
      c. Water: Drum Level, Drum Pressure, Steam Flow, Feedwater Flow, Feedwater Pressure, and Feedwater Temperature.
      d. BMS: Flame Signal, Alarms
   7. Each screen shall indicate operational parameters such as flow, temperature, pressure, valve position, and on/off status of equipment. All values shall be displayed in engineering units adjacent to the pictorial point of measurement, and the color of the displayed value shall change depending on the alarm status of the measured value. Those points in alarm shall change color and flash until acknowledged.

8. Pumps, fans, and electric motor drives shall be illustrated in color and shall be solid or flashing per the status of various switches and as indicated below. Pumps and motor drives shall be shown on the screens as separate entities.
    a. When the L/O/R switch is not "LOCAL", the motor shall be blue indicating the PLC cannot control the motor.
    b. When the L/O/R switch is "REMOTE" and the motor is powered, the motor shall be red.
    c. When the L/O/R switch is "REMOTE" and the motor is not powered, the motor shall be green.
9. On/off valves in the "OPEN" position shall be red. When the PLC logic wants the on/off valve "OPEN" and it is not "OPEN", the valve shall flash red. On/off valves in the "CLOSED" position shall be green. When the PLC logic wants the on/off valve "CLOSED" and it is not "CLOSED", the valve shall flash green. Modulating valves "CLOSED" shall be green. Otherwise they shall be red. Set point and actual valve percent open shall be displayed with the valve for all modulating valves. If a valve fails to open or close within a specified period of time when commanded, it shall flash half red and half green and annunciate on alarm screen.
10. Pictorial screens shall be developed by the PLC manufacturer with input from DES. Flow schematics shall be presented based on the P&IDs. All sample "screens" shall be submitted in color for approval. The graphics shall be high quality and shall accurately reflect the individual equipment installation including piping configuration.

PART 3 EXECUTION

3.01 TESTS, INSPECTIONS, AND REPORTS

A. General
    1. The PLC supplier shall perform and document all QA/QC inspections and tests that are normally completed by the supplier in the process and manufacture assembly of the system. All materials and work shall be subject to inspection during manufacture and assembly of the system.

B. Preliminary Review Meeting
    1. The Contractor shall convene one mandatory meeting for DES prior to logic programming to discuss the proposed system architecture and review graphic screens including screen and function layout for the field operator workstations and the SCADA server and workstations. The intent is to discuss how the system will satisfy the specification before the Contractor has gone far down a path that does not satisfy DES requirements. This meeting can be used by both parties to answer any questions.
    2. This meeting will be held at vendor’s facility.
    3. Submit color copies of the graphic screens, prior to the meeting.
    4. Allow for one 8-hour day for the meeting. This meeting should be scheduled immediately after the initial submittal of the PLC system so that package can be reviewed face to face.

C. Preliminary Testing
    1. The PLC supplier shall stage the system and perform preliminary testing to ensure readiness. The PLC supplier shall provide a comprehensive FAT plan for DES approval and notify DES 30 days prior to commencement of the test.
    2. Preliminary testing shall demonstrate the following:
        a. All equipment is complete, powered, interconnected and functioning.
        b. All control modules are functional, operating in their fully redundant mode, and are error free.
        c. All control logic and database configuration is complete, and initial timing and tuning parameters are set.
        d. All operator interface devices and graphic displays are loaded and fully functional.
        e. All logging, first-in/first out alarm tracking, and historian functions are operational.

f. All I/O modules are functional.
g. All foreign device interfaces are functional.

D. Factory Acceptance Test
1. The supplier shall perform a factory acceptance test of the assembled system. DES will witness the test.
2. The PLC system supplier shall perform an extensive acceptance test. The system shall be completely assembled and powered up. A technician capable of implementing hardware and programming corrections for the duration of the test shall be provided for the duration of factory acceptance testing.
3. A representative from DES will be present for the factory acceptance test. DES shall verify that all hardware and control strategies have been implemented in accordance with the specifications and project documentation. All graphics will be reviewed. All security features will be reviewed.
4. The PLC system supplier shall submit a test plan that includes field I/O simulation.
5. Test all wiring for proper grounding, open circuits, and proper continuity.
6. Test the control schemes for complete and proper operation of all analog and digital signals and their associated logic.
7. Test all communication and data transfer capability to independent sub-systems via foreign device interfaces.
8. Test all graphic displays for correct operation.
9. Test all reporting, logging, and historian functions.
10. Test the workstations and printers for correct configuration and operation.
11. Verify full load processor speed for each controller.
12. Verify spare I/O.
13. Verify data highway speeds.

E. Start-up and Testing
1. System Start-up: The PLC/SCADA system supplier shall provide field personnel on-site for system start-up and check out. The field personnel shall be qualified and capable of performing the duties required.
2. Training: The PLC/SCADA system supplier shall provide on-site technical training to plant maintenance and operations personnel. The training personnel shall be qualified and capable of performing the duties required.

F. Spare Parts and Special Tools
1. Accessories, special tools and spare parts required for proper operation, maintenance and testing of the system shall be provided.
2. A minimum of one box (10 fuses) of spare fuses for each size used shall be provided.

3.02 PLC/SCADA SUPPLIER SERVICES

A. The PLC/SCADA system supplier shall provide all Engineering and Project Management services necessary to implement the complete system.

B. Installation Inspection and Testing
1. The PLC system supplier shall provide a field service representative to inspect the installation of the PLC. The representative shall perform testing per the system supplier's protocol to validate the integrity and functionality of the installed system.
2. The representative shall be required after equipment inspection and test, to certify in writing that the installation meets the performance requirements and the PLC supplier's warranty remains in place.

3.03 TRAINING AND MANUALS

A. Training Scope
1. Provide on-site training for a minimum of 8 Operators and 4 others (supervisor, Instrument Technician, Engineer, Etc.) on operations. Training must be thorough and include the

basic and fundamental elements, the interaction with the field devices, and how to control the boilers.

2. Since all people cannot attend training at one time, provide training in 2 different shifts.
3. In general, operational training shall cover:
   a. System Safety: Review of alarms and appropriate actions to follow.
   b. Functional Operation of the System.
   c. Operator Commands.
   d. Alarms.
   e. Start-Up, Shutdown, and Troubleshooting Procedures.
4. Boiler training shall include but not be limited to the following:
   a. Burner sequences including burner firing, light-off, and shut-down with consideration for both natural gas and oil fuels.
   b. Burner train components and function.
   c. Operation and maintenance procedures for burner and burner train related items.
5. Maintenance training shall include:
   a. Physical Layout of Each Piece of Hardware.
   b. Troubleshooting & Diagnostic Procedures.
   c. Repair Instructions.
   d. Preventive Maintenance Procedures and Schedules.
   e. Calibration Procedures.
6. Provide three hard copies of all manuals and programs and an electronic copy.

END OF SECTION 230910.20

SECTION 230910.48
STEAM PLANT LOGIC

PART 1 GENERAL

1.01 REFERENCE STANDARDS

A. ASME B31.1 - Power Piping; 2024.

1.02 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.
   1. ASME INTERNATIONAL (ASME)
   2. ASME B31.1 Power Piping
   3. NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)
   4. NFPA 85 Boiler and Combustion Systems Hazards Code

1.03 RELATED REQUIREMENTS

A. Refer to SECTION 23 09 10 for Steam and HW Plant PLC.

1.04 SUMMARY

A. This SECTION contains the logic control sequence descriptions for the following systems:

B. Boiler 1-4
   1. Burner Management Systems
   2. Combustion Controls, Draft Controls, and Drum Level Controls

1.05 SUBMITTALS

A. DES approval/acceptance is required for submittals with a “DES” designation, submittals not having a designation are for information only. Submit the following in accordance with SECTION 01 33 00 SUBMITTAL PROCEDURES:
   1. Shop Drawings
      a. Logic Diagrams; DES
   2. Certificates
      a. Applicable Codes; DES
      b. Engineer/Technician Qualification Resume; DES
      c. Submit control logic engineers, programmers, and field integrator(s) for approval prior to them performing any work. Submit experience requirements and list of similar projects.

1.06 QUALITY ASSURANCE

A. Applicable Codes
   1. Regardless of fuel input rating, the equipment, installation and operation of all boilers shall conform to the latest edition of NFPA 85 as it applies to the style, fuels fired, and control scheme specified for each boiler.
   2. Provide a certificate indicating that all logic is in accordance with NFPA 85.
   3. All work shall be in accordance with the ASME Boiler and Pressure Vessel Code Sections I and VIII, ASME B31.1 Power Piping Code, and the National Board Inspector's Code. The Contractor shall refer to the Authorized Inspector (which for this project is DES Inspector who will interface and coordinate with Owner’s AI) for direction for any discrepancies with boiler external versus boiler non-external piping.

B. Experience Requirements
   1. Engineers and technicians that perform the design, installation, logic programming, start-up, testing, and training of the PLC and field devices including burner management systems, combustion control systems, and balance of plant systems shall have experience as specified.

2. Engineers and technicians shall have performed design, installation, logic programming, start-up, testing, and training of a minimum of 5 separate projects of similar equipment to this project within the last 5 years. All of this experience must be while working with the same PLC and SCADA manufacturer and system as provided for this project. Of the 5 projects, a minimum of two natural gas fired boilers of capacity 50,000 PPH or greater shall be included. Of the 5 projects, a minimum of 1 multiple burner boilers firing natural gas of capacity 50,000 PPH or greater shall be included. Of the 5 projects, a minimum of 2 projects shall include a significant amount of balance of plant equipment, i.e. deaerators, feedwater pumps, condensate receivers, condensate pumps, water softeners, etc.

C. Engineer/Technician Qualification Resume
   1. Submit printed and signed resumes of the Engineer(s) and technician(s) who shall perform the design installation and programming logic start-up, testing, and training of the burner management systems, combustion control systems, and balance of plant systems. The resumes of the Engineer(s) and technician(s) shall list all applicable experience related to the design, logic programming installation, start-up, training and testing. The resumes shall demonstrate compliance with the specified experience requirements. More than one Engineer or technician may be provided. In the event more than one Engineer or technician is provided, provide a resume for each person which shall indicate his/her specialty.
   2. The resumes shall include a list of similar installations that include location of installation, PLC manufacturer and scope equipment steam capacity of boilers, type of combustion control system, types of fuels, scope of work, and name, address, and phone number of contact person. Information regarding degree of difficulty of controls portion of project will be helpful. This person shall be contacted so make sure the person still works there and the phone number is correct.
   3. DES shall review all resumes and approve all personnel that have demonstrated the experience requirements specified.

D. Logic Review Meeting
   1. As specified in SECTION 23 09 10.20 for the Factory Acceptance Test for the PLC.

E. Logic Diagrams
   1. Submit logic diagrams in accordance with the requirements specified in SECTION 23 09 10.20.

1.07 DEFINITIONS

A. General
   1. The following abbreviations are used in this SECTION
      a. BMS - Burner Management System
      b. CCS - Combustion Control System
      c. PLC - Programmable Logic Controller
      d. MMI - Man-Machine Interface or PLC Field Operating Work Station or SCADA Work Station
      e. FD - Forced Draft Fan

PART 2 PRODUCTS

2.01 BLR-1 THROUGH BLR 4 (BMS & CCS)

A. General
   1. All existing boilers will have a new BMS and CCS.
   2. Boiler 1 and 4 are currently coal fired boilers, and are being switched to natural gas primary firing with number two fuel oil as a secondary fuel under this project. BLR-1 and fu4 will each have two burners, but both burners will act as one - there will be no separate air or fuel control for either burner, and a flame-out of either burner will trip the boiler.

3. Boiler 2 and 3 will each have two new oil-fired burners added. The existing gas burners (updated in 2018) will remain. Both burners will act as one - there will be no separate air or fuel control for either burner, and a flame-out of either burner will trip the boiler.
4. Provide the necessary engineering services, equipment, materials, installation labor, calibration, check out, testing, and start-up of the BMS in accordance with the requirements of NFPA 85. The system shall be automatic and all boilers will be treated as single burner boilers with respect to logic (keeping in mind that there are 2 burners per boiler, but they are not being controlled as one).
5. The burner management system (BMS) shall be a microprocessor based system designed to provide the proper burner sequencing, ignition, and flame monitoring protection for a natural gas fired boiler in conjunction with limit and operating controls, the BMS shall program the fan driver, ignition, and fuel valves to provide for proper and safe burner operation. The control shall also provide continuous operating status and lockout information in the event of a safety shut-down.
6. The burner management system shall be an Allen Bradley Compact Logix PLC with a Panel View touch screen. The PLC shall be connected to the existing central SCADA system in the control room located on the first level of the plant.
7. Provide the logic, I/O, touchscreen interface, lights, horn, and all related components in a stand-alone enclosure as specified in SECTION 23 09 10.20 - PLC.

B. System Design Requirements
1. The BMS shall be designed to operate reliably and to minimize the number of false trips. As a minimum, the BMS shall incorporate the following features:
   a. The BMS shall be designed, installed and programmed in accordance with the requirements of NFPA 85.
   b. The BMS shall incorporate a continuous purge of the furnace to ensure that the boiler is free of any accumulation of combustibles prior to light-off and after flame out.
   c. The BMS shall be designed to supervise the operation of the fuel-air equipment associated with the natural gas and fuel oil.
   d. The BMS shall accept operator commands and perform operations based upon all permissives being met.
   e. The BMS shall continuously monitor the boiler including but not limited to steam drum pressure and drum level. Monitored values shall be alarmed and shall shut down equipment as necessary to avoid hazardous furnace conditions or equipment damage.
   f. The BMS shall monitor the operation of the fuel trains including but not limited to operating pressures, differential pressures, and flows. If a piece of the equipment fails to respond to a command from the BMS, the equipment trip shall be initiated. The BMS shall provide indication of the equipment which has initiated the fuel equipment trip. Tripped equipment shall be successfully shut down before reset of the trip is permitted.
   g. Inputs to the BMS shall include those inputs required to provide overall protection as stated in NFPA 85.
   h. The unit shall start reliably and repeatedly by depressing a single button without requiring operator adjustments to controls.
2. The BMS shall interface to the combustion control system to position and monitor devices for start-up and shut-down which are normally modulated during on-line operation. The following outlines the procedure but it is Vendor’s responsibility to determine operating sequence for the new burner equipment.
   a. For purging, the BMS shall control the speed of the forced draft (FD) fan and position the FD and windbox dampers by generating a logic signal for the combustion control system. The combustion controls shall respond to the BMS output by opening the dampers and ramping the fans to that required by NFPA 85.

b. For establishing the ignition and burner flames, the BMS shall position the fuel control valve and FD fan inlet and windbox dampers at low fire position by generating a logic signal for the combustion control system. The combustion control system shall close the fuel control valve to a minimum position and drive the FD fan and FD fan inlet and windbox damper actuators to their minimum position to where a safe light-off air flow is established. The position of the dampers shall be established by the burner manufacturer.
c. The logic signals for the combustion control interface shall consist of isolated contacts, utilizing the combustion control system power, whether alternating or direct current and at any voltage between 5 and 120.
d. Required inputs include contact closures to prove the gas flow control valves and FD fan inlet air damper and windbox dampers are in the low fire position.

C. System Functional Requirements
1. The Operator shall have the capability for initiating the start and stop sequences listed below. An Operator must push the start button (local panel only) before the burner start-up sequence for any burner is initiated. Un-assisted (remote start-up) for any reason is prohibited. Once initiated, the burner control system shall automatically place the burner in service or remove it from service.
2. The following shall be included with the system:
   a. Initiate a purge.
   b. Initiate burner "start" and "stop".
   c. Interrupt burner system operation.
   d. Switch fuels during opertion.
3. The safety system shall include the following limit devices incorporated into the Master Fuel Trip Logic as a minimum:
   a. Flame failure.
   b. Ignitor flame failure during start-up.
   c. High boiler drum pressure.
   d. High and low pressure for natural gas.
   e. Low water level cutout.
   f. Low combustion air flow.
   g. FD fan failure.
   h. ID fan failure.
   i. Loss of instrument air pressure.
   j. High and low furnace pressure.
   k. Any additional required by NFPA 85.
   l. Operator Estop from Main Control Room.
4. Interrupt alarm sound at the local panel by depressing a "silence/acknowledge" button. The BMS display shall retain its indication when an Operator interrupts the alarm sound. The message display shall retain the message identifying the reason for alarm until the cause for alarm has moved to a satisfactory position out of the alarmed range.
5. The BMS shall assume control of the boiler firing rate controls while the boiler is shutdown to limit the flow of air through the boiler.
6. The BMS shall automatically open and close the fuel safety shutoff valves (where applicable) according to the sequence of operation specified by the referenced Codes.
7. The BMS shall not rely on the combustion controls' controller functions to achieve a safe shutdown of the system. The operation of limit switches, emergency stop buttons, and flame detector chassis shall interrupt the electrical power to the fuel safety shutoff valves by opening of hard-wired contacts and prevent further operation of the boiler until reset by an Operator.
8. Main Burner Control
   a. Starting and stopping shall be accomplished through the local PLC MMI.

b. Remote emergency shutdown provisions shall be provided in the control room.

9. Ignitor Control
    a. Ignitors shall be started automatically after the required safeties are satisfied upon the Operator pressing the burner start button on the local panel and stopped automatically at the main flame trial for ignition period. The burner safety valves shall open only after ignitor operation has been established by verifying ignition energy for the burner. Ignitor fuel trip due to ignition failure shall be indicated to the Operator.
10. Furnace Purge
    a. The furnace purge control shall incorporate prelight off and post purges of the furnace to ensure that the boiler is free of any accumulation of combustibles. Completion of the furnace purge shall be indicated to the Operator.
    b. The BMS shall prevent starting any fuel equipment if the furnace firing permissives are not met.
    c. The furnace purge control shall provide indications to the Operator of the status and the progress of the furnace purge. The BMS shall assume control of the boiler firing rate (combustion) controls during boiler start-up to purge the boiler and to position the fuel valves and dampers to low fire position prior to and during ignition of the burner.
    d. A furnace purge shall be required on any master fuel trip.
11. Re-Lighting Burner
    a. Each Boiler will have two burners per boiler. Individual modulating burner fuel and air control is not required. When a flame out occurs in one burner and there is a flame in the other burner, the BMS shall perform a master trip.

D. Flame Scanners
1. Provide new flame scanners and hardware in the BMS cabinet.

E. Alarms and Annunciation
1. General:
    a. The BMS shall provide indications of operation and failure using audible and visual means. Audible indications shall be limited to indications of failures or of impending failures.
    b. The BMS shall include a "first-out" feature that will indicate and record the first alarm to go off when a series of alarms are generated including when the boiler is tripped.
    c. Visual indications shall be provided to indicate all system control functions. An alphanumeric message display shall be provided which shall be part of the standard BMS package. The display shall be in plain English and shall provide burner cycle status, flame energy status, and alarm indication. The display shall also provide timing during purge, flame signal strength, burner history, and menu headings. The BMS must be configured and be provided with the necessary hardware to communicate with the SCADA system to provide flame signal strength, light off sequence, alarms, valve, and switch status, and all BMS messages. Provide display and communication hardware that support communications. Scroll, reset, and mode keys shall be provided with the BMS display to provide access to current and historical information and to reset the BMS in the event of a lockout condition.
    d. The BMS shall provide indications of operation and failure using audible and visual means via the MMI.
2. The BMS shall incorporate the necessary hardware and logic to provide indication of the following operating conditions at the MMI as indicated:
    a. Audible and graphical indication that power was lost upon reinstatement of electrical power.
    b. Continuous indication that monitored operating conditions are within normal parameters when the burner is operating.
    c. Audible alarm and graphical indication via BMS display that fuel valves are not proven closed upon energization of the BMS and initiation of purge.

d. Indication that a purge is in progress and the time elapsed in the purge cycle.
e. Indication that the purge is complete but low fire conditions required for burner ignition are not satisfactory.
f. Indication that boiler pressure or flow or fuel conditions are not suitable for burner operation. Note that the status of boiler and fuel conditions shall have no effect upon accomplishing a purge except for total flame failure.
g. Indication of igniter and main flame trial for ignition.
h. Indication of the delay required by NFPA 85 before repeating an attempt to light an igniter flame.
i. Indication that flame is not detected at the burner.

F. Additional Interlocks and Alarms
1. The following requirements shall be provided for the BMS system operation. This include typical interlocks and system alarms.
2. Loss of power shall be sensed and shall include all sources of power required to complete interlock functions, any sources of power for combustion control, and sources of power to burner management systems. In addition, loss of power for the forced and induced draft fans shall be immediately sensed and an interlock provided.
3. Provide natural gas low pressure switch. The low-pressure switch shall be interlocked with the BMS, shall cause a burner trip, and shall be alarmed.
4. As a minimum, provide valve position switches as follows to meet all requirements per NFPA 85:
a. Both natural gas safety shut-off valves closed.
b. Low fire position of natural gas control valve.
5. Provide wiring from interlock devices to logic cabinet. Wiring type and size shall be as recommended by manufacturer for compatibility with equipment.
6. Switches shall be interlocked with the BMS, shall cause a boiler trip, and shall be alarmed.
7. Provide low instrument air pressure switch. Switch shall be interlocked with BMS, shall cause a boiler trip, and shall be alarmed.
8. Provide a boiler emergency fuel trip push button on the field panels and in the local and main control room with accidental trip guards (lift cover type). Pressing the button shall trip the boiler and cause an alarm.
9. The high steam drum pressure switch shall trip the boiler.

2.02 COMBUSTION CONTROL

1. General
a. The boiler combustion control system shall be a fully metered, cross-limited combustion control system with oxygen trim. The fuel and air control loops shall ensure the proper amount of air based on the fuel selected. An oxygen trim control loop shall optimize boiler efficiency. Cross limiting shall exist in the manual and automatic modes.
b. Combustion controls shall automatically regulate the firing rate in accordance with the load demand and shall meet the specified burner turndown. The control system shall maintain air-fuel mixtures within the limits required for stable and efficient combustion throughout the specified firing range and, as applicable, during changes in firing rates. A means shall be provided to permit manual control of the firing rate, when desired. The combustion control system shall provide smooth operation when switching between automatic and manual operation. The system shall alarm when the load demand drops below the minimum firing rate provided by the control system.
c. Proof of minimum fire position for the natural gas flow control valve, and all dampers shall be included in the BMS logic.
d. Flow of natural gas, fuel oil and air shall be measured and included in the combustion control system logic for each boiler.

e. The primary variable, steam pressure, shall be measured and compared to an operator adjustable set point. The error shall be acted upon by the boiler master control loop to generate a firing rate demand signal.
f. BLR-1 FD and ID fan will be converted to electric drive. The FD and ID fan motors shall be specified with VFD drives and turn down the fan speed as low as possible to take advantage of saving electrical energy, but not to the point where safety is compromised. When the VFD is in by-pass mode (FD fan motor running at constant speed), the control device shall be the FD fan inlet damper with the windbox damper being used for O2 trim. Provide for both scenarios - VFD running and in by-pass.
g. BLR-2,3,4 FD and ID fan will remain steam turbine drives. The FD and ID fan turbines shall modulate the fan speed to control air flow. The FD fan inlet damper shall be used to control air flow if the turbine is set to operate in manual with turbine at full speed with the windbox damper being used for O2 trim. Provide for both scenarios – turbine in auto mode running and in by-pass.

B. Boiler Master Control Loop
1. Currently the existing boilers are operated without a Boiler Master. Owner would prefer that a Boiler Master is programmed into the operating system during the Burner conversion. The Vendor shall program Boiler Master as part of this project.
2. The Boiler Master control loop shall determine the boiler firing rate. The Boiler Master control loop shall provide for selection of firing rate control from the Plant Master controller (auto-mode) or from an Operator adjustable boiler percent demand (manual-mode). The boiler master shall create the demand signal for the fuel-air.
3. The MMI shall provide digital and analog display of plant master signal, loading index, steam drum pressure, steam and feedwater flows, and control signal output. Load index bias, load index ratio, and steam drum pressure and boiler flow shall be displayed digitally.
4. The Boiler master shall be programmed by Vendor in the existing Balance of Plant PLC.

C. Fuel, Air, and Oxygen Trim Loops
1. The fuel, air, and oxygen trim control loops shall provide additional windbox damper control and control for the forced and induced draft fans using a field adjustable fuel-air ratio curve for each fuel. Fine tuning of the windbox damper shall be accomplished with oxygen trim. The fuel air ratio control loops shall interface with the boiler master control.
2. The MMI shall provide digital and analog display of control output to fuel valves, air demand index, and percent oxygen. Digital displays shall be provided for fuel-air ratio, fuel air bias, and boiler efficiency. Oxygen set point shall be displayed adjacent to actual measured oxygen.

2.03 DRAFT CONTROL

A. Provide draft control per NFPA 85.

2.04 DRUM LEVEL CONTROL

A. General
1. Feedwater drum level control shall be provided in the CCS.
2. Provide three element control for normal operation and single element control for start-up. Selection of which control mode to use shall be Operator selectable. The transfer from one mode to the other shall be bumpless.
3. Manual control of the feedwater control valve shall be permitted by an Operator.

B. Three Element Control
1. The three element system shall maintain a normal water level in the drum based on three independent variables: Steam flow from the boiler drum, feedwater flow to the boiler drum, and water level in the boiler drum.
2. The signal from the drum level transmitter shall be compared to an Operator adjustable set point. The difference resulting from this comparison shall have proportional plus integral action taken upon it, and the resulting signal shall be summed with the total boiler

steam flow. The output of the steam flow-drum level error summator shall become a demand for feedwater in the feedwater flow control loop. The feedwater flow control loop shall compare the feedwater demand signal to the actual feedwater flow signal. The error shall be acted upon by the feedwater flow control loop to generate a demand signal for the control valve.

C. Single Element Control
   1. The single element system shall maintain a normal water level in the drum based on one variable: Water level in the drum.
   2. The signal from the drum level transmitter signal shall be compared to an Operator adjustable set point. The difference resulting from this comparison shall have proportional and integral control taken upon it. The resultant shall be compared to the actual feedwater control valve position signal, and the error shall be acted upon by the control loop to generate a new demand signal for the control valve.

D. PLC/SCADA Screen Information
   1. The SCADA screen shall indicate drum level, drum level set point, signal output to feedwater control valve, steam flow, drum pressure, feedwater header pressure, feedwater header and economizer outlet temperature, feedwater flow and drum level control mode.
   2. The SCADA screen for shall be same for each boiler.

PART 3 EXECUTION

3.01 GENERAL TESTING REQUIREMENTS

A. General
   1. The Contractor shall be responsible for the performance of all tests and inspections as specified herein to demonstrate that the boiler combustion systems, BMS systems, and instrumentation systems including SCADA as installed, are in compliance with contract requirements.
   2. During system start-up tests, factory-trained engineers or technicians employed by individual suppliers of such components as instrumentation and controls shall be present as required to insure the proper functioning, adjustment, and testing of the individual components and systems, and to train plant operation personnel in the operation and maintenance of them.
   3. A detailed written record of the start-up performance, including burner setting data over the entire load range, shall be furnished to DES before the Contractor's and sub-contractor's test personnel leave the site.
   4. All labor, equipment, and test apparatus required for testing shall be furnished by the Contractor. Fuel shall be supplied by DES. All defects disclosed by the tests shall be rectified by the Contractor. Boilers and balance of plant systems shall be tested as completed and approved by DES.

B. Phasing
   1. The minimum steam load from spring through fall is below the maximum capacity of individual equipment (boilers, pumps, etc.) and therefore cannot be tested at full load except during the winter. In order to allow for full load testing of the equipment, the Vendor shall furnish and install a temporary silencer to allow for the blow down of any excess steam that cannot be delivered to the DES customer distribution system during startup and commissioning. Location of silencer shall be coordinated with DES. All boilers need to be tested at full load regardless of timing.
   2. Boiler 1 and 4 shall be completed first and commissioned prior to work commencing on Boiler 2 and 3.

3.02 GENERAL BOILER INSTRUMENTATION AND CONTROL SYSTEM START-UP

A. The Contractor shall provide the services of qualified and experienced service technicians to place the new combustion control and BMS systems in service.

B. A minimum of one service technician shall be engaged in the start-up for each unit. The work shall include start-up services equivalent to one man for a period of at least five days per boiler. Should additional time or personnel be required due to errors in the design of the systems or their installation, it shall be provided at no additional cost to DES. All system adjustments including instrument setpoint adjustments, fuel control valve adjustments, safety device adjustments, etc. shall be made during start-up. All systems shall be completely functional in all respects prior to the specified performance demonstrations.

C. The start-up shall be documented; consisting of presentation to DES of a description of the work performed each day during the start-up plus copies of all data sheets, forms and notes prepared by the service technicians during the start-up. A description of the tests or calculations performed to establish the setting of safety limit switches and the final setting of each switch shall be furnished to the DES Project Coordinator. Satisfactory operation of each switch will be demonstrated in the presence of the DES Project Coordinator.

D. The Contractor shall tune boilers to keep existing emission rates for all fuels for all boilers within permitted levels.

E. Testing
   1. Provide field testing and adjustment of completed control system.
   2. All tests and inspections at the site shall be made under the direction of and be subject to the approval of the DES Project Coordinator. Proposed performance test procedures shall be submitted to the DES Project Coordinator 10 days prior to the proposed test date. The Contractor shall operate the boiler and all appurtenances prior to final testing and shall insure that all necessary adjustments have been made. All testing equipment, including Gauges, thermometers, calorimeter, Orsat apparatus, thermocouple pyrometers, fuel flow meters, water meters, and other test apparatus shall be provided by the Contractor and set up and calibrated prior to the test. Calibrated test equipment other than installed equipment shall be used for testing and inspection except as herein specified otherwise. Draft, fuel pressure, and steam flow may be measured by permanent Gauges and meters. The Contractor shall employ the services of an independent certified testing agency for providing an analysis of the fuel being used for the tests.
   3. Control of noise levels developed by exhaust steam, including muffler, globe, and gate valves, shall be conducted in such a manner as not to create a nuisance or hazard, and shall be subject to the approval of the DES Project Coordinator.
   4. Field Test: When installation of each boiler control system is complete, calibrate field equipment and verify transmission media operation before the system is placed on line. All testing, calibrating, adjusting, and final field tests shall be completed by the Contractor.
   5. Operational Load Test: Test the boiler(s) continuously under varying load conditions to demonstrate proper operability of the combustion control, flame safeguard control, programming control, and safety interlocks. Conduct this test after the adjustment of the combustion controls has been completed under the combustion test.
   6. Operating Tests: After adjustment and achievement of stable operation of the boiler, the boiler shall be tested continuously for 24 hours minimum, to demonstrate control and operational conformance to the requirements of this specification under varying load conditions ranging from the specified 100 percent capacity to the minimum burner turndown ratio without on-off cycling. In each case, the operating tests shall cover the periods for the capacities tabulated below and shall be in addition to the start-up and instruction requirements:
      a. First 4 hours 25% Capacity
      b. Next 4 hours 50% Capacity
      c. Next 4 hours 75% Capacity

d. Next 4 hours 100% Capacity
e. Next 8 hours Automatic Control (if load is available)

7. Sequencing: The system shall start, operate, and stop in strict accordance with the specified operational sequence.
8. Flame Safeguard: Verify the operation of the flame safeguard controls by simulated flame and ignition failures. Test the burner having an intermittent pilot by simulating main flame failure while the pilot is burning. Verify the trial-for-pilot ignition, trial-for-main flame ignition, combustion control reaction, and valve closing times by stop watch.
9. Boiler Limit and Fuel Safety Interlocks: Safety shutdown shall be caused by simulating interlock actuating conditions for each boiler limit and fuel safety interlock. Safety shutdowns shall occur in the specified manner.
10. Combustion Controls: Demonstrate the accuracy, range, and smoothness of operation of the combustion controls by varying the steam demand through the entire firing range required by the turndown ratio specified for the burner.
11. Fuel Records: For all testing and burning of fuel during testing and start-up, keep accurate record of fuel burned for DES's environmental records.

3.03 BOILER PERFORMANCE AND EFFICIENCY TESTING

A. Prior to scheduling any performance or efficiency tests, submit evidence of pretest simulations including all testing required by previous paragraphs. Evidence shall consist of itemized check list of all control, indicating, and interlock functions. Check list shall certify that all functions are properly operational.

B. For all boilers on all fuels, conduct an efficiency test in accordance with the ASME Power Test Code. Submit the ASME Test Form for abbreviated efficiency test summary sheet (PTC 4.1-a) and calculation sheet (PTC 4.1-b).

C. Efficiency tests shall be performed on each boiler firing each fuel.

D. Conduct a performance test on each boiler at 25, 50, 75, and 100 percent load. Test form shall be completed in its entirety and submitted to the DES Project Coordinator for approval. Test form shall include outputs from temporary NOx, 02, CO, and opacity meters.

E. Conduct continuous functional test for 168 hours for each boiler.

3.04 TRAINING AND MANUALS

A. Provide training and manual in accordance with paragraph "TRAINING AND MANUALS" of SECTION 23 09 10.20.

END OF SECTION 230910.48

SECTION 231113
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. Overfill prevention valve.
G. Back Pressure Regulating Valve.
H. Flexible connectors.
I. Aboveground fuel storage tanks.
J. Fuel Oil pump set Skid.
K. Master Control Panel.
L. Tank Monitoring System.
M. Leak detection and monitoring system.
N. Fuel Oil Fill Station and Remote spill container.

1.02 REFERENCE STANDARDS

A. API RP 1615 - Installation of Underground Petroleum Storage Systems; 2011 (Reaffirmed 2020).
B. ASME BPVC - Boiler and Pressure Vessel Code; 2023.
C. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels; 2023.
D. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators; 2023, with Errata (2024).
E. ASME B1.1 - Unified Inch Screw Threads (UN, UNR, and UNJ Thread Forms); 2024.
F. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard; 2020.
G. ASME B16.9 - Factory-Made Wrought Buttwelding Fittings; 2024.
H. ASME B16.11 - Forged Fittings, Socket-Welding and Threaded; 2021.
I. ASME B16.12 - Cast Iron Threaded Drainage Fittings; 2019.
J. ASME B16.39 - Malleable Iron Threaded Pipe Unions: Classes 150, 250, and 300; 2019.
K. ASME B18.2.1 - Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series); 2012 (Reaffirmed 2021).
L. ASME B18.2.2 - Nuts for General Applications: Machine Screw Nuts; and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series); 2022.
M. ASME B31.3 - Process Piping; 2022, with Errata (2023).
N. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2022.

O. ASTM A105/A105M - Standard Specification for Carbon Steel Forgings for Piping Applications; 2023.

P. 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; 2023.

Q. ASTM A193/A193M - Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications; 2024a.

R. ASTM A194/A194M - Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both; 2023.

S. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2023a.

T. ASTM A312/A312M - Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes; 2022a.

U. ASTM A358/A358M - Standard Specification for Electric-Fusion-Welded Austenitic Chromium-Nickel Stainless Steel Pipe for High-Temperature Service and General Applications; 2019.

V. ASTM A403/A403M - Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings; 2022b.

W. ASTM A733 - Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples; 2016 (Reapproved 2022).

X. ASTM B687 - Standard Specification for Brass, Copper, and Chromium-Plated Pipe Nipples; 1999 (Reapproved 2023).

Y. ASTM F436/F436M - Standard Specification for Hardened Steel Washers Inch and Metric Dimensions; 2019.

Z. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2018, with Amendment (2019).

AA. MSS SP-80 - Bronze Gate, Globe, Angle, and Check Valves; 2019.

BB. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010, with Errata .

CC. NACE SP0286 - Electrical Isolation of Cathodically Protected Pipelines; 2007.

DD. NFPA 30 - Flammable and Combustible Liquids Code; 2024, with Amendment.

EE. NFPA 31 - Standard for the Installation of Oil-Burning Equipment; 2024.

FF. UL 142 - Steel Aboveground Tanks for Flammable and Combustible Liquids; Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data:
   1. Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.
   2. For pumps, include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories details, material descriptions, and dimensions of individual components and profiles.
   3. Include construction details, material descriptions, and dimensions of individual components and profiles.
   4. Include furnished specialties and accessories.
   5. For tanks, include material type, pressure rating, and capacity and installation details.
      a. Recommended tank support locations.
      b. Weight of entire tank assembly, empty and flooded.

c. Design and construction of primary tanks, insulation, secondary containment, supports, pipe connections, platforms.
d. Application and performance data on coatings from manufacturer of coatings.
e. Data certifying tanks are designed for surcharge loads of platforms shown.
f. Certification of compliance with specified standards.
g. Certification that steel tank manufacturer participates in Steel Tank Institute (STI) Quality Assurance Program.
h. Design, construction, performance, dimensions of emergency relief vents.

C. Shop Drawings: Indicate tanks, system layout, pipe sizes, location, and elevations. For fuel oil tanks, indicate dimensions and accessories, including manholes and hold down straps.

D. Certificates: Certify that products meet or exceed specified requirements.

E. Project Record Documents: Record actual locations of piping system, storage tanks, and system components.

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

G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
1. Valve Repacking Kits: One for each type and size of valve.

1.04 QUALITY ASSURANCE

A. Welding Materials and Procedures: Comply with ASME BPVC.

B. Welders Certification: In accordance with ASME BPVC-IX.

C. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

D. Valves: Manufacturer's name and pressure rating marked on valve body.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Lift and support fuel oil storage tanks only at designated lifting or supporting points, as shown on Shop Drawings. Do not move or lift tanks unless empty.

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

C. Store pipes and tubes with protective PE coating to avoid damaging the coating and to protect from direct sunlight.

1.06 WARRANTY

A. Provide 10 year manufacturer warranty for Tank.

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.
2. Comply with applicable regulations for installation of fuel oil system.
3. Provide certificate of compliance from Authority Having Jurisdiction indicating approval of installation of fuel oil system.

B. Carbon Steel Pipe:
1. ASTM A53/A53M, Type E or S, Grade B, seamless or electric welded, Schedule 40.
2. End Connections and fittings:
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. Stainless Steel Pipe:
1. Comply with One of the Following:
a. ASTM A312/A312M, Type TP304L, seamless only, Schedule 40S for pipe less than 8 inches in diameter or Schedule 10S for pipe 8 inches and larger.
b. ASTM A358/A358M, Grade 304L, Class 1 or 3, longitudinally welded.
1) 100 percent of factory longitudinal welds, radiographically inspected in accordance with ASME BPVC-VIII-1.
2) 0.25 inch minimum wall thickness for pipe 12 inches and smaller and 0.312 inch for pipe greater than 12 inches.
2. Fittings 2-1/2 inches and Larger:
a. Stainless steel, buttweld type.
b. Comply with One of the Following:
1) ASTM A403/A403M, Class WP-S, Grade WP 304L, seamless only, and ASME B16.9 of the same thickness as the adjoining pipe.
2) ASTM A403/A403M, Class WP-XX, Grade WP 304L, wall thickness as indicated.
(a) Fabricate starting material by fusion only after the addition of filler metal.
(b) Prohibit forming with fusion without addition of filler material.
(c) Radiographically inspect all factory longitudinal welds in accordance with ASME BPVC-VIII-1.
3. Fittings 2 inches and Smaller:
a. Stainless steel, socket weld type.
b. Comply with ASME B16.11 and ASTM A182/A182M.

D. All joints shall be of the socket-welded or butt-welded type. Threaded joints are prohibited, with the exception of valves with a nominal size of 1 inch or less, and unions.

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 (or higher).
2. Carbon Steel: Comply with ASTM A105/A105M.
3. Stainless Steel: Comply with ASTM A182/A182M, Grade F304 or F304L, forged type.
4. Gaskets, Non-Isolating:
a. 1/8 inch thick.
b. Comply with ASME B16.12, raised-faced type.
c. Material: Buna-N.
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.

d. Stainless Steel Material:
1) Bolts: Comply with ASTM A193/A193M, Class 2, Grade 8.
2) Nuts: Comply with ASTM A194/A194M, Grade 8.
3) Washers: Comply with ASTM F436/F436M, flat circular.

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 (or higher), as defined in ASME B16.5.
3. Welded Nipples: Comply with ASTM A733 or ASTM B687 and construct of same material as connecting pipe.
4. Threaded Unions:
a. Comply with ASME B16.39, Class 150.
b. Materials: Comply with ASTM A312/A312M, Grade 304 or 316.
c. Dielectric Unions: Comply with dimensional, strength, and pressure requirements of ASME B16.39, Class 150.

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.

E. Vertical Support: Steel riser clamp.

F. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

2.04 GATE VALVES

A. Manufacturers:
1. Apollo Valves
2. Bonney Forge
3. Nibco, Inc
4. Milwaukee Valve Company
5. Or approved substitution.

B. MSS SP-80, Class 125, carbon steel or stainless steel body, stainless steel trim, rising stem, handwheel, inside screw, solid wedge disc, threaded or socket weld ends.

C. UL listed for fuel oil.

2.05 GLOBE VALVES

A. Manufacturers:
1. Apollo Valves
2. Nibco, Inc
3. Milwaukee Valve Company
4. Or approved substitution.

B. MSS SP-80, Class 125, carbon steel or stainless steel body, stainless steel trim, handwheel, stainless steel disc, teflon seat, threaded or socket weld ends.

C. UL listed for fuel oil.

2.06 BALL VALVES

A. Manufacturers:
   1. Apollo Valves
   2. Nibco, Inc
   3. Milwaukee Valve Company
   4. Or approved substitution.

B. MSS SP-110, Class 150, 400 psi CWP, carbon steel or stainless steel, three piece body, stainless steel ball, regular port, teflon seats and stuffing box ring, blow-out proof stem, lever handle with balancing stops, threaded or socket weld ends.

C. UL listed for fuel oil.

2.07 SWING CHECK VALVES

A. Manufacturers:
   1. Apollo Valves
   2. Hammond Valve
   3. Nibco, Inc
   4. Milwaukee Valve Company
   5. Or approved substitution.

B. MSS SP-80, Class 125, carbon steel or stainless steel body, bronze swing disc, threaded or socket weld ends.

C. UL listed for fuel oil.

2.08 RELIEF VALVES

A. Manufacturers:
   1. Armstrong International, Inc
   2. ITT McDonnell & Miller
   3. Spirax-Sarco
   4. Or approved substitution.

B. Carbon steel or stainless steel body, teflon seat, steel stem and springs, automatic, direct pressure actuated at maximum 200 psi, UL listed for fuel oil, capacities ASME certified and labelled.

2.09 STRAINERS

A. Manufacturers:
   1. Armstrong International, Inc
   2. Green Country Filter Manufacturing
   3. WEAMCO
   4. Or approved substitution.

B. Threaded carbon steel or stainless steel body for 175 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen.

C. UL listed for fuel oil.

2.10 OVERFILL PREVENTION VALVE

A. Manufacturers:
   1. Morrison Bros. Co
   2. Preferred Utilities Mfg. Corp.
   3. Or approved substitution.

B. Automatic valve designed for aboveground tanks with a drop tube. Valve shall be compatible with renewable fuel oils and biofuels.

C. Provide single stage valve, rated for fill flow and pressure, which stops flow completely at 95 percent of tank capacity.

D. Valve shall include method for draining oil trapped above the valve into the tank.

2.11 BACK PRESSURE REGULATING VALVE

A. Manufacturers:
   1. Fisher
   2. Preferred Utilities Mfg. Corp.
   3. Or approved substitution.

B. Set pressure of 150 PSIG, adjustable spring range from 30 to 150 PSIG.

C. Cast iron body, hardened stainless steel trim, teflon seat, stainless steel diaphram.

2.12 FLEXIBLE CONNECTORS

A. Manufacturers:
   1. Flexicraft Industries
   2. Penflex
   3. Or approved substitution.

B. Bronze inner hose and braided exterior sleeve, suitable for minimum 200 psi CWP and 250 degrees F.

2.13 ABOVEGROUND FUEL STORAGE TANKS

A. Manufacturers:
   1. Highland Tank & Manufacturing; www.highlandtank.com
   2. Modern Welding Company; www.modweldco.com
   3. Brown Tank; www.browntank-mn.com
   4. Or approved substitution.

B. Tank: UL 142 listed and labeled.

C. Double wall tank.
   1. 304 stainless steel inner tank
   2. Carbon steel outer shell
   3. 2 inches of thermal insulation between the inner tank and outer shell.

D. Ladder with cage and platform designed to meet OSHA regulations, allowing for safe access and egress without requiring fall arrest. Step-off platform and swing gates for secure entry and exit.

E. Perimeter safety rail.

F. Accessories and connections:
   1. One 24-inch manway at top of tank, UL listed manhole with bolted gaskets and cover.
   2. One 24-inch manway at base of tank, UL listed manhole with bolted gaskets and cover.
   3. Fuel oil tank fill connection with overfill protection valve and drop pipe extended to within 6 inches of the tank bottom and braced at tank bottom, end with a 45 degree miter
   4. Pump suction connection.
   5. Fuel oil return connection with drop pipe extended with 6 inches of the tank bottome and braced at tank bottom, end with a 45 degree miter..
   6. Level transmitter connection.
   7. Emergency relief and flame arrest.
   8. Tank drain.
   9. Secondary emergency vent
   10. Tank level alarm
   11. Leak monitor pipe

G. Capacity: 40,000 gallons.

H. Pressure Relief Device: Provide code approved pressure relief device to prevent accumulation of explosive vapors in event of fire. Devices shall be sized as per Code requirements.

I. Tank Drain: Provide one bottom mounted code approved non-freeze drain valve with internal stop to drain water or sludge accumulation without spillage due to breakage.

J. Lifting Lugs: Furnish tank with required lifting lugs.

K. Urethane topcoat, tan color external coating.

2.14 FUEL OIL PUMP SET SKID

A. Provide a duplex pump and strainer set that is factory assembled with components piped and mounted on a continuously welded steel plate containment basin with minimum 3" steel side rails. The basin shall be sized to contain potential leaks from all factory piping and components. The electrical motors and components shall be mounted above the maximum level of the containment basin.

B. Manufacturers:
   1. Preferred Utilities Mfg. Corp.
   2. Simplex, Inc
   3. Suntec
   4. Viking Pump, Inc
   5. Or approved substitution.

C. Pumps:
   1. Heavy duty bi-rotational positive displacement rotary type pumps.
   2. Cast iron housing and self-adjusting mechanical seals.
   3. Rated for minimum 150 psi working pressure.
   4. Pumps that have aluminum, brass, or bronze housings or rotors are not acceptable.
   5. Packing gland equipped pumps, close-coupled pumps, Carbonator shaft-mounted pumps or centrifugal pumps are not acceptable.

D. Motors:
   1. TEFC, rigid base, standard NEMA frame motors.
   2. Pump and motor assemblies shall be factory assembled on a structural steel channel.
   3. Rotating parts shall have a steel OSHA guard.

E. Piping Furnished with Pumps: Steel with ferrous fittings and welded joints.

F. Pump Isolation and Check Valves:
   1. Locate one valve on the suction and discharge of each pump. Isolation valves must allow off-line pump maintenance without system loss of availability. Isolation valves shall be full-port ball valves to provide full flow while open and positive shutoff when closed.
   2. Provide check valves on the discharge of each pump

G. Strainers:
   1. Duplex, basket type with 40 mesh stainless steel metal screen baskets. Located on suction side of pumps.
   2. Strainer shall be equipped with a factory mounted and wired differential pressure switch to indicate that the basket needs to be checked and cleaned.

H. Relief Valves:
   1. Sized to relieve the full outlet flow of the pump without causing the pump motor to overload or any component's pressure rating to be exceeded if the discharge is inadvertently valved off.
   2. Relief valves must be externally mounted from the pumps and piped to the return line in the field according to NFPA 30.
   3. Pump internal relief valves shall not be accepted.

I. Compound and Pressure Gauges:
   1. Provide and mount a compound gauge on the suction side of the strainers.
   2. Provide and mount a pressure gauge on the discharge side of each pump.
   3. Gauges selected must provide mid-scale readings under normal operating pressures.
   4. Each gauge shall be equipped with an isolation ball valve.

J. Control Cabinet:
   1. Provide a completely pre-wired and factory tested control cabinet to ensure job site reliability.
   2. The pump set and control cabinet shall be the product of one manufacturer for single source responsibility.
   3. The control cabinet shall be constructed to NEMA 4 standards.
   4. Doors shall be fully gasketed with a turned edge, piano hinges, and a three point lockable latching mechanism. Cabinet interior shall be primed and finished in a white gloss, chemical resistant enamel. Cabinet exterior shall be primed and finished in durable, chemical resistant, textured gray enamel, suitable for industrial environments.
   5. Cabinet interior shall be primed and finished in a white gloss, chemical resistant enamel.
   6. Cabinet exterior shall be primed and finished in durable, chemical resistant, textured gray enamel, suitable for industrial environments.
   7. All control wiring shall be terminated at a numbered terminal strip to facilitate field connections to remote equipment. All switches shall have maintained contacts. All cabinet front devices shall be identified by black phenolic labels with engraved white lettering.
   8. Preprogrammed and configured nonproprietary PLC hardware.
   9. Cabinet shall consist of, but not be limited to, the following:
      a. Magnetic motor starters with overload protection
      b. Motor circuit breakers
      c. “Hand-off-Auto” switch for each pump
      d. Pump selector switch for selection of lead pump
      e. Power on Indicating light
      f. Pump running Indicating lights
   10. Provide alternating controls. If primary pump fails, a failure alarm shall be initiated and backup pump shall be enabled automatically. The pumps shall be switched automatically between primary and stand-by based on run time. The device with the lowest run time shall become the primary device when both devices are stopped. If the primary device runs continuously for 720 hours (FA), the stand-by device shall be started and the primary device shall stop. The stand-by device shall become the primary.
   11. When a pump is commanded to start, controller shall be provided with a feedback signal verifying proof of pump operation via current sensor or flow sensor.
   12. Building Automation System (BAS) Interface: Provide all hardware, gateways, network controllers, transducers, software and devices as required for this interface. Provide listing of all input/output points including point description and associated engineering units for each point. Manufacturer shall be responsible for coordination of all communication requirements with BAS Contractor, translation of network protocols, testing of communications between systems, and joint commissioning of systems.
   13. Interface shall provide information on pump run status, flow switch status, leak switch status, high strainer DP status, general alarm. Coordinate monitoring and controls with Level and Leak Detection and Monitoring System.

2.15 MASTER CONTROL PANEL

A. Provide a master control panel for the fuel storage tank, pumps and fuel delivery system. Panel shall be UL listed and in a lockable NEMA 4 enclosure. Controls shall be PLC based.

B. Pump and tank control shall be integrated with the tank level monitoring system such that when the tank fuel level drops to low level, pump shall be stopped and a "Low Fuel" alarm generated.

C. Provide display to indicate tank levels, tank operating status, pump operating status, audible and visual alarms and alarm silence button.

D. Building Management System (BMS) Interface: Provide all hardware, gateways, network controllers, transducers, software and devices as required for this interface. Provide listing of all input/output points including point description and associated engineering units for each point. Manufacturer shall be responsible for coordination of all communication requirements with BMS Contractor, translation of network protocols, testing of communications between systems, and joint commissioning of systems.

2.16 TANK MONITORING SYSTEM

A. Manufacturers:
   1. Veeder-Root Model TLS-450 Plus
   2. Or approved substitution.

B. Provide digital tank level and monitoring system, meeting EPA requirements of 0.1 GPH volumetric tank tightness testing and continuous statistical leak detection. Provide unit with internal clock with battery backup, data keypad, large LED readout, function keys, audible alarm, and alarm silence switch. Unit shall be programmed to read level in inches or gallons. Provide tank management software to track fuel usage, remaining inventory, and inventory before and after boiler operation.

C. Provide level, temperature, and water detection sensor for each tank.

D. System shall be suitable for operation with 120 V, 60 cycle, 1-phase

E. High and Low Fluid Level Alarm System:
   1. Automatic continuous on-line monitoring of all tanks.
   2. Visual and audible indicators combined with fluid level monitor.
   3. Manual alarm test and silencing controls.
   4. Low level alarm actuation adjustable 0-25 percent of tank capacity. High level alarm actuation adjustable 75-100 percent of tank capacity.

F. Remote Alarm Annuciator:
   1. Visual and audible high-level alarms adjacent to tank fill box. Locate in NEMA 250 Type 4X weatherproof exterior wall or pole-mounted panels.
   2. Alarm shall include flashing red light with 180-degree visibility for each tank and 95 dB horn or 100 mm (4 inch) diameter bell. Provide alarm silence control.
   3. Provide identification sign: "WHEN ALARM SOUNDS - FUEL TANK FILLED TO CAPACITY - DO NOT OVERFILL".

G. Provide interface for connection to Level and Leak Detection and Monitoring System and Building Management System (BMS). Interface shall provide information on actual fuel level for each tank, level alarms for each tank, inventory management and product order notification. Coordinate monitoring and controls with fuel oil pump set controls andl level and leak detection and monitoring system. Provide listing of all input/output points including point description and associated engineering units for each point.

H. System may be combined with leak detection system specified in Leak Detection and Monitoring System.

2.17 LEAK DETECTION AND MONITORING SYSTEM

A. Cable and Sensor System: Comply with UL 1238.

B. Monitoring Points: Provide fuel oil spill/leak detection system to monitor the following points:
   1. Annular (interstitial) space in storage tank
   2. Exterior supply and return fuel oil piping
   3. Pump assembly containment pan

C. Tank annular space leak detection system shall be of dry type or hydrostatic monitoring type.

D. Detection system shall continuously monitor the status of each monitoring point. System shall detect presence of, or absence of, hydrocarbons and other non-polar liquids. System shall recognize three ambient media of dry, water, and hydrocarbon. System shall function in ambient temperature range from -40°C to 50°C. System response time for detection of hydrocarbon shall be programmable from 0 to 5 seconds after sensors are covered.

E. System shall be FM approved and UL Labeled. System shall be intrinsically safe for Class 1, Division 1, Group D hazardous locations.

F. Control Unit: Microprocessor based, with RS-232 data output port, serial/parallel data output and seventy two (72) hour power-down memory backup. Liquid Crystal Displays (LCD) shall display probe number and probe status. Alarm conditions and relay closure shall be programmable with keypad entries.

G. Double Wall Tank Interstitial Probes: Complete with sensors, detector head cap with visual status indicators, flexible cable, and stainless steel guide cable. Detector head cap shall provide visual display status for dry, water, and hydrocarbon states.

H. Building Management System (BMS) Interface: Provide BACnet IP or BACnet MS/TP interface for communicating all operating and alarm information to site BAS. Provide all hardware, gateways, network controllers, transducers, software and devices as required for this interface. Provide listing of all input/output points including point description and associated engineering units for each point. Manufacturer shall be responsible for coordination of all communication requirements with BMS Contractor, translation of network protocols, testing of communications between systems, and joint commissioning of systems.

2.18 FUEL OIL FILL STATION AND REMOTE SPILL CONTAINER

A. Fuel receiving port shall be designed for receiving fuel supply from the delivery trucks and filling main fuel oil storage tank in a controlled manner via direct piped connection to the main tank fill port. The enclosure shall be of welded stainless steel construction with lockable hinged doors and include spill containment with leak sensor and ground stud. Provide required valves and accessories including three (3) inch main inlet quick disconnect coupling, main inlet ball valve, check valve, manual pump, fusible link fire valve on outlet and outlet shut off valve.

B. Controller shall include tank level transmitter, tank full visual alarm, tank high fuel alarm, audible alarm, control power switch and control power indicator. Unit shall be suitable for operation with 120V, 60 Hz, single phase.

C. Remote Spill Container
   1. Manufacturers:
      a. Morrison Bros.; https://morbros.com/
      b. Or approved substitution.
   2. Container and Lid: 12 gauge stainless steel.
      a. Weather-tight enclosure.
      b. Lockable with a padlock.
      c. 15-gallon capacity.
      d. Gas spring cylinder or hydraulic arm to hold the lid in the up position when fueling.
      e. Integrate sump drain with 1/2-inch locking ball valve.
   3. Pipe Connection: Stainless steel.
   4. Pedestal Mount: Stainless steel.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine tank before installation. Owner shall reject tanks that are damaged.

B. Prior to setting the tank, the tank's coating shall undergo a wet sponge holiday test to identify any defects.

C. Tank shall be installed on a manufacturer-approved underlayment or coating.

D. Examine areas for compliance with requirements for installation tolerances and other conditions affecting performance of fuel oil piping.

E. Examine installation of fuel burning equipment and fuel handling and storage equipment to verify actual locations of piping connections before installing fuel oil piping.

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

3.02 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. Comply with NFPA 30 and NFPA 31 requirements for prevention of accidental ignition.

3.03 PIPING INSTALLATION

A. Install in accordance with manufacturer's instructions and API RP 1615.

B. Provide nonconducting dielectric connections wherever jointing dissimilar metals. Install to NACE SP0286.

C. Route piping in orderly manner and maintain gradient.

D. Group piping whenever practical at common elevations.

E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

F. Provide clearance for installation of insulation and access to valves and fittings.

G. Install firestopping to preserve fire-resistance rating of partitions and other elements.

H. Prepare pipe, fittings, supports, and accessories not prefinished, ready for finish painting.

I. Finish Painting:
   1. Coat with Waterborne 100% Acrylic Gloss Enamel over Waterborne Metal Primer.
      a. Primer (Touch-up if pre-primed): 1 coat S-W Pro-Cryl Universal Primer, B66-310 Series.
      b. Finish: 2 coats S-W 0 VOC Acrylic Gloss, B66-600 Series.
      c. Color: Brown

J. Identify piping systems, including underground piping. See Section 230553.

K. 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.

L. Install valves with stems upright or horizontal, not inverted.

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

N. Install individual burner fuel oil supply branches from underside of main piping.

O. Install piping free of sags and bends.

P. Install system components with pressure rating equal to or greater than system operating pressure.

Q. Fuel oil supply and return piping shall have welded joints.

R. Install fittings for changes in direction and branch connections.

S. Install eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

T. Pressure gauges should be of the compound type except at the discharge of pumps.

U. Install vacuum breaker at the high point of the system.

V. Install 3/4-inch vents at high points in the system and 3/4-inch drains at low points in the piping system.

W. Insulate exterior fuel oil supply and return piping with 2" closed-cell polysiocyanurate insulation with ASJ and covered with stucco finished aluminum outer jacket. Insulation at supports shall have a minimum compressive strength of 130 PSI.

X. Install sleeves and sleeve seals for piping penetrations of walls, ceilings, and floors.

Y. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.04 PIPING JOINT CONSTRUCTION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe. Bevel plain end ferrous pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Prepare piping connections to equipment with flanges or unions.

D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

E. 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.

F. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
   1. Inspect pipe and pipe fittings for roundness before they are fit-up or set in place.
   2. Properly clean and prepare pipe base material before fit-up. Verify joint land and bevel.
   3. Preheat pipe base material as required by welding procedure specification. Temperature of pipe material must be a minimum of 32°F before welding.
   4. Properly align and adjust joint as required by welding procedure and thickness of material. Verify tolerances after tacking sequence.
   5. Use weld material diameter as procedurally required for type and thickness of work being done.
   6. Use sufficient argon pre-purge and argon post-purge for GTAW processes. Post purge should be until weld is no longer glowing plus five (5) seconds. Maintain purge for at least two (2) layers of weld material.
   7. Properly store welding materials.
   8. Clean tacks before welding out. Remove slag after each pass by grinding to avoid slag inclusion.
   9. Brush each weld free of rust and paint with rust resistant product that matches piping surface color.

G. Flanged Joints: Install gasket material, size, type, and thickness for service application. Install gasket concentrically positioned.

H. Flared Joints: Comply with SAE J513. Tighten finger tight then use wrench according to fitting manufacturer's written instructions. Do not over tighten.

3.05 HANGER AND SUPPORT INSTALLATION

A. Pipe hanger and support and equipment support materials and installation requirements are specified in Division 23 Specification Section "Hangers and Supports for HVAC Piping Systems."

3.06 FUEL TANK INSTALLATION

A. Install the complete tank system and all associated accessories in strict accordance with the manufacturer's recommendations and all applicable fire and environmental codes. Obtain all required state and local permits prior to commencement of installation.

B. Clean and flush aboveground tanks prior to delivery to site. Seal until pipe connections are made.

C. Install aboveground tanks on a structural concrete pad. Secure each tank to the concrete pad with appropriate anchors designed to withstand anticipated loads.

D. Prior to setting the tank, the tank's coating shall undergo a wet sponge holiday test to identify any defects.

E. Tank shall be installed on a manufacturer-approved underlayment or coating.

F. Clearly mark all sides of each tank with the appropriate warning signs, including "FLAMMABLE" or "COMBUSTIBLE" (as applicable based on the fuel type), "NO SMOKING", product identification, and any other signage required by applicable codes.

G. Provide NFPA 704 compliant placards for hazardous materials.

H. Provide electrical ground in accordance with NFPA 70.

I. Upon completion of the installation, the system shall be inspected and approved by the system supplier or their certified contractor. The system supplier shall provide a comprehensive checklist of critical quality and safety items specific to the installed system and verify in writing that the installation complies with these specifications and all applicable fire and environmental codes.

3.07 TANK MONITORING AND LEAK DETECTION SYSTEM

A. Wire sensors back from various leak detection and level monitoring points.

B. Program system and set up fuel leak alarms, level alarms for each tank, inventory management, product order notification and interface with BAS.

C. Install leak detection and monitoring system. Install alarm panel inside building where indicated.

3.08 FUEL OIL PUMP SET SKID INSTALLATION

A. Install a factory assembled fuel oil pumping and monitoring system to ensure a reliable supply of fuel oil to the boilers. System to be factory fabricated and tested, and certified as a complete unit.
   1. Pump sets must be fully tested prior to shipment. Testing shall include both a pressure and vacuum testing period.
      a. The complete pump set shall be pressure tested to rated pressure using an air pressure source. The test shall confirm that the pump set piping system can maintain rated pressure for four hours.
      b. The complete pump set shall be brought to a vacuum greater than 25" Hg. The test shall confirm that the pump set piping system can maintain vacuum for four hours.
      c. Following a pressure and vacuum test the pump set shall be given a full operational test.
   2. Field assembled units are not acceptable.

B. Drip containment base shall be located 36 inches above the surface of the finished floor.

C. Install pump skid with access space for periodic maintenance including removal of motors, impellers, and accessories.

D. Install suction piping with minimum fittings and change of direction.

3.09 FUEL OIL ACCESSORIES

A. Install duplex strainer in fuel oil pump suction.

B. Install fuel oil receiving station.
   1. Install strict accordance with manufacturer's instructions.
   2. Install permanent local signs for operator instructions, warning signs and alarms.

3.10 LABELS AND IDENTIFICATION

A. Nameplates, pipe identification, valve tags, and signs are specified in Division 23 Specification Section "Identification for HVAC Systems and Equipment."

3.11 FIELD QUALITY CONTROL

A. Prepare fuel oil piping according to ASME B31.1, "Power Piping", and as follows:
   1. Leave joints, including welds, uninsulated and exposed for examination during test.
   2. Flush system with clean water. Clean Strainers.
   3. 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 flaged joints to isolate equipment.

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

C. Perform the following tests on fuel oil 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. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the 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.
   3. After hydrostatic test pressure has been applied for at least one hour, examine piping, joints, and repeat hydrostatic test until there are no leaks. The test pressure shall be maintained for at least one hour without any pressure drop or leakage. During this time all welds and joints shall be visually inspected for leakage.
   4. Prepare written report of testing.
   5. Prepare test and inspection reports.

D. Inspect and test fuel oil piping according to NFPA 31, "Tests of Piping" Paragraph; and according to requirements of authorities having jurisdiction.

E. Test leak detection and monitoring system for accuracy by manually operating sensors and checking against alarm panel indication.

F. Subject tank to air test in accordance with manufacturer's instructions.

G. Bleed air from fuel oil piping using manual air vents.

H. Perform the following tests with the assistance of a factory authorized service representative on the fuel oil pump set:
   1. Start fuel oil pumps to verify for proper operation of pump, and check for leaks. The pump set shall be operated normally.
   2. Motor amps shall be noted at no load and full load for each motor. The motor amps shall be within 10% of rated motor amps.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   4. The relief valve shall be set and tested.
   5. Operation of pump set instrumentation shall be tested.
   6. A copy of the test procedures shall be sent to the engineer and owner. The owners and or the engineer at their discretion shall observe this and all other tests.

7. A certificate of factory testing, together with a copy of the wiring diagram and arrangement diagrams shall be placed in the control cabinet prior to shipment.

END OF SECTION 231113

SECTION 231123
FACILITY NATURAL-GAS PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Pipe, pipe fittings, valves, and connections for natural gas piping systems.

1.02 REFERENCE STANDARDS

A. ANSI Z21.80/CSA 6.22 - Line Pressure Regulators; 2019.

B. ANSI Z223.1 - National Fuel Gas Code; 2024.

C. API RP 2009 - API Recommended Practice 2009; 8th Edition.

D. API Spec 6D - Specification for Valves; 2021, with Addendum (2025).

E. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators; 2023, with Errata (2024).

F. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2021.

G. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard; 2020.

H. ASME B16.9 - Factory-Made Wrought Buttwelding Fittings; 2024.

I. ASME B16.11 - Forged Fittings, Socket-Welding and Threaded; 2021.

J. ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges; 2021.

K. ASME B16.33 - B16.33 - Manually Operated Metallic Gas Valves for Use in Gas Piping Systems up to 175 psi; 2024.

L. ASME B31.1 - Power Piping; 2024.

M. ASME B31.9 - Building Services Piping; 2020.

N. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2022.

O. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2019.

P. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2020, with Errata (2023).

Q. AWS WHB-2.9 - WHB-2.9 WELDING HANDBOOK VOLUME 2 - PART 1: WELDING PROCESSES; 2004.

R. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2018, with Amendment (2019).

S. MSS SP-78 - Gray Iron Plug Valves, Flanged and Threaded Ends; 2011.

T. NFPA 54 - National Fuel Gas Code; 2024.

1.03 SUBMITTALS

A. See Section 013000 - 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.

C. Submit a certified copy of welder’s procedures and qualifications in conformance with ASME B31.1 for each welder and welding operator.

D. Welders' Certificates: Submit certification of welders' compliance with ASME BPVC-IX.
   1. Submit the assigned number, letter, or symbol that will be used in identifying the work of each welder to the DES Project Coordinator.

E. Shop drawings.

F. Test reports.

1.04 QUALITY ASSURANCE

A. Perform work in accordance with applicable codes.

B. Valves: Manufacturer's name and pressure rating marked on valve body.

C. Weld piping in accordance with qualified procedures using performance qualified welders and welding operators in accordance with API RP 2009, ASME BPVC-IX, and ASME B31.1. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1.

D. Identify pipe with marking including size, ASTM material classification, and ASTM specification.

E. Weld all structural members in conformance with AWS A5.8M/A5.8, and AWS WHB-2.9.

1.05 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.

E. Discard pipe sections and fittings that have been damaged.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of the products and that essentially duplicate items that have been in satisfactory use for at least two years prior to bid opening.

B. Asbestos or products containing asbestos are not allowed.

C. Submit catalog data and installation instructions for pipe, valves, all related system components, pipe coating materials and application procedures.

D. Conform to NFPA 54 and with requirements specified herein.

2.02 NATURAL GAS PIPING, ABOVE GRADE

A. Steel Pipe:
   1. Sizes less than 2 inches, ASTM A53/A53M, Grade B, Type F, Schedule 80 black, threaded or welded ends.
   2. Sizes 2 inches and larger, ASTM A53/A53M, Grade B, Type F, Schedule 40 black, plain end beveled for butt welding.
   3. Threaded Fittings: ASME B16.3, black malleable iron.
   4. Socket-Welding Fittings: ASME B16.11, forged steel.
   5. Butt-Welding Fittings: ASME B16.9. No backing rings.
   6. Joints: Threaded or welded to ASME B31.1.

2.03 FLANGES, UNIONS, AND COUPLINGS

A. Unions for Pipe Sizes 1.5 Inches and Under:
   1. Ferrous Pipe: Class 150 malleable iron threaded unions in accordance with ASME B16.3.

B. Flanges for Pipe Size Over 1.5 Inch:
   1. Ferrous Pipe: Class 150 malleable iron threaded or forged steel slip-on flanges.

2. ASME B16.5 steel flanges with flange faces having integral grooves of rectangular cross sections which afford containment for self-energizing gasket material.
3. Gaskets:
    a. Non-asbestos compressed material in accordance with ASME B16.21 , 1/16 inch thickness, full face or self-centering flat ring type, containing aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR) suitable for a maximum 600 degree F service, rated for hydrocarbon service.
    b. Flexitallic style CG gaskets with flexicarb filling may also be used for gas service.

2.04 SEALANTS AND STEEL PIPE THREADED JOINTS

A. Provide joint sealing compound as listed in UL FLAMMABLE & COMBUSTIBLE.

B. For taping, use tetrafluoroethylene tape conforming to UL FLAMMABLE & COMBUSTIBLE.

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.
5. Floor Supports: Concrete pier or steel pedestal with floor flange; fixture attachment.

2.06 BALL VALVES

A. Manufacturers:
1. Apollo Valves
2. Milwaukee Valve Company
3. Nibco, Inc.
4. Or approved substitution.

B. Valves less than 2 inches:
1. Provide valves less than 2 inches conforming to ASME B16.33 of materials and manufacture compatible with system materials used. Valves shall be lockable.

C. Valves 2 inches and larger:
1. Provide valves 2 inches and larger of carbon steel conforming to API Spec 6D, Class 150. Valves shall be lockable.

2.07 PLUG VALVES

A. Construction 2-1/2 Inches and Larger: MSS SP-78, 200 psi CWP, cast iron body and plug, pressure lubricated, Teflon or Buna N packing, flanged ends. Provide lever operator with set screw.

2.08 STRAINERS

A. Manufacturers:
1. Titan Flow Control, Inc.
2. Or approved substitution.

B. Size 2 inch and Under:
1. Threaded brass body for 175 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen.
2. Class 150, threaded bronze body 300 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen.

C. Size 1-1/2 inch to 4 inch:
1. Class 125, flanged iron body, Y pattern with 1/16 inch stainless steel perforated screen.

D. Size 5 inch and Larger:
   1. Class 125, flanged iron body, basket pattern with 1/8 inch stainless steel perforated screen.

2.09 LINE PRESSURE REGULATORS AND APPLIANCE REGULATORS INDICATORS

A. Manufacturers:
   1. Fisher
   2. Or approved substituion.

B. Compliance Requirements:
   1. Line Pressure Regulator: ANSI Z21.80/CSA 6.22.

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 with flanges or unions.

D. Piping and fittings shall be clear and free of cutting burrs and defects in structure or threading. Repair of defects in piping or fittings is not allowed. Replace defective items when found.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions and applicable provisions of NFPA 54. Perform all pipe cutting without damage to the pipe with an approved type of mechanical cutter, unless otherwise authorized. Use wheel cutters where practicable. On steel pipe six inches and larger, an approved gas cutting and beveling machine may be used.

B. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.

C. Do not conceal piping. Run exposed.

D. Make changes in direction of piping with fittings only. Mitering or notching pipe to form elbows and tees or other similar type construction is not permitted.

E. Branch connection may be made with either tees or forged branch outlet fittings. Provide branch outlet fittings which are forged, flared for improvement of flow where attached to the run, and reinforced against external strains.

F. Install piping to maintain headroom, conserve space, and not interfere with use of space.

G. Group piping whenever practical at common elevations.

H. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

I. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

J. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

K. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting. Provide color code marking of piping to match existing fuel gas piping. Mark as specified in Section 230553 Identification for HVAC Piping and Equipment.
   1. All steel surfaces shall be coated to match existing piping system.
   2. Touch up shop primed surfaces with ferrous metal primer. Solvent clean surfaces that have not been shop primed. Mechanically clean surfaces that contain loose rust, loose mill scale and other foreign substances by power wire brushing and prime with ferrous metal primer.
   3. Finish coat all surfaces with two coats of approved coating exterior oil paint.

L. Install valves with stems upright or horizontal, not inverted.

M. Install shutoff valves easily accessible for operation, protected from physical damage, and marked with a metal tag to clearly identify the piping system controlled.

N. Sleeve pipes passing through partitions, walls and floors.

O. Pipe Hangers and Supports:
   1. Support gas piping systems in buildings with metal hangers suitable for the size of piping or tubing.
   2. Do not support any gas piping system by other piping.
   3. Conform spacing of supports in gas piping and tubing installations to the requirements of NFPA 54.
   4. Install in accordance with ASME B31.9. Conform the selection and application of supports in gas piping and tubing installations to the requirements of MSS SP-58.
   5. In the support of multiple pipe runs on a common base member, use a u-bolt, clip or clamp where each pipe crosses the base support member. Spacing of the base support members is not to exceed the hanger and support spacing required for any of the individual pipes in the multiple pipe run. Rigidly connect the clips or clamps to the common base member. Provide a clearance of 1/8 inch between the pipe and clip or clamp for all piping which may be subjected to thermal expansion.
   6. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
   7. Place hangers within 12 inches of each horizontal elbow.
   8. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
   9. Support vertical piping at everyfloor. Support riser piping independently of connected horizontal piping.
   10. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

P. Protection and Cleaning of Materials and Components:
   1. Protect equipment and pipe openings by closing with caps or plugs during installation. Do not leave gas piping open to atmosphere. In order to prevent accidents, positive isolation between existing gas service is required until system is commissioned.
   2. At the completion of all work, thoroughly clean the entire system.

Q. Pipe Joints
   1. Design and install pipe joints to effectively sustain the longitudinal pull-out forces caused by contraction of the piping or superimposed loads.
   2. Threaded Metallic Joints:
      a. Provide threaded joints in metallic pipe with tapered threads evenly cut and made with UL approved joint sealing compound for gas service or tetrafluoroethylene tape applied to the male threads only. Threaded joints up to 1-1/2 inches in diameter may be made with approved tetrafluoroethylene tape. Threaded joints less than 2 inches in diameter may be made with approved joint sealing compound. After cutting and before threading, ream pipe and remove all burrs. Caulking of threaded joints to stop or prevent leaks is not permitted.
   3. Welded Metallic Joints:
      a. Beveling, alignment, heat treatment, and inspection of welds shall conform to the requirements of NFPA 54 and ASME B31.1.
      b. Remove weld defects and make repairs to the weld, or remove the weld joints entirely and reweld.
      c. After filler metal has been removed from its original package, protect and store so that its characteristics or welding properties are not affected adversely. Do not use electrodes that have been wetted or have lost any of their coating.

4. Provide drips, grading of the lines, freeze protection, and branch outlet locations as shown and conforming to the requirements of NFPA 54.

3.03 APPLICATION

A. Install unions downstream of valves and at equipment or apparatus connections.

B. Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.

C. Install globe valves for throttling, bypass, or manual flow control services.

3.04 FIELD QUALITY CONTROL

A. General
   1. Submit test reports in booklet form tabulating test and measurements performed; dated after award of this contract, and stating the Contractor's name and address, the project name and location, and a list of the specific requirements which are being certified.
   2. Test entire gas piping system at operating pressure to ensure that it is gastight prior to putting into service. Prior to testing, blow out the system, clean, and clear all foreign material. Test each joint with an approved gas detector, soap and water, or an equivalent nonflammable solution. Inspect and test each valve.
   3. Complete testing before any work is covered, enclosed, or concealed, and perform with due regard for the safety of employees and the public during the test.

B. Pressure Test
   1. Submit test reports in booklet form tabulating test and measurements performed; dated after award of this contract, and stating the Contractor's name and address, the project name and location, and a list of the specific requirements which are being certified.
   2. Before appliances are connected, test by filling the piping systems with air or an inert gas to withstand a minimum pressure of 50 pounds per square inch gauge for a period of not less than 10 minutes as specified in NFPA 54 without showing any drop in pressure. Do not use oxygen for test. Measure pressure with a calibrated gauge to be read in increments of not greater than 1 pound. Isolate the source of pressure before the pressure tests are made.
   3. DES shall witness test.

C. Test with Gas
   1. Before turning on gas under pressure into any piping, close all openings from which gas can escape. Immediately after turning on the gas, check the piping system for leakage by using a laboratory-certified gas meter. Conform all testing to the requirements of NFPA 54. If leakage is recorded, shut off the gas supply, repair the leak, and repeat the tests until all leaks have been stopped.

D. Purging
   1. After testing is completed, and before connecting any appliances, fully purge all gas piping. Purge piping to a safe area external to the building. Do not purge piping into the combustion chamber of an appliance. Do not purge the open end of piping systems into confined spaces or areas.

END OF SECTION 231123

SECTION 232213
STEAM AND CONDENSATE HEATING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Pipe and pipe fittings.

B. Steam piping system.

C. Steam condensate piping system.

1.02 REFERENCE STANDARDS

A. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2021.

B. ASME B31.1 - Power Piping; 2024.

C. ASME B31.9 - Building Services Piping; 2020.

D. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2022.

E. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2023a.

F. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2020, with Errata (2023).

G. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2018, with Amendment (2019).

1.03 SYSTEM DESCRIPTION

A. When more than one piping system material is selected, ensure systems components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, unions, and couplings for servicing are consistently provided.

B. Provide pipe hangers and supports in accordance with MSS SP-58 unless indicated otherwise.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

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

C. Welders Certificate: Include welders certification of compliance with ASME BPVC-IX.

D. Field quality-control reports.

E. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for mulitple pipes, expansion joints and loops, and attachments of teh same to teh building structure.

F. Locations of pipe anchors and alignment guides and expansion joints and loops.

G. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.

H. Locations of and details for penetration and fire-stopping for fire- and smoke-rated wall and floor and ceiling assemblies.

I. Shop Drawings: Detail the piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of teh same to the building structure. Indicate location of anchors, alignment guides, and expansion joints and loops.

1.05 QUALITY ASSURANCE

A. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural We

B. Pipe Welding: Qualify processes and operators according to the following:
   1. Comply with provisions in ASME B31.1 Series, "Code for Pressure Piping."
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. ASME Compliance: Comply with ASME B31.1, "Power Piping" and ASME B31.9, "Building Services Piping" for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp flash tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

1.06 COORDINATION

A. Coordinate layout and installation of steam and condensate piping and suspension system components with other construction, including light fixtures, hydronic piping, fire-suppression system components, and partition assemblies.

B. Coordinate size and location of access panels for servicing steam system components.

C. Coordinate pipe fitting pressure classes with products specified in related Sections.

D. Coordinate installation of pipe sleeves for penetrations through exterior walls and floor assemblies. Coordinate with requirements for fire stopping specified in Division 7 Section "Through-Penetration Fire Stop Systems" for fire and smoke wall and floor assemblies.

E. Coordinate the location of emersion wells and automatic control valves with the equipment supplier.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

A. Comply with ASME B31.1 code for installation of piping system.

2.02 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressures and temperatures:
   1. HP Steam Piping: 225 psig (saturated).
   2. Condensate Piping: 65 psig at 250 degrees F.
   3. Air-Vent and Vacuum-Breaker Piping: Equal to pressure of the piping system to which it is attached.

2.03 SPECIAL MATERIAL REQUIREMENTS

A. All HP steam service lines shall not contain any piping, fittings, valve bodies, or instrumentation bodies constructed of brass, copper, or cast-iron.

B. All other service shall be as specified below.

2.04 MEDIUM AND HIGH PRESSURE STEAM PIPING (225 PSIG MAXIMUM)

A. Steel Pipe: ASTM A53/A53M, black steel, plain ends, welded and seamless, Grade B, and minimum of Schedule 40.
   1. Fittings: ASME B16.3 malleable iron Class 300, or ASTM A234/A234M wrought steel welding type.
   2. Joints: Threaded, or AWS D1.1/D1.1M welded.

2.05 MEDIUM AND HIGH PRESSURE STEAM CONDENSATE PIPING

A. Steel Pipe: ASTM A53/A53M, black steel, plain ends, welded and seamless, Grade B, and minimum of Schedule 80.
   1. Fittings: ASME B16.3 malleable iron Class 300 or ASTM A234/A234M wrought steel.

2. Joints: Threaded, or AWS D1.1/D1.1M welded.

2.06 FITTINGS

A. Cast-Iron Threaded Fittings: ASME B16.4; Classes 150 and 300 as indicated in piping applications articles.

B. Malleable-Iron Threaded Fittings: ASME B16.3; Classes 150 and 300 as indicated in piping applications articles.

C. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in piping applications articles.

D. Cast-Iron Threaded Flanges and Flange Fittings: ASME B16.1, Classes 150 and 250 as indicated in piping applications articles; raised ground face, and bolt holes spot faced.

E. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

F. Wrought-Steel Flanges and Flanged Fittings: ASME B16.5. including bolts, nuts, and gaskets of the following material group, end connections, and facings:
   1. Material Ground: 1.1.
   2. Gasket: Flexitallic Spiral Wound gaskets B 16.20.
   3. End Connections: Butt-welding.
   4. Facings: Raised Face.

G. Steel Pipe Nipples: ASTM A 733, made of ASTIM A 53/A 53M, black steel of same Type, Grade, and Schedule as pipe in which installed.

2.07 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Flexitallic Group Incorporated. (Style CGI)
   2. ASME B16.20, spiral-wound nonmetallic, flat, asbestos free gasket with a solid metal inner ring: 1/8-inch maximum thickness unles thickness or specific material is indicated.
      a. Full-Face Type: For flat-face, Class 150, cast-iron and cast-bronze flanges.
      b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

D. Welding Materials: Comply with Secion II, Part C, of ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

PART 3 EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Prepare piping connections to equipment with flanges or unions.

D. Keep open ends of pipe free from scale and dirt. Whenever work is suspended during construction protect open ends with temporary plugs or caps.

E. After completion, fill, clean, and treat systems.

3.02 STEAM PIPING APPLICATIONS

A. HP Steam Piping, NPS 16 and smaller: Schedule 40, Type E, Grade B, steel pipe; Class 300 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

B. Condensate piping above grade, NPS 2 and smaller, shall be the following:
   1. Schedule 80, Type S, Grade B, steel pipe, Class 300 cast-iron fittings; and socket welded and threaded joints.

C. Condensate piping above grade, NPS 2-1/2 and larger, shall be the following:
   1. Schedule 80, Type E, Grade B, steel pipe; Class 300 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

3.03 ANCILLARY PIPING APPLICATIONS

A. Blowdown Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.

B. Air-Vent Piping:
   1. Inlet: Same as service where installed.
   2. Outlet: Type K annealed-temperr copper tubing with soldered or flared joints.
   3. Vacuum-Breaker Piping: Outlet, same as service where intalled.

3.04 INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordiantion Drawings.

B. Unless otherwise indicated, install branch connection to steam mains using 45-degree fittings in main pipe, with takeoff coming out the top of the main pipe. Use of 90-degree tee fittings is permissable if 45-degree fittings are impractical. If length of branch takeoff is less than 10 feet, pitch branch line down toward mains at a 0.4 percent grade.

C. Install immersion wells and automatic control valves according to the manufacturer's installation instructions.

D. Install in accordance with manufacturer's instructions.

E. Route piping in orderly manner, plumb and parallel to building structure, and maintain gradient.

F. Install piping to conserve building space and avoid interference with use of space.

G. Sleeve pipe passing through partitions, walls, and floors.

H. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

I. Install piping free of sags and bends.

J. Install fittings for changes in direction and branch connections.

K. Provide clearance for installation of insulation and access to valves and fittings.

L. Select system components with pressure rating equal to or greater than system operating pressure.

M. Reduce pipe sizes using eccentric reducer fitting installed with level side down.

N. Install drains, consisting of a tee fitting, NPS 3/4 full port ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

O. Install vents, consisting of a tee fitting, NPS 3/4 full port ball valve, and short NPS 3/4 threaded nipple with cap, at high points in piping system mains and elsewhere as required for system venting and hydrostatic testing.

P. Slope steam piping one inch in 40 feet in direction of flow. Use eccentric reducers to maintain bottom of pipe level.

Q. Slope steam condensate piping at a minimum uniform grade of 0.4 percent downward in direction of condensate flow. Provide drip trap assembly at low points and before control valves. Run condensate lines from trap to nearest condensate receiver. Provide loop vents over trapped sections.

R. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.

S. Prepare unfinished pipe, fittings, supports, and accessories ready for finish painting.

T. Install piping to permit valve servicing.

U. Install valves with stems upright or horizontal, not inverted.

V. Install branch connections to mains using tee fittings in main pipe, with the branch connected to top of main pipe.

W. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

X. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

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

Z. Install strainers on supply side of control valves, pressure-reducing valves, traps, and elsewhere as indicated. Install NPS 3/4 nipple and full port ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blow-off connection for strainers smaller than NPS 2.

AA. Comply with requirements in Section 230533 "Identification for HVAC Piping and Equipment" for identifying piping.

BB. Install drip legs at low points and natural drainage points such as ends of mains, bottoms of risers, and ahead of pressure regulators, and control valves
    1. On straight runs with no natural drainage points, install drip legs at intervals not exceeding 300 feet.
    2. Size drip legs same size as main. In steam mains NPS 6 and larger, drip leg size can be reduced but to no less than NPS 4.

CC. Install sleeves for piping penetrations of wall, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

DD. For piping that penetrates an exterior concrete wall or concrete slab, install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Secion 230517 "Sleeves and Sleeve Seals for HVAC Piping."

3.05 STEAM AND CONDENSATE PIPING SPECIALTIES INSTALLATION

A. Comply with requirements in Section 232214 "Steam and Condensate Piping Specialties" for installation requirements for strainers, flash tanks, special-duty valves, steam traps, thermostatic air vents and vacuum breakers, and steam and condensate meters.

3.06 HANGERS AND SUPPORTS

A. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for installation of hangers and supports. Comply with requirements below for maximum spacing.

B. Install the following piping attachments:
    1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
    2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.

3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support veritcal runs.

C. Install hangers for steel steam supply piping with the following maximum spacing:
1. NPS 3/4: Maximum span, 9 feet.
2. NPS 1: Maximum span, 9 feet.
3. NPS 1-1/2: Maximum span, 12 feet.
4. NPS 2: Maximum span, 13 feet.
5. NPS 2-1/2: Maximum span, 14 feet.
6. NPS 3 and Larger: Maximum span, 15 feet.

D. Install hangers for steel steam supply piping with the following maximum spacing:
1. NPS 3/4: Maximum span, 7 feet.
2. NPS 1: Maximum span, 7 feet.
3. NPS 1-1/2: Maximum span, 9 feet.
4. NPS 2: Maximum span, 10 feet.
5. NPS 2-1/2: Maximum span, 11 feet.
6. NPS 3 and Larger: Maximum span, 12 feet.

E. Support vertical runs at roof, at each floor, and at maximum 10-foot intervals between floors.

3.07 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints: 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.

D. Welded Joints: Construct joints according to AWS D10.12M/D10.12 or ASME Section IX, using qualified processes and welding operators according to "Quality Assurance" Article.

E. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.08 FIELD QUALITY CONTROL

A. Prepare steam and condensate piping according to ASME B31.1, "Power Piping" and ASME B31.9 "Building Services Piping," 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 reaction due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush system with clean water. Clean strainers.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing agains test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.

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

C. Perform the following tests on steam and condensate piping:
1. Use ambient temperature water as a testing medium unless there is a risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.

2. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the 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 yeild strength.
3. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components and repeat hydrostatic test until there are no leaks.

D. Prepare written report of testing.

E. Prepare test and inspection reports.

END OF SECTION 232213

SECTION 232214
STEAM AND CONDENSATE HEATING SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Steam traps.

B. Steam air vents.

C. Flash tanks.

D. Direct operated pressure reducing valves.

E. Pilot-operated steam pressure reducing valves.

F. Safety relief valves.

G. In-line and insertion vortex flow meters.

1.02 REFERENCE STANDARDS

A. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard; 2020.

B. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels; 2023.

C. ASME B31.9 - Building Services Piping; 2020.

D. ASTM A105/A105M - Standard Specification for Carbon Steel Forgings for Piping Applications; 2023.

E. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings; 2004 (Reapproved 2023).

F. 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; 2023.

G. ASTM A216/A216M - Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service; 2021.

H. ASTM A276/A276M - Standard Specification for Stainless Steel Bars and Shapes; 2024.

I. ASTM A351/A351M - Standard Specification for Castings, Austenitic, for Pressure-Containing Parts; 2018, with Editorial Revision (2019).

J. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures; 1999 (Reapproved 2022).

K. ASTM A536 - Standard Specification for Ductile Iron Castings; 1984, with Editorial Revision (2019).

L. ASTM A743/A743M - Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application; 2021.

M. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2020.

1.03 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data:
   1. Provide for manufactured products and assemblies required for this project.
   2. Include product description, model, dimensions, component sizes, rough-in requirements, service sizes, and finishes.
   3. Submit schedule indicating manufacturer, model number, size, location, rated capacity, load served, and features for each specialty.
   4. Include electrical characteristics and connection requirements.

C. Manufacturer's Installation Instructions: Indicate application, selection, and hookup configuration. Include pipe and accessory elevations.

D. Operation and Maintenance Data: Include installation instructions, servicing requirements, and recommended spare parts lists.

E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. Steam Trap Service Kits: One for each type and size.

1.04 QUALITY ASSURANCE

A. Pipe Welding: Qualify procedures and operators according to teh following:
   1. ASME Compliance: Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp flash tanks to comply with ASME tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

B. Perform Work in accordance with State of Minnesota standard for installation of boilers and pressure vessels.

1.05 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 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressures and temperatures unless otherwise indicated:
   1. High Pressure Steam Piping: 225 psig (saturated).
   2. Condensate Piping: 65 psi at 250 degrees F,
   3. Air-Vent and Vacuum-Breaker Piping: Equal to pressure of the piping system to which it is attached.
   4. Makeup-Water Piping: 80 psig at 150 degrees F.
   5. Blowdown Drain Piping: Equal to pressure of the piping system to which it is attached.
   6. Safety-Valve-Inlet and -Outlet Piping: Equal to pressure of the piping system to which it is attached.

2.02 SPECIAL MATERIAL REQUIREMENTS

A. All high pressure steam service shall not contain any piping, fittings, valve bodies, or instrumentation bodies constructed of brass, copper, or cast-iron.

B. All other services shall be as specified below.

2.03 VALVES

A. Gate Valves: Cast steel body ASTM A2l6 WCB, Class 300, ll-l/2 to l3 percent chromium stainless steel flexible wedge and hard faced (stellite) or nickel copper alloy seats, ASME flanged ends, OS&Y, rising stem, bolted bonnet.
   1. Provide factory installed globe-valved bypass when main valve is 75 mm (3 inch) pipe size or greater and serves steam main longer than 6 m (20 feet). Conform to MSS SP-45.
   2. Drill and tap bosses for connection of drains if valve is installed in vertical orientation in steam service. Conform to MSS SP-45.

B. Globe Valves: Cast steel body ASTM A216 WCB, Class 300, 11 1/2 to 13 percent chromium stainless steel or stellite disc and seat, ASME flanged ends, OS&Y, rising stem, bolted bonnet, renewable seat rings.

1. Drill and tap bosses for connection of drains when installed in vertical position shown. Conform to MSS SP 45.

C. Stop-Check Valves:
   1. Body and Bonnet: Cast Steel, ASTM A216 WCB
   2. End Connections: Flanged.
   3. Disc: Cylindrical with removable liner and machined seat.
   4. Stem: Stainless Steel.
   5. Seat: Alloy Steel
   6. Disc: Stellite Faced Steel
   7. Operator: Outside screw and yoke with cast-iron hand-wheel.
   8. Pressure Class: 300.
   9. Operation: Valves shall automatically close tightly when boiler steam pressure becomes less than that of the steam header. Valves shall operate without sticking or chattering at minimum boiler turndown.

D. Check Valves: Swing-type, cast steel body ASTM A216 WCB, Class 300, 11-1/2 to 13 percent chromium stainless steel or stellite faced WCB disc and stellite seat, ASME flanged ends, bolted cover, renewable disc and seat.

E. Butterfly Valves for Steam Service: Carbon steel body, triple-offset design, lug or flanged type, Class 300, stainless steel nitrided disc, stainless steel seat, stainless steel shaft, stainless steel/graphite laminated seal ring, neck extending beyond pipe insulation, geared handwheel operator for valves 100 mm (4 inch) pipe size and over, lever operator for valves 75 mm (3 inch) pipe size and under.
   1. Provide factory installed globe-valved bypass when main valve is 75 mm (3 inch) pipe size or greater and serves steam main longer than 6 m (20 feet). Conform to MSS SP-45.

F. Provide factory installed globe-valved bypass when main valve is 75 mm (3 inch) pipe size or greater and serves steam main longer than 6 m (20 feet). Conform to MSS SP-45.
   1. Carbon steel body, ball and stem, Class 300, reinforced TFE seat, stem seal and thrust washer; end entry, threaded ends.

G. Bottom Blowoff Valves: Type: Seatless, sliding plunger, 0S&Y, designed for blowoff service. Sliding disc-type or globe-type valves are not permitted.
   1. Construction: ASTM A216 WCB cast steel body, Class 300, ANSI flanged ends. Valves shall have handwheel with rotating handle.
   2. Conform to ASME B31.1.

2.04 STRAINERS

A. Y-Pattern Strainers:
   1. Body: ASTM A 126, Class B cast steel, with bolted cover, bottom drain connection and blow-off valve.
   2. End Connections:
      a. Threaded ends for strainers NPS 2 and smaller.
      b. ANSI 300 flanged ends for strainers NPS 2-1/2 and larger.
   3. Strainer Screen: Stainless-steel, 20 mesh strainer, and perforated stainless-steel basket with 50 percent free area.
   4. Tapped blow off plug with blow off valve.
   5. Pressure class: 300

2.05 STEAM TRAPS

A. Inverted Bucket Steam Traps:
   1. Manufacturers:
      a. Armstrong International, Inc.
      b. Barnes & Jones, Inc.

c. Dunham-Bush, Inc.
d. Hoffman Specialty.
e. Spirax-Sarco.
f. Sterling.
g. Or approved substitution.

2. Cast iron body, bolted cover, stainless steel internals including hardened valve and seat, and threaded pipe-end connections for pressures up to 250 psi and temperatures up to 450 degrees F.
3. Stainless steel body, bolted cover, stainless steel internals including hardened valve and seat, and threaded pipe-end connections for pressures up to 450 psi and temperatures up to 750 degrees F.

B. Float and Thermostatic Steam Traps:
1. Manufacturers:
a. Armstrong International, Inc.
b. Barnes & Jones, Inc.
c. Dunham-Bush, Inc.
d. Hoffman Specialty.
e. Spirax-Sarco
f. Or approved substitution.
2. Body and Bolted Cap: ASTM A 126, cast iron.
3. End Connections: Threaded.
4. Float Mechanism: Replaceble, stainless steel.
5. Head and Seat: Hardened stainless steel.
6. Trap Type: Balanced pressure.
7. Thermostatic Bellows: Stainless steel or Monel.
8. Thermostatic air vent capable of withstanding 45 degrees F of superheat and resisting water hammer without sustaining damage.
9. Vacuum Breaker: Thermostatic with phosphor bronze bellows, and stainless-steel cage, valve, and seat.
10. Pressure class: 300

C. Thermodynamic Steam Traps:
1. Manufacturers:
a. Armstrong International, Inc.
b. Barnes & Jones, Inc.
c. Dunham-Bush, Inc.
d. Hoffman Specialty.
e. Spirax-Sarco.
f. Or approved substitution.
2. Body: Stainless steel with screw-in cap.
3. End Connections: Threaded.
4. Disc and Seat: Stainless steel.
5. Pressure class: 300

2.06 STEAM AIR VENTS

A. Manufacturers:
1. Armstrong International, Inc.
2. Barnes & Jones, Incorporated.
3. Dunham-Bush, Incorporated.
4. Hoffman Specialty; Division of ITT Industries.
5. Spirax-Sarco.
6. Sterling.

7. Or approved substitution.

B. Body: Cast iron, bronze or stainless steel.

C. End Connections: Threaded.

D. Float, Valve, and Seat: Stainless steel.

E. Thermostatic Element: Phosphor bronze bellows in a stainless-steel cage.

F. Pressure class: 300

2.07 VACUUM BREAKERS

A. Manufacturers:
1. Armstrong International, Incorporated
2. Dunham-Bush, Incorporated
3. Hoffman Specialty; Division of ITT Industries.
4. Johnson Corporation (The).
5. Spirax Sarco, Incorporated
6. Or approved substitution.

B. Body: Cast iron, bronze, or stainless steel.

C. End Connections: Threaded.

D. Sealing Ball, Retainer, Spring, and Screen: Stainless steel.

E. O-ring Seal: EPR.

F. Pressure class: 300

2.08 FLASH TANKS

A. Shop or factory fabricated of welded steel according to ASME Boiler and Pressure Vessel Code, for Class 300 rating; and bearing ASME label. Fabricate with tappings for low-pressure steam and condensate outlets, high-pressure condensate inlet, air vent, safety valve, and legs.

B. Configuration to comply with drawings.

2.09 PILOT OPERATED STEAM PRESSURE REDUCING VALVES

A. Manufacturers:
1. Armstrong International, Inc.
2. Hoffman Specialty.
3. Leslie Controls, Inc.
4. Spence Engineering Company, Inc.
5. Spirax-Sarco.
6. Or approved substitution.

B. ASME labeled.

C. Size, Capacity, and Pressure Rating: Factory set for inlet and outlet pressures indicated.

D. Descrption: Pilot-actuated, diaphram type, with adjustable pressure range and positive shutoff.

E. Main Valve: Valve size 2 inches and under: Cast iron body rated for 1725 kPa (250 psi), threaded ends.

F. Main Valve: Valve size 2-1/2 inches and larger: Cast steel body Class 300, ASME flanged ends, valve plug and seat shall be replaceable, Type 316 stainless steel or Monel, stainless steel trim.

G. Pilot Valve: Valve plug and seat shall be replaceble, stainless steel or Monel.

H. Trim: Hardeded stainless steel.

I. Head and Seat: Replaceable, main head stem guide fitted with flushing and pressure-arresting device cover over pilot diaphragm.

J. Gaskets: Non-asbestors materials.

K. Capacities and Characteristics: Refer to equipment schedules.

2.10 SAFETY RELIEF VALVES

A. Manufacturers:
   1. Armstrong International, Inc.
   2. ITT McDonnell & Miller, a xylem brand.
   3. Spirax-Sarco.
   4. Or approved substitution.

B. Valve: Bronze body, stainless steel valve spring, stem, and trim, direct pressure actuated, capacities ASME certified and labelled.

C. Accessories: Drip pan elbow.

D. Provide valves and accessories to protect piping systems and pressure vessels from over-pressure.

E. All valves shall comply with ASME Boiler and Pressure Vessel Code (Section I and VIII). Flow capacities shall be certified by National Board of Boiler and Pressure Vessel Inspectors (NB).

F. SECTION I AND SECTION VIII STEAM SAFETY VALVES GREATER THAN 15 PSIG: Cast Steel Class 300 inlet flange, Class 150 outlet flange, External spring, bolted yoke design, with lifting lever, stainless steel trim, lapped seats, Steel Spring, Stainless steel control rings.

G. SECTION VIII STEAM SAFETY VALVES SETPOINT 15 PSIG OR LESS: Cast Iron, Class 125 inlet flange, Class 125 outlet flange, Enclosed spring, bolted bonnet design, with lifting lever, stainless steel trim, lapped seats, Steel Spring, Stainless steel control rings.

H. Note: Cast Iron safety valves are only allowed on low pressure steam (< 15 psig).

2.11 IN-LINE AND INSERTION VORTEX FLOW METERS

A. Manufacturers:
   1. EMCO Flow Systems; Division of Advanced Energy Company.
   2. ISTEC Corp.
   3. Onicon, Inc; System 10, 20, or 40: www.onicon.com/#sle.
   4. Preso Meters; a division of Racine Federated Incorporated.
   5. Spirax Sarco, Incorporated.
   6. Or approved substitution.

B. Meters shall have a microprocessor to display Totalizer flow, flow rate, temperature, pressure, time, and date; alarms for high and low flow rate and temperature.
   1. Computer shall have 4 to 20-mA or 2 to 10 volt output for temperature, pressure, and contact closure for flow increments.
   2. Independent timers to store four peak flow rates and total flow.
   3. Interface compatible with central workstation described in Division 23 Section "Instrumentation and Controls for HVAC."
   4. Microprocessor Enclosure: NEMA 250, Type 4.

C. Sensor: Vortex type with stainless-steel wetted parts and flange connections; and with a piezoelectric sensor removable and serviceable without shutting down the process. At least 10:1 turndown with plus or minus 1 percent accuracy over full-flow range.

PART 3 EXECUTION

3.01 VALVE APPLICATIONS

A. Install shutoff duty valves at branch connections to steam supply mains, at steam supply connections to equipment, and at the outlet of steam traps.

B. Install safety valves on pressure-reducing stations and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

C. Valves NPS 1-1/2 and smaller shall have threaded ends; valves NPS 2 and larger shall have flanged ends.

D. No cast iron valves or devices for high pressure steam service (greater than 15 psig) unless specifically specified in this section.

3.02 PIPING INSTALLATION

A. Install piping to permit valve servicing.

B. Install drains, consisting of a tee fitting, NPS 3/4 full port-ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

C. Install valves according to Section 230523 "General-Duty Valves for HVAC Piping."

D. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

E. Install drain and trap connections on top side of any steam valve mounted in the vertical position.

F. Provide warmup valves on all steam valves greater than NPS 3 with downstream piping longer than 20 ft.

G. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

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

I. Install strainers on supply side of control valves, pressure-reducing valves, traps, and elsewhere as indicated. Install NPS 3/4 nipple and full port ball valve in blow-down connection of strainers NPS 2 and larger. Match size of strainer blow-off connection for strainers smaller than NPS 2.

J. Flash Tank:
   1. Pitch condensate piping down toward flash tank.
   2. If more than one condensate pipe discharges into flash tank, install a check valve in each line.
   3. Install thermostatic air vent at tank top.
   4. Install safety valve at tank top.
   5. Install full-port ball valve, and swing check valve on condensate outlet.
   6. Install inverted bucket or float and thermostatic trap at low-pressure condensate outlet, sized for three times the calculated heat load.
   7. Install pressure gage on low-pressure steam outlet according to Section 230519 "Meters and Gages for HVAC Piping."

3.03 STEAM TRAP SIZE AND CAPACITY

A. General: Steam traps of size and capacity as indicated on Drawings, or as required based on selection criteria below.

B. Float and Thermostatic Traps: Cast-iron body and bolted cap; renewable, stainless-steel float mechanism with renewable, hardened stainless-steel head and seat; maximum operating pressure of 125 psig; balanced-pressure, stainless-steel or Monel thermostatic bellow element.
   1. Thermostatic air vent capable of withstanding 45 degrees F of superheat and resisting water hammer without sustaining damage.

C. Inverted Bucket Traps: Cast-iron body and cap, pressure rated for 250 psig; stainless-steel head and seat; stainless-steel valve retainer, lever, and guide pin assembly; brass or stainless-steel bucket.
   1. Strainer: Integral stainless-steel inlet strainer within the trap body.
   2. Air Vent: Stainless-steel thermostatic air vent.

D. Stream Trap Selection Criteria:
   1. Select steam traps on actual equipment condensate load times a safety factor of three unless specified on the drawings, at the following differential pressures:
      a. 1/2 psi pressure differential for low pressure steam.
      b. 2 psi pressure differential for steam pressure up to 30 psi.
      c. 50% of available pressure for steam pressures above 30 psi.
   2. Select steam traps for piping drip applications based on calculated condensate load during piping warm up times a safety factor of three or as specified on the drawings.
      a. Thermodynamic traps or inverted bucket traps for high pressure steam on drip applications.
      b. Base condensate load calculations on warm-up of Schedule 40 steel pipe from 50 degrees F, 75% effective insulation, external surface area of piping drained and operating steam pressure. Select traps at the following differential pressures:
      c. 1/2 psi pressure differential for low pressure steam.
      d. 2 psi pressure differential for steam up to 30 psig.
      e. 50% of available pressure for steam pressures above 30 psig.

3.04 LOW PRESSURE STEAM TRAP APPLICATIONS

A. Float and Thermostatic Traps:
   1. Finned tube radiation and convectors (low pressure steam - modulating control).
   2. Unit heaters (low pressure steam - modulating control).
   3. Air handling unit coils (low pressure steam - modulating control).
   4. Steam to water heat exchangers (low pressure steam - modulating control).
   5. Flash tanks.
   6. Kitchen and laundry equipment.
   7. Hospital sterilizer equipment.
   8. As indicated on Drawing or Details.

B. Inverted Bucket Traps:
   1. Humidifiers.
   2. Steam main and riser drip legs.
   3. As indicated on Drawing or Details.

3.05 HIGH PRESSURE STEAM TRAP APPLICATIONS

A. Float and Thermostatic Traps:
   1. Kitchen and laundry equipment.
   2. Hospital sterilizer equipment.
   3. As indicated on Drawing or Details.

B. Inverted Bucket Traps:
   1. As indicated on Drawings or Details.

C. Thermodynamic Traps:
   1. Steam main and riser drip legs.
   2. Equipment drip legs.

3.06 STEAM TRAP INSTALLATION

A. Install steam traps in accessible locations as close as possible to connected equipment

B. Install full port ball valve, strainer, and union upstream from trap; install union, check valve, and full port ball valve downstream from trap unless otherwise indicated.

3.07 PRESSURE REDUCING VALVE INSTALLATION

A. Install pressure-reducing valves in accessible location for maintenance and inspection.

B. Install baffle plates where recommended by the pressure reducing valve manufacture.

C. Install bypass piping around pressure-reducing valves, with globe valve equal in size to area of pressure-reducing valve seat ring, unless otherwise indicated.

D. Install slow acting shut-off valves on both sides of pressure-reducing valves.

E. Install unions or flanges on both sides of pressure-reducing valves having threaded- or flanged-end connections respectively.

F. Install pressure gages on high and low-pressure side of pressure-reducing valves after the bypass connection according to Division 23 Section “Meters and Gages for HVAC Piping." Use condensate loops on all steam pressure gage applications.

G. Install strainers with blow-down valves upstream of pressure-reducing valve.

H. Install safety valve downstream from pressure-reducing valve station.

I. Install HPS main drip leg and trap up stream of pressure reducing valve.

J. Install LPS main drip leg and trap down stream of pressure reducing valve.

3.08 STEAM OR CONDENSATE METER INSTALLATION

A. Install meters with lengths of straight pipe upstream and downstream according to steam meter manufacturer's written instructions.

B. Provide data acquisition wiring. See Section 230900 "Instrumentation and Control for HVAC."

3.09 SAFETY VALVE INSTALLATION

A. Install safety valves according to ASME B31.1, "Power Piping" and ASME B31.9, "Building Services Piping."

B. Pipe safety-valve discharge without valves to atmosphere outside the building.

C. Install drip-pan elbow fitting adjacent to safety valve and pipe drain connection to nearest floor drain.

D. Install exhaust head with drain to waste, on vents equal to or larger than NPS 2-1/2.

3.10 TERMINAL EQUIPMENT CONNECTIONS

A. Size for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install traps and control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valves. If parallel control valves are installed, only one bypass is required.

D. Install vacuum breakers downstream from control valve, close to coil inlet connection.

E. Install a drip leg at coil outlet.

F. Pipe outlet from coils to drip leg. From drip leg, install a float-and-thermostatic trap, sized at 3 times the condensate load of equipment, at 1/2-psig differential. Locate steam trap inlet at least 12 inches below the coil outlet connection.

END OF SECTION 232214

SECTION 235230
BURNERS

(BURNER VENDOR)

PART 1 GENERAL

2.01 REFERENCE STANDARDS

A. 29 CFR 1910.146 - Permit-Required Confined Spaces; Current Edition.

B. ASME B31.1 - Power Piping; 2024.

2.02 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.
   1. ASME INTERNATIONAL (ASME)
   2. ASME B31.1 Power Piping
   3. ASME PTC 4 Fired Steam Generators
   4. ASME SEC I Power Boilers ASTM INTERNATIONAL (ASTM)
   5. NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)
   6. NFPA 85 Boiler and Combustion Systems Hazards Code
   7. OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA)
   8. 29 CFR 1910.146 Permit-required Confined Spaces

2.03 RELATED REQUIREMENTS

A. Sections
   1. The following Sections apply to this SECTION, with the additions and modifications specified herein.
      a. SECTION 23 09 10 - STEAM AND HW PLANT FIELD DEVICES
      b. SECTION 23 09 10.20 - STEAM AND HW PLANT PLC
      c. SECTION 23 09 10.48 - STEAM AND HW PLANT LOGIC
      d. SECTION 23 52 50 - BOILER COAL TO GAS CONVERSION
      e. SECTION 23 52 60 - BOILER FANS AND ACCESSORIES

2.04 SECTION DESCRIPTION

A. This SECTION specifies new burners for Boiler (BLR)-1 through 4. These units are being permanently converted from coal to natural gas firing primary with Number 2 fuel oil as secondary fuel in this project. The work includes but is not limited to providing new burners and associated natural gas and number 2 fuel oil fuel trains. Other work specified elsewhere includes replacement of some boiler trim, new BMS and controls, complete engineering design for installation of new burners, and other related work to convert from coal to gas-only firing.

B. The scope of this project includes the removal of coal firing and providing new low NOx burners. This work includes new natural gas and number 2 fuel oil fuel trains, new burner management systems, and integration and programming of combustion controls in existing Ovation SCADA system. The following information regarding the existing boilers is provided to assist the Contractor in the procurement of the new burners and fuel trains. The burners shall be provided as specified in of this SECTION. The burner manufacturer shall review drawings of the boilers in the Contract Documents and perform field investigations looking inside the boilers verifying geometry and configuration to assure full coordination and no flame impingement.

C. The burner manufacturer is responsible for verifying sizing of FD and ID fans and controls work as described herein.

D. It is the Vendor’s responsibility to coordinate all work with the burner manufacturer to install a functionally complete system.

2.05 SUBMITTALS

A. DES approval/acceptance is required for submittals with a “DES” designation, submittals not having a designation are for information only. Submit the following in accordance with SECTION 01 30 00 SUBMITTAL PROCEDURES:
   1. Product Data
      a. Process and instrumentation diagram(s) showing all devices from boiler to burner; DES
      b. Burner; DES
      c. Drawing showing modifications required to existing boiler to accommodate new burner; All modifications shall be clearly identified; DES
      d. Boiler analysis to determine burner installed location.
      e. Drawings showing construction of burner parts, windbox, and assembly of complete system;
      f. Analysis and verify sizing of existing FD & ID fan;
      g. Drawings, with dimensions, showing burner overall sizes and mounting on the boiler;
      h. Drawings indicating modifications to boiler.
      i. Drawings and catalog data on all equipment in ignitor (pilot) train and main fuel trains. Include data on pressure and temperature ratings, flow vs. pressure drop, performance characteristics;
      j. External connection diagram for burner mounted limits and valves;
   2. Test Reports
      a. Performance, Efficiency, and Emissions Testing;
      b. DES Stack test protocol; DES
      c. Stack test report;
   3. Certificates
      a. Burner Coordination Statement; DES (The burner submittal will not be approved until this statement has been submitted.)
   4. Manufacturer's Field Reports
      a. Installation Certification Statement; DES
      b. Qualification Statement; DES
   5. Operation and Maintenance Data
      a. Operation and Maintenance Manuals; DES (Operation and Maintenance manuals shall include a general description of the entire system, clearly identifying the operational and functional features of each component. The manual shall include operating instructions and recommended maintenance schedules and procedures. A complete bill of materials and manufacturer's bulletins, general information drawings and installation drawings shall be provided. Provide name, address, and phone number for manufacturer’s representative responsible for aftermarket equipment support.)
      b. Burner Manufacturer's O&M information;
      c. Burner Start-Up Information including test reports. BMS and Controls O&M including logic diagrams;
      d. BMS and Control Field Devices O&M.

2.06 QUALITY ASSURANCE

A. Qualification Statement
   1. The model and size of the proposed burner shall have been applied to at least 5 boilers which are similar in size, proportion, and arrangement to the furnace of the existing boilers while firing natural gas and fuel oil. Provide a list of installations including the following information: location of installation, steam capacity of boiler, number of burners per boiler, burner heat input, guaranteed emissions (NOx and CO), actual measured emissions (NOx and CO), fuel burned, name, address, and phone number of contact person. The

proposed burner supplier shall have been involved in the design, manufacturing, and commissioning of burners for a minimum of 15 years.

B. NFPA 85
   1. Regardless of fuel input rating, the equipment, installation and operation shall conform to the latest edition of NFPA 85.

C. Burner Coordination Statement
   1. As per the Quality Assurance paragraph in SECTION 23 52 50 - BOILER COAL TO GAS CONVERSION, prior to providing burner submittals, the Contractor shall submit a coordination statement indicating that the internal boiler walls and furnaces of the boilers were inspected and that the burner being provided was coordinated with the actual configuration of the boiler wall and floor. If Boilers require computational analysis to verify and guarantee boiler production and efficiency after conversion, this shall be completed by Contractor and included in project cost. The burner manufacturer shall review the dimensions of the furnaces, to confirm that the proposed installation will have good pattern and temperature distribution with out flame impingement or local overheating. Any design or construction related issues must be addressed in writing. The statement shall be signed by the Contractor and an employee of the burner manufacturer.

D. Burner Manufacturer's Representative
   1. The Contractor shall secure the services of the burner manufacturer's representative. The burner manufacturer's representative shall be on-site for a minimum of one day during the installation of the burner. The burner manufacturer's representative shall be on-site for the start-up of the boilers for a minimum of 5 calendar days per boiler. This is to assist in commissioning, start-up and training.

E. Installation Certification Statement
   1. The Contractor shall prepare and submit an installation certification statement signed by the Contractor and burner manufacturer's representative. The installation certification statement shall indicate that the burner and burner trains have been installed in accordance with the burner manufacturer's recommendations. This statement may be submitted only after all controls have been tuned, final testing has been performed, and internal inspections of the boiler have been performed to verify final installation and no deterioration of parts, tubes or refractory and no evidence of flame impingement or hot spots.

F. Applicable Codes
   1. All work shall be in accordance with the ASME SEC I Boiler and Pressure Vessel Code, ASME B31.1, the National Board Inspector's Code, and the laws of the State of Minnesota, and other applicable local laws.
   2. The Contractor shall refer to the Authorized Inspector for direction for any discrepancies with boiler external versus boiler non-external piping.

G. Confined Space
   1. The furnace of the boilers is a confined space. The Contractor shall follow DES requirements and Federal OSHA Regulations (((29 CFR 1910.146))) confined space entry guidelines for entering all confined spaces. All personnel performing work inside of the boilers must be trained in confined space entry procedures and must submit all papers indicating training prior to entrance. All confined space entry is subject to the Site's procedures.

H. Lock-Out/Tag-Out
   1. The Contractor shall perform lock-out/tag-out procedures to secure the boilers at all time during construction.

I. Quality Assurance

1. The requirements of paragraph 1.05 "Quality Assurance" of SECTION 23 09 10.48, apply to this SECTION.

J. Fire Watch
1. The Contractor must perform "Fire Watch" activities when performing “hot work” around the boiler and the Contractor must adhere to welding requirements.

2.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver components as a factory assembled unit to the extent possible, with protective crating and covering. All equipment shall be stored in accordance with manufacturer’s recommendation. Inspect equipment immediately upon arrival and any irregularities or damage shall be reported to the manufacturer/supplier and DES Project Coordinator immediately.

2.08 PROJECT CONDITIONS

A. Existing Boiler and Burner Nameplate Data
1. Boiler 1-4
a. Manufacturer: Edge Moor Iron Company
b. Manufacturer Order Number: 2086 (S/N not found)
c. National Board No.: TBD
d. Year Built: 1934
e. Boiler Type: Watertube
f. Maximum Design Rated Output: 125,000 pph
g. Normal Operating Pressure: 225 psig
h. Maximum Design Pressure: 425 psi
i. Heat Recovery: None
j. Fuels Fired: Pulverized Coal (Boiler 1-4) and natural gas (Boiler 2&3 only).

B. Fuel Analysis
1. The following fuel analysis is provided to be used for design and selection of the burner and ancillary equipment to satisfy capacity and emissions specifications:

C. Natural Gas
1. Analysis percent by volume:
a. Methane CH4 90.0 (maximum)
b. Ethane C2H6 5.0 (maximum)
c. Propane C3H8 5.0
d. Nitrogen N2 ---
e. Oxygen O2 ---
f. TOTAL 100.00
g. Higher Heating Value (HHV) at STP = 1,020 /Cubic Foot
h. Gas Gravity = 0.6
i. Available natural gas pressure = 30 psig nominal.
2. Number 2 Fuel Oil
a. Commercially available low sulfur number 2 fuel oil.
b. Winter blend
c. Sulfur Content 15 ppm (by weight).
d. Energy content (HHV) = 138,000 btu/gal

D. Expected Boiler Efficiencies
1. These are operating efficiencies on natural gas in existing boilers. It is anticipated that the boiler manufacturer will achieve similar efficiencies. In the event that this is determined to not be feasible, Vendor shall notify DES and propose changes to improve boiler efficiency.
2. Steam Boiler: typical 80 percent thermal efficiency

E. Other Burner Design properties

1. The burner design combustion air temperature after the air preheater shall be 450 degrees Fahrenheit.
2. The site elevation is approximately 610 feet above sea level.

F. Boiler Drawings
1. Boiler drawings are attached in Contract Documents.

PART 2 PRODUCTS

3.01 BURNER

A. General
1. Provide a new low NOx gas and fuel oil burner for BLR-1 and 4 with fuel input capacities and emissions as specified below, subject to the existing boiler conditions and fuel parameters as specified in Paragraph 1.7.
2. Provide a new low NOx fuel oil burner for BLR-2 and 3 with fuel input capacities and emissions as specified below, subject to the existing boiler conditions and fuel parameters as specified in Paragraph 1.7.
3. For each boiler, provide a dual burner arrangement system in one common windbox, with both burners operating simultaneously as a single burner. Switch over from gas to oil and oil to gas shall be possible at any firing rate. If burner installation requires a different configuration to achieve satisfactory performance (e.g. no flame impingement on furnace wall), Vendor shall specify.
4. Burners shall be sidewall mounted in existing burner openings with any modifications completed by Vendor.

B. Heat Input
1. Each unit (BLR-1 through 4) shall have dual burners as specified. The total heat input to each boiler shall be 130 MMBTU/HR (higher heating value). So for each boiler, each burner will have a heat input of 65 MMBTU/HR.

C. Turndown
1. The burner shall be designed so that each boiler has a fuel heat input turndown of 10 to 1 from rated maximum fuel input on natural gas.
2. The burner shall be designed so that each boiler has a fuel heat input turndown of 8 to 1 from rated maximum fuel input on number 2 fuel oil. This limit is directed by guarantee on emissions.
3. Do not go below specified turndown unless guarantees for NOx and CO on lb/MMBTU basis can be maintained.

D. Emissions Limits in Flue Gas
1. General
   a. Emissions shall be achieved without the use of over fire air, flue gas recirculation, steam injection, or air pre-heat.
   b. Emission limits shall be satisfied at maximum rated fuel input capacity to a turndown as specified in 2.1.3.
   c. Emissions shall be satisfied with all boiler controls operating in automatic, including oxygen trim.
   d. Emissions shall be satisfied with a maximum of 15 percent excess air at 25% to 100% of boiler rated load.
   e. Emissions limits are stated in terms of higher heating value of fuel heat input.
2. NOx (Nitrogen Oxide) Emissions
   a. Shall not exceed 0.1 LB/MMBTU of heat input for natural gas firing corrected to 3% oxygen.
   b. Shall not exceed 0.1 LB/MMBTU of heat input for number 2 fuel oil firing corrected to 3% oxygen.
3. SO2 (Sulfur Dioxide) Emissions

a. There are no expressed emission limits for SO2 emissions for natural gas or number 2 fuel oil as it is fuel dependent. Commercial natural gas and low sulfur number 2 fuel are proposed fuels.

4. CO (Carbon Monoxide) Emissions
   a. Shall not exceed 0.06 LB/MMBTU for natural gas firing corrected to 3% oxygen.
   b. Shall not exceed 0.06 LB/MMBTU for number 2 fuel oil firing corrected to 3% oxygen.
5. VOC (Volatile Organic Compounds) Emissions
   a. Shall not exceed 0.002 LB/MMBTU for natural gas firing corrected to 3% oxygen.
   b. Shall not exceed 0.002 LB/MMBTU for number 2 fuel oil firing corrected to 3% oxygen.
6. PM10 (Particulate Matter equal to or less than 10 Microns) Emissions
   a. Shall not exceed 0.006 LB/MMBTU for natural gas firing corrected to 3% oxygen.
   b. Shall not exceed 0.01 LB/MMBTU for number 2 fuel oil firing corrected to 3% oxygen.
7. PM2.5 (Particulate Matter equal to or less than 2.5 Microns) Emissions
   a. Shall not exceed 0.006 LB/MMBTU for natural gas firing corrected to 3% oxygen.
   b. Shall not exceed 0.008 LB/MMBTU for number 2 fuel oil firing corrected to 3% oxygen.
8. Opacity
   a. No visible plume shall exist when firing natural gas or number 2 fuel oil.

E. Burner Pressure Drop
   1. Airside pressure drop for the burner at 15% excess air shall not exceed 8.0 inches water column at 100% full load. See SECTION 23 52 60 - BOILER AND HWG FANS AND ACCESSORIES for expected pressure drop and calculations required to size fan.

F. Burner Type
   1. Natural gas, Number 2 fuel oil, dual burner acting as one, modulating firing.
   2. Gas Burner
      a. The gas burner assembly shall be of the multi-spud type, provided with a low NOx design. The inlet connection, manifold, and gas spuds shall be fabricated of stainless steel. Gas spud orifices shall be large enough to allow passage of dust particles. Filters are not permitted. Manifold shall be constructed so as to not crack under the heat it will be subjected to. There shall be no modulating parts within the burner (including register during operation).
   3. Oil Burner
      a. The oil burner shall be of removable gun type. Steam atomization shall be provided as primary type of atomization. Air atomization shall also be provided in the event steam is not available and it is desired to start boiler without steam.
   4. Ignitor (Pilot)
      a. Interrupted, electrically ignited, natural gas and fuel oil. Provide adequately sized ignition transformer mounted inside a NEMA 4 enclosure on front of the windbox for each individual burner.

G. Performance
   1. Ignition
      a. Ignitor flame shall form close to the point of ignition and shall be stable.
   2. Main Burner Flame Characteristics at all Loads
      a. Throat refractory shall be sufficiently heated to provide stable flame on firing.
      b. Unburned fuel or carbon shall not be deposited on the refractory.
      c. No carryover of luminous flame into the convection section of the boiler.
      d. Flame impingement as defined by ABMA guidelines on furnace tubes or refractory is not permitted.
   3. General Burner Operation

a. The burner shall incorporate low NOx fuel and air staging to achieve emissions. Only low NOx burner technology shall be used as necessary to meet NOx emissions requirements for NOx reduction. Flue gas recirculation (FGR), over fire air, steam injection, and air pre-heat are not an acceptable means for satisfying low NOx emission specifications for this project.
b. All components of the burner shall be factory assembled to the maximum extent feasible to minimize field installation, check-out, and start-up requirements. If possible, the burners shall be factory mounted in the new windbox.
c. Where possible, all valves, switches, regulators, and gauges for gas and ignitor trains shall be shop piped, skid mounted, and arranged to provide easy access to manual shut-off valves and gauges.
d. The burner shall be designed in accordance with the applicable code requirements of NFPA 85. All applicable components shall have the approval requirements of Factory Mutual. The burner shall be designed to meet site requirements, with regard to site elevation, ambient air temperature at the forced draft fan inlet, power supply availability, and equipment location. Equipment supplied for indoor use shall have a minimum rating of NEMA 12 rated electrical components; equipment supplied for outdoor use shall have a minimum rating of NEMA 4 rated electrical components.

H. Air Distribution
1. Windbox Damper
a. The forced draft fan shall have a variable frequency drive and a variable vane inlet damper. A windbox damper shall also be provided with the burner.
b. The windbox damper along with the forced draft fan inlet damper (if necessary to achieve turndown) shall be selected by the burner manufacturer to achieve the specified burner performance and safe light off procedure in the event the FD fan VFD must be in by-pass.
c. The burner manufacturer shall identify the required combustion control system and burner management system input and outputs for the damper to ensure safe reliable boiler operation in accordance with NFPA 85.
d. The burner manufacturer shall provide a damper actuator (per SECTION 23 09 10 - STEAM AND HW PLANT FIELD DEVICES) with the new damper per SECTION 23 52 60 - BOILER AND HWG FANS AND ACCESSORIES.
2. Windbox
a. The burner manufacturer shall provide a new windbox.The windbox shall be designed to assure balanced peripheral distribution of combustion air into the air register, so as to meet burner performance. The windbox shall be provided with vanes and baffles to evenly distribute combustion air as required.
b. The windbox shall be fabricated using a minimum 1/4" carbon steel ASTM A36 plate, and shall be complete with required structural framing to provide structural rigidity. An access door shall be provided. The windbox shall be primed and painted. The windbox shall be field welded to the boiler steel or secondary support steel with sufficient framing To prevent flexing of boiler steel.
c. The geometry of the windbox must be coordinated with the existing boiler dimensions and final installed location prior to submitting the burner for review.
3. Air Register
a. The burner shall include a combustion air register assembly which shall avoid flame impingement of furnace walls while providing internal staging of combustion air within the flame envelope to limit NOx emissions. Internal windbox baffling shall be provided to insure even air distribution to the burner.
4. Burner Throats
a. The Vendor is responsible for designing the burner throat and tube reviewing the existing arrangement and spacing in the field before preparing the burner submittal. The Vendor shall indicate any design changes necessary for the new burner

arrangement, and will be responsible for all boiler modifications. If boiler tubes are impacted, tubes can be relocated but not capped.
        b. Burner throats must be fabricated to limit flame and heat away for boiler tubes and refractory.
        c. Any modification to the refractory shall be completed by Vendor.

I. Burner Front Hub
    a. The burner front hub shall be complete with mounts for the oil atomizer, ignitors, flame scanners, and sightglasses, and shall be readily accessible. The front plate shall be fabricated from a minimum of 1/4 inch carbon steel. There shall be at least two 1-inch diameter observation port for visual checking of the flame pattern.
    b. Provide a flame scanner as specified in SECTION 23 09 10 - STEAM AND HW PLANT FIELD DEVICES.

3.02 BURNER FUEL TRAINS

A. Components
    1. The Vendor shall supply all of the devices in the fuel trains, including all piping, stop valves, fittings, hangers, strainers, pressure regulating valves, natural gas and fuel oil flow meters, pressure transmitters, and pressure Gauges. All Vendor supplied devices in the fuel trains must be included with the burner submittal package.

B. New Burner Devices Required for the Boilers
    1. Provide all components required for natural gas and fuel oil. This includes but is not limited to the following for each boiler for the new burners. All components required may not be listed. Devices are specified in SECTION 23 09 10 - STEAM AND HW PLANT FIELD DEVICE unless approved otherwise.
    2. Natural gas train (main and pilot train) including fuel gas measurement, strainers, shutoff valves, pressure regulators, vent valves, high and low pressure switches, gauges, and transmitters.
    3. Fuel oil train including fuel measurement, shutoff valves, strainers, pressure regulators, vent valves, high and low pressure switches, gauges, and transmitters.
    4. Fuel oil steam and air atomization systems.
    5. The following miscellaneous components:
        a. Flame scanners
        b. Ignition transformers
        c. Windbox differential pressure switch
        d. Low instrument air pressure switch

3.03 CONTROLS

A. General
    1. The combustion controls and burner management system logic devices shall be PLCs as specified in SECTION 23 09 10 - STEAM AND HW PLANT PLC. The logic shall be similar per SECTION 23 09 10.48 - STEAM AND HW PLANT LOGIC. The burner manufacturer shall either provide all logic devices and logic for all the BLRs, or provide logic requirements to the Integrator.

PART 3 EXECUTION

4.01 INSTALLATION

A. Low NOx Burners
    1. Low NOx burner shall be installed in accordance with the manufacturer's recommendations.
    2. A manufacturer's representative shall be present during low NOx burner installation as described in Paragraph "QUALITY ASSURANCE".

3. The Contractor shall arrange piping to allow access to boiler/windbox openings and the burner without disassembly of the piping. The Contractor shall submit evidence that the burner manufacturer has reviewed and approved the burner train piping arrangement.
4. If the burner fails to meet performance or emissions guarantees, the Contractor shall submit a plan to DES for making the necessary modifications to meet the performance requirements. All cost associated with these modifications shall be the responsibility of the Contractor.
5. Arrange fuel trains, controls and other devices to permit removal of burner parts, including register, without removing valves.
6. All devices shall be accessible for maintenance or replacement without removal of other devices. Do not mount any piping or devices within two feet of boiler side and top casings, and do not attach any piping or devices to boiler side and top casings.

4.02 INSPECTIONS AND TESTS

A. Prior to initiating boiler operation, the Contractor shall obtain written permission from the DES Project Coordinator. In addition, the burner manufacturer shall verify that the burner and burner trains have been installed in accordance with the burner manufacturer's recommendations. This shall be indicated in the installation certification statement.

B. Performance, Efficiency, and Emissions Testing
1. Prior to scheduling any performance, efficiency, or emissions tests, submit evidence of pretest simulations including all testing required by SECTION 23 09 10 - STEAM AND HW PLANT FIELD DEVICES. Evidence shall consist of itemized checklist of all control, indicating, and interlock functions. Checklist shall certify that all functions are properly operational.
2. Conduct an efficiency test in accordance with the ASME PTC 4 Power Test Code. Submit the ASME Test Form for abbreviated efficiency test summary sheet (PTC 4.1-a) and calculation sheet (PTC 4.1-b). Efficiency tests shall be performed on each boiler firing natural gas.
3. Conduct performance tests on each boiler at the required load as indicated on the performance test summary form at the end of this section. Test form shall be completed in its entirety and submitted to DES.
4. Conduct Functional Varying Load 168 hour on-line functional test.
5. Conduct an emissions test to demonstrate compliance with the specified emission rates.
    a. The Contractor shall secure the services of an independent testing agency to perform a stack test. All stack test methods shall be performed in accordance with Environmental Protection Agency test methods. Test for NOx in accordance with EPA method 7. The test Contractor shall prepare and submit to DES for approval a stack test protocol that clearly identifies all of the proposed test methods. Upon completion of the stack tests, the stack test Contractor shall submit a stack test report including the results of the stack test.
    b. If for any reason the burner fails to meet the emission guarantees, the Contractor shall resolve the problem and retest the boiler. Re-testing of the boiler shall be performed at the expense of the Contractor.
    c. Emissions testing shall be performed with all boiler controls operating in automatic, including oxygen trim.
    d. The emissions testing for the report must be performed without any modifications to the controls or burners. Therefore, it is required that the burner start-up include preliminary emissions testing to ensure that emission levels can be satisfied while in automatic. Once emissions testing has begun, no modifications to the controls or burners will be allowed. If it is discovered that emissions cannot be satisfied with the "current" set-up, all official testing must be performed again, starting from the beginning.

C. Hydrostatic Testing

1. If required by the Authorized Inspector due to boiler modifications, the Boiler shall be hydrostatically tested.
2. Hydrostatic testing of the boiler shall be performed in accordance with SECTION I of the ASME Boiler and Pressure Vessel Code and the National Board Inspector's Code.
3. Hydrostatic testing shall take place immediately after the all new boiler external piping is installed and all cleaning services have been performed.
4. If Hydrostatically tested, Contractor shall complete a boilout of the boiler as the first step of commissioning.

D. Inspection Reports
1. If any boiler tube modifications occur, the Contractor shall submit all documentation regarding boiler inspection and testing including the inspector's signed report and ASME and National Board Code papers that document the repair and hydrostatic testing.

E. Final Inspection
1. After all tests are satisfactorily completed, the Contractor and Engineer shall inspect the furnace to ensure the integrity of the burner.
2. Evidence of refractory damage, flame impingement, or boiler tube damage or distortion are prohibited.
3. Adverse conditions resulting from the burners shall be repaired by the Contractor at no expense to DES.

4.03 DES TRAINING

A. Training shall be provided for all new equipment provided. Training shall be provided by the Vendor or burner manufacturer's representative and the controls supplier and integrator through the Contractor.

B. Training shall include but shall not be limited to the following:
1. Burner sequences including light-off and shut-down for both natural gas and fuel oil.
2. Burner train components and function.
3. Operation and maintenance procedures for burner and burner train related items.
4. Review of Operation and Maintenance Manuals.

C. Minimum Requirements
1. Training for the items listed above shall include both classroom and hands on. Two training sessions shall be scheduled to account for shifts. Training shall be a minimum of one day per session. Training shall be scheduled after the boiler has been commissioned and successfully tested.

4.04 BOILER START UP PERFORMANCE SHEETS

A. Performance test data sheets for natural gas and fuel oil are provided for contractor to completer during testing. This form or similar shall be provided and completed by contractor based on test conditions for DES’s record.

B. PERFORMANCE TEST DATA SHEET - NATURAL GAS FIRING

DATE OF TEST:
BLR: 2 OR 3
PERCENT LOAD (PERCENT) 25 50 75 100
STEAM FLOW (PPH) 37,500 75,000 112,500 150,000
ACTUAL STEAM FLOW (PPH)
DRUM OPERATING PRESSURE (PSIG)
STACK TEMPERATURE (DEGREE F)
WINDBOX PRESSURE (INCH W.C.)
FURNACE PRESSURE (INCH W.C.)
BOILER EXIT PRESSURE (INCH W.C.)
GAS FLOW (SCFH)
GAS PRESSURE (PSIG)
AIR FLOW (SCFH)
OXYGEN AT BOILER OUTLET (PERCENT)
CO AT BOILER OUTLET (PPM)
NOX AT BOILER OUTLET (PPM)

A. PERFORMANCE TEST DATA SHEET – No. 2 Oil FIRING - BLR-2 AND 3

DATE OF TEST:
BLR:
PERCENT LOAD (PERCENT) 25 50 75 100
STEAM FLOW (PPH) 37,500 75,000 112,500 150,000
ACTUAL STEAM FLOW (PPH)
DRUM OPERATING PRESSURE (PSIG)
STACK TEMPERATURE (DEGREE F)
WINDBOX PRESSURE (INCH W.C.)
FURNACE PRESSURE (INCH W.C.)
BOILER EXIT PRESSURE (INCH W.C.)
OIL FLOW (GPM)
OIL SUPPLY PRESSURE (PSIG)
OIL GUN PRESSURE (PSIG)
STEAM ATOMIZATION PRESSURE (PSIG)
AIR FLOW (SCFH)
OXYGEN AT BOILER OUTLET(PERCENT)
CO AT BOILER OUTLET (PPM)
NOX AT BOILER OUTLET (PPM)

END OF SECTION 235230

SECTION 253526
INTEGRATED AUTOMATION COMPRESSED AIR SUPPLY

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Compressed Air Distribution:
   1. Piping.
   2. Fittings.

B. Compressed air delivery.

C. Compressed air system accessories.

1.02 REFERENCE STANDARDS

A. ASME A13.1 - Scheme for the Identification of Piping Systems; 2023.

B. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard; 2020.

C. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2021.

D. ASME B16.24 - Cast Copper Alloy Pipe Flanges, Flanged Fittings, and Valves: Classes 150, 300, 600, 900, 1500, and 2500; 2021.

E. ASME B31.1 - Power Piping; 2024.

F. ASTM B32 - Standard Specification for Solder Metal; 2020.

G. ASTM B813 - Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube; 2016.

H. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2019.

I. CAGI - The Compressed Air and Gas Handbook; 2003.

J. ISO 8573-1 - Compressed Air — Part 1: Contaminants and Purity Classes; 2010.

K. NFPA 99 - Health Care Facilities Code; 2024, with Errata.

1.03 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

1.04 QUALITY ASSURANCE

A. Products: Listed, classified, and labeled as suitable for the purpose intended.

PART 2 PRODUCTS

2.01 SYSTEM AIR QUALITY CLASS REQUIREMENTS

A. Configure system to comply with ISO 8573-1 to supply air quality as:
   1. Maintenance-free or Process: Air Quality Class 1.4.2.

B. Review system configuration and coordinate piping and component location when excluded from project drawings.

C. Review total flow and header pressure demand requirements and increase proposed storage capacity by 25 percent to overcome unforeseen field conditions.

2.02 COMPRESSED AIR DISTRIBUTION

A. Piping:
   1. System Compliance: ASME B31.1. Comply with NFPA 99 for healthcare facilities.
   2. Pipe identification: Comply with ASME A13.1.
   3. Solder Filler Metal: Comply with ASTM B32 with water healthcare flux complying with ASTM B813 as applicable.

4. Brazing Filler Metal: Silver type of the BCuP series or copper phosphorus alloys for general duty brazing complying with AWS A5.8M/A5.8.

B. Fittings:
1. Type: Black iron, schedule 40 or heavier, threaded for diameters three inches and smaller and welded or flanged for larger diameters.
2. Couplings: Quick connect fully compatible with pipe material.
3. Connection Details:
a. Copper Unions and Wrought Copper Solder Joint: Complying with ASME B16.22.
b. Class 300, Cast Copper Alloy Flanges: Comply with ASME B16.24.
c. Class 150, Flanges: Comply with ASME B16.5.
d. Dielectric Fittings: Isolated type when used to join copper alloy and ferrous metals.
e. Dielectric Unions: Custom factory-made for pressures above 250 psig.
4. Ball Valves:
a. Type: Full port.
b. Material: 316 stainless steel.
c. Connection:
1) 2.5 inches and lower: Threaded type.
2) 3 inches and above: Flanged type.
d. Accessories: Lockable tag ball valve for branch drops.
5. Check Valves:
a. Type: Full port with elastomeric hinge.
b. Material: 316 stainless steel.
c. Connection:
1) 2.5 inches and lower: Threaded type.
2) 3 inches and above: Flanged type.
d. Accessories: Lockable-tag ball valve for branch drops.
6. Elbows: Long of the L type.
7. Wyes: 45 degree type. Use to branch out from headers.
8. Tees: Standard 90 degree tees are acceptable only when installed facing up for aluminum pipe installations with specialty fittings or for branch drops.
9. Hangers, Supports and Clamps: Standard wall and/or pipe rack mount in accordance with Section 220529.

2.03 COMPRESSED AIR DELIVERY

A. Point of Use: Provide a hanger-fastened or wall-fastened flow isolation lockable tag ball valve.

B. Plumbing Loads Tie-in's: See Section 221500 and drawings.

C. Pressure Reducing Stations: Filter, pressure regulator, lubricator, and lockable tag ball valve. assembly with a pressure drop under three psig or better.

2.04 COMPRESSED AIR SYSTEM ACCESSORIES

A. Pressure Gauges: Brass, select working pressure to be at mid-span of gauge. Comply with Section 220519 requirements.

PART 3 EXECUTION

3.01 INSTALLATION

A. Pipe Size: Select sizes to maintain a uniform air velocity of 20 fps to minimize point to point pressure drops per recommendations of CAGI guidelines.

B. Furnish and install listed products and appurtenances in compliance with Section 221500 and Section 220548 requirements.

C. Fittings:

1. Eccentric Reducers: Use where piping reductions are to match airflow direction.
2. Flexible Fittings: Use to decouple air compressors and other vibrating equipment and upstream of pipe segments exposed to ambient conditions.
3. Pressure Rating: Fittings such as nipples, flanges, unions, transitions, end caps, and other types are to be provided with the same or higher pressure rating than system.

D. Branch Connections: From the top of the header line.

E. Mechanical Areas: Run pipe exposed and conceal from view in other areas. Observe and follow service clearances required for adjacent equipment.

F. Supports: Rigidly support valves and other connected equipment to prevent piping/tubing strain.

G. Branches: Provide a valve per branch to ease the downstream segment servicing.

H. Drain Traps:
1. Install at the end of each main branch and at every low point along the piping system.
2. Pipe trap to the nearest floor drain without interfering with walkways or service clearance of adjacent equipment.
3. Install air and drain piping with a two percent slope downward in the direction of the flow.

I. Pipe and Tubing Modifications:
1. Cut square and accurately with a tube cutter (sawing is not permitted) to field-determined measurements.
2. Ream to remove burrs while ensuring that material is free of leftover materials such as chips, oil, and/or grease.
3. Fit pieces without springing or forcing them into place avoiding any potential gaps that can compromise system integrity.
4. Avoid leaving excess flux inside completed joints. Thoroughly wash the outside of each joint with clean hot water after assembly to remove oxide coating.

J. Clean internal distribution and delivery components prior to starting the system.

3.02 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Valve Test: Operate all types including compressor discharge, solenoid, isolation, check, pressure regulating, and pressure relief.

C. Pressure Decay Test:
1. Operate system to maintain setpoint for a minimum of two consecutive hours.
2. Record noted pressures at the system supply air location and its farthest delivery station.
3. Repeat these readings every morning and evening for the next three (3) consecutive days.
4. Test will pass and system can be turned over only when all recorded readings are lower than 5 percent from setpoint as the acceptable discrepancy.

END OF SECTION 253526

SECTION 260500
COMMON WORK RESULTS FOR ELECTRICAL

PART 1 GENERAL

1.01 SCOPE OF WORK

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

B. The work included under Division 26 shall consist of furnishing labor and materials necessary for the complete installation of electrical systems shown on the Contract Drawings and Specifications. Work shall be complete and in operating condition at the completion of Contract.

C. Include minor items which are obviously and reasonable necessary to complete the installation and usually included in similar work even though not specifically mentioned in the Contract Documents.

D. Deviations due to particular manufacturer's requirements shall be provided at no additional cost to the Owner.

E. Where material quantities are shown, they are for the convenience of the Contractor only. The Contractor shall be responsible to verify quantities.

F. Coordinate with the Mechanical Contractor and Other Contractors for coordination drawings for all disciplines. Coordination drawings shall include plan view and elevations.

G. Coordinate with Mechanical Contractor and Other Contractors as to low voltage systems to be removed and/or replaced with project phasing.

H. The model numbers and series of the equipment (where mentioned) are current at the time the contract documents were prepared. Some of the model numbers or series/lines may be end-of-life or obsolete at the time submittals are created or when equipment is ordered for installation. Verify model numbers and software/firmware prior to ordering the equipment to review the status of the models. Provide current model equipment and software providing equivalent or better performance and features at no additional cost to the Owner.

1.02 RELATED WORK

A. Divisions 00 and 01 apply to all work of Division 26 and are an integral part of this Section. Where the conditions specified are at variance with other Divisions, this Section takes precedence. This Section specifies conditions, procedures, equipment and material particular to the electrical work and applies to all electrical work of the Contract Documents.

B. Division 00 and 01 and this Section and all Addenda form a part of and apply to all contracts or sub-contracts relating to Division 26 work. Copy these documents to all Sub-contractors receiving other Sections of Division 26.

C. Where a Specification Section refers to other sections under the Article of Related Work, this is done for Contractor's convenience only. It shall not relieve the Contractor of responsibilities stated in other Sections of the Specifications. The Contractor is responsible for information contained in this division's Specifications as well as for electrical requirements and information contained in other divisions.

1.03 PERMITS, LICENSES, AND FEES

A. Provide temporary permits, permanent permits and licenses required for the completion of the work included under this contract. Fees and expenses required to obtain such permits shall be paid for by the electrical contractor.

B. Provide inspections as requested by each contractor and as required by regulating agencies or where required by code. Include and pay charges for inspection agencies and provide the Owner with a certificate of final inspection and approval by authority having jurisdiction.

C. Refer to General Conditions for state and local sales tax requirements. Provide records of these taxes to the Owner upon request.

1.04 REFERENCES

A. Material and workmanship to comply with applicable codes. As a minimum include State and Federal laws, local ordinances, Utility Company regulations and requirements and interpretations of the following by the local authority having jurisdiction:
   1. State and Local Building Codes.
   2. State and Local Fire Codes.
   3. National Electrical Code.
   4. State and Local Electrical Codes.
   5. OSHA Regulations.
   6. State Elevator Code.
   7. State and Local Energy Codes.
   8. State and Local Accessibility Codes.
   9. State Department/Board of Health Requirements.
   10. State and Local Fire Marshal Requirements.

B. Comply with all of the following codes and standards as a minimum:
   1. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
   2. NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems; 2021.
   3. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

C. If drawings and specifications are in conflict with these codes, notify the Engineer prior to rough-in.

D. Where requirements of the drawings and specifications exceed or are greater than codes, laws, regulations, and standards, the requirements of the drawings and specifications shall be followed.

E. The following is list of organizations and their abbreviations where referred to in the specifications as standards of construction.
   1. ADA – Americans with Disabilities Act
   2. ANSI - American National Standards Institute
   3. ASHRAE – American Society of Heating, Refrigeration and Air Conditioning Engineers
   4. ASIS International - American Society for Industrial Security
   5. ASTM – American Society for Testing and Materials
   6. BICSI - Building Industry Consulting Service International
   7. DHS - Department of Homeland Security
   8. FM – Factory Mutual
   9. IEC - International Electrotechnical Commission
   10. IEEE – Institute of Electrical and Electronic Engineers
   11. ISO - International Organization for Standardization
   12. NEC – National Electrical Code (NFPA 70)
   13. NECA - National Electrical Contractors Association
   14. NEMA – National Electrical Manufacturers Association
   15. NESC - National Electrical Safety Code
   16. NFPA – National Fire Protection Agency
   17. NIST – National Institute of Standards and Technology

18. OSHA – Occupational Safety and Health Administration
19. TIA - Telecommunications Industry Association
20. UFAS - Uniform Federal Accessibility Standards
21. UL – Underwriters' Laboratories, Inc.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Prior to Work: Pre-construction submittals shall be provided to Consultant with appropriate promptness as to cause no delay to the work.

B. Project Timeline: Project timeline will not be altered due to lateness of submittals. Contractor will remain bound to deliver a timely, complete, and finished project as stipulated in their contract and specified herein.

C. Failure to Provide: The failure of Contractor to provide pre-construction submittals or meetings as required herein may result in the withholding of payment for work and/or the cancellation of the contract.

D. Coordination:
1. Coordinate the work with other trades to avoid placement of other utilities or obstructions within the spaces dedicated for communications devices.
2. Coordinate arrangement of communications devices with the dimensions and clearance requirements of the actual equipment to be installed.
3. Notify Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.06 DEFINITIONS

A. The terms listed below are defined as follows:
1. Furnish: Obtain, coordinate, deliver to the job site and guarantee.
2. Supply: Same as Furnish.
3. Install: Furnished by others, receive on site, unload, store, set in place, connect, place in operation and guarantee workmanship of installation.
4. Provide: Furnish and install.
5. Connect: Bring service to the equipment and make final attachments, including necessary disconnect switches, control switches, outlets, etc.
6. Conduit: In addition to conduit includes fittings, hangers, pullboxes, supports, etc. as required for a complete and proper installation.
7. Concealed: Hidden from sight in walls, ceilings or floors.
8. Exposed: Surface mounted, not hidden from sight.
9. Building Structure: Columns, beams, joists, walls. Metal decking, joist bridging shall not be used for supporting electrical equipment.
10. As Required: As needed to provide a complete and satisfactorily operating system complying with all governing codes and the intent of the project contract documents.
11. Approved Equal: The manufacturer names mentioned are to set a standard, and another manufacturer, model brand name may be used if fully equal or superior in all aspects at the opinion of the engineer. Contractor shall obtain approval from Engineer for substitute manufacturer. Refer to Division 01 for Product Substitution forms and required procedures. Submit completed product substitution form(s) with any proposed alternate manufacturers.
12. Prior Approved Equal: Approved Equal that Contractor shall obtain approval (issued via addendum) prior to bid. Submit to architect & engineer with all required forms a minimum of 8 business days prior to bid date.
13. Relocate: Existing equipment to be relocated to new location and existing conduit and branch circuiting (conductors) to be extended to new location and reconnected. Install completely in new location.

1.07 DRAWINGS & SPECIFICATIONS

A. Furnish all labor, equipment and material for the complete installation of the 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 conduits, pathways, etc. have not been shown but 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 conduits, cable tray, outlets, and equipment shall be coordinated and installed to avoid interference with all other trades.
   1. Field changes necessary or as a result of varying construction conditions shall have the written acceptance of the 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. 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.

G. 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.

H. The 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 higher cost 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.

1.08 SUBMITTALS

A. Substitutions shall be submitted through a bidding contractor and submitted to engineer 10 working days prior to bid opening. Include detailed information concerning substitution. Acceptable substitutions will be issued in an Addendum to the Contract Documents prior to the

bid date. Extra costs incurred as a result of substitution, including those of other contractors are the responsibility of the submitting contractor, including engineering redesign costs.

B. Submittals shall be done in accordance with the General Conditions and as listed under Division 01.
   1. Submit copies for each item as required per individual sections of the specifications.
   2. Submit each specific section number separately and all submittals listed as "Before Installation" together in a single submittal. (i.e. 260533.13 - Conduit for Electrical Systems).
   3. Submit all submittals electronically with the exception of Samples and the final O&M manuals/record drawings.
      a. Format
         1) PDF Creation: All Submittals shall be combined to one single, text-searchable PDF file.OCR pages if not text-searchable.
            (a) 300 DPI Color minimum
         2) Bookmarking: Bookmarking of PDF shall be extensive.
      b. The Contractor will review, stamp, and send to the Engineer for review with at least 1/2 of 8.5x11 inch page available for Engineer stamp and comments. The Engineer will retain reviewed copies for their files and forward copy to the Architect, Owner and to the Contractor.

C. Submittals for each portion of the Work shall be complete and accurate. Incomplete or partial submittals will be rejected and will require resubmittal.
   1. Submittals may be made of portions of the Work, but each Submittal shall be complete in respect to the information necessary for proper review by Engineer.
   2. All Submittals for each specification section shall be combined (unless noted otherwise) to ensure "design intent" of the system assembly.
   3. Show dimensions and clearances required for each piece of equipment.
   4. Clearly mark each copy to identify pertinent products or models being proposed.
   5. Cross out non-related material to submittal. Any accessories or optional items that are not crossed out will be assumed to be included.

D. Some submittals shall be submitted before installation and some shall be after installation. Most shall be before installation but some examples of items to be included in submittals after construction include (but are not limited to):
   1. Field Test Reports
   2. Installation Instructions
   3. O&M Manuals
   4. Record Drawings

E. Submit Record Drawings in accordance with the General Conditions and as listed under Division 00 and 01. Electrical contractor shall maintain on job site an entire set of complete up to date record drawings throughout construction (full size set of construction documents with changes). Electrical contractor shall include, but not limited to, the following: Addenda, Proposal Requests, Architectural Supplemental Instructions, Requests for Information, Field Modifications, Owner Changes, contractor initiated changes, etc. and branch circuiting, home runs, junction boxes, pull boxes, etc., relocated devices, etc. and remote power supplies, control boxes, and controls. One-line and riser diagrams shall reflect field changes.

F. Submit Operating, Maintenance and Warranty Data Manuals in accordance with the General Conditions and as listed in Division 00 and 01.

G. Resubmittals
   1. Required Revisions: Make corrections or changes in submittals required by EGE Engineers and resubmit when Engineer's stamp requires resubmittal.
      a. Clearly identify changes made other than those requested by EGE Engineers by "clouding" or other suitable means acceptable to Engineer for noting changes. Only

changes that are "clouded" and changes requested by EGE Engineers will be reviewed on a resubmittal. EGE Engineers is not responsible for reviewing resubmittals that are not "clouded" on resubmittal.

2. If the Engineer rejects (Revise & Resubmit, Submit Specified Item, or Rejected) two (2) times for the same section the Engineer will be compensated for any additional reviews. Compensation will be incorporated by Change Order and deducted from the Contractor's application for payment.
3. Contractor is responsible for delays caused by the resubmittal process.

1.09 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Initiate, maintain and supervise all safety precautions required with this work in accordance with the regulations of the Occupational Safety and Health Administration (OSHA) and other governing agencies.
   2. The Contractor, after completion of the work, shall furnish the Owner a Certificate of final inspection and approval from the inspection bureaus having jurisdiction.

B. Environmental Requirements:
   1. Do not remove or disturb any asbestos containing materials from the project. Immediately stop work and notify the Owner if asbestos containing materials are suspected.
   2. Dispose of any PCB containing materials as per local and national requirements.
   3. Separate, store and dispose of regulated waste according to local, state and federal regulations.

C. Provide new, first quality material for all products specified. Do not reuse materials unless indicated or approved by the Engineer.

D. Comply with the NEC as applicable to the construction and installation of equipment specified in this section.

E. Provide equipment specified throughout divisions 26, 27, and 28 that has been listed and labeled by a nationally recognized testing laboratory.

F. Comply with ANSI as applicable to equipment specified in this section.

G. Comply with NEMA as applicable to equipment specified in this section.

1.10 PROJECT/SITE CONDITIONS

A. Inspection of Site:
   1. Before submitting a proposal on the Work, the Contractor and Subcontractors shall examine the site of the proposed work and thoroughly familiarize themselves with existing conditions and limitations affecting the performance of their Work. No extra compensation will be allowed because of a misunderstanding as to the amount of Work involved or lack of knowledge of existing conditions which could have been discovered or reasonable anticipated prior to bidding.
   2. Conduits, pipes, ducts, lights, devices, speakers, etc., shown on the drawings as existing have been based on existing plans and casual site observations, and may not be installed as originally shown. It is the Contractor's responsibility to visit the site and make exact determination of the existence, location and condition of such facilities prior to submitting a bid.

B. Correlation of Work:
   1. Consult the drawings and specifications of all other Divisions for correlating information and lay out work so that it will coordinate with other trades. Verify dimensions and conditions (i.e., finished ceiling heights, footing and foundation elevations, beam depths, etc.) with the Architectural and Structural drawings. Notify the Engineer of any conflicts that cannot be resolved, in the field, by affected trades. Replacement of work due to lack

of coordination and failure to verify existing conditions will be completed at no cost to the Owner.

2. Install all conduit, cable tray, busduct, equipment, etc. allowing proper code and maintenance clearances and to avoid blocking passageways and access panels.
3. Where work must be replaced due to the failure of the Contractor to verify the conditions existing on the job, such replacement must be accomplished at no cost to the Owner. This applies to shop fabricated work as well as to work fabricated in place.
4. Throughout the course of the work, minor changes and adjustments to the installation may be requested by the Engineer. The Contractor shall make adjustments without additional cost to the Owner, where such adjustments are necessary to the proper installation and operation within the intent of the Contract Documents. This does not include work already completed.
5. Equipment outlines shown on detail plans of 1/4"=1'-0" scale or larger and/or dimensions indicated on the plans are limiting dimensions. Do not install any equipment that exceeds the equipment outlines shown or reduces indicated clearances.
6. Obtain exact location of connection to equipment, furnished by others, from the vendor/contractor furnishing the equipment.
7. Drawings and specifications are complementary and what is called for in either on is as binding as if called for in both.
8. Include the better quality, greater quantity, and higher cost for an item or arrangement where a disagreement exists in the drawings and specifications.

1.11 TEMPORARY ELECTRICAL SERVICE

A. Provide and maintain a complete temporary electrical power service for the use of all trades during construction.
   1. Refer to general Conditions for responsibilities for energy costs charges.
   2. Special service requirements such as large heating loads, welders, three-phase equipment, etc., shall be paid for by the contractor requiring such service.

B. Provide and maintain a complete temporary lighting service for use by all trades during construction.
   1. Provide adequate lighting suitable for conditions for high quality workmanship and for safety throughout the area of construction. Provide minimum requirements of one (1) 200 watt luminaire per each 400 square feet or per room, whichever is smaller.
   2. Provide LED strip lighting as required in areas traversed or occupied by building occupants.
   3. Provide and maintain an exit and egress safety lighting system where required by code or OSHA.

1.12 WARRANTY

A. Provide guarantee of workmanship and materials for the period of one (1) year after final completion of the work as evidenced by issuance of the final certificate by the Engineer.

B. Correct defects at contractors expense those defects due to faulty workmanship or materials that arise during the warranty period and make corrections to the satisfaction of the Owner and Engineer. Reconstruction and repairs shall include damages to the finish or the building resulting from the original defect.

C. Guarantee shall cover shipping and handling any required components to the site and correcting defects (materials and labor).

D. Guarantee does not apply to injuries occurring after final acceptance and due to wind, fire, violence, abuse or carelessness or other Contractors or their employees or the agents of the Owner.

E. This guarantee shall be longer where other guarantees for longer lengths of time are noted otherwise.

F. Any complaints received by the 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.
   1. Upon the receipt of complaint from the Engineer or Owner, the Contractor shall investigate complaint immediately, and complete the necessary work within seventy-two (72) hours, or as directed in writing by the Engineer.
   2. 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.

G. Warranty related repairs or replacement shall be completed within 14 days of notice by the Engineer. Schedule and perform repairs immediately if delay interferes with Owner occupancy or will result in damage to the Owner facility.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 ROUGH-IN

A. Verify locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Consult the Contract Drawings and Specifications of other Divisions and other trades for correlating information and layout work so that it will not interfere with other trades. Verify dimensions and conditions; i.e., finished ceiling heights, wall elevations, sections, footing and foundation elevations, beam depths, ductwork and piping, etc. with architectural, mechanical and structural drawings. If conflicts occur such that resolution is not possible by the affected trades on the job, notify the Engineer so a resolution can be worked out. Where work must be replaced due to failure to verify conditions existing on the job, such replacement shall be accomplished at no extra cost to the Owner. This shall apply to shop fabricated Work as well as work fabricated in place.

3.02 INSTALLATION

A. Arrange for chases, slots, and openings in other building components during progress of construction to allow for electrical installation.

B. Install material and equipment in accordance with manufacturers' recommendations, instructions, and current NECA and UL standards.

C. Install equipment and materials to provide required access for servicing and maintenance. Coordinate equipment location with required access panels and doors. Allow ample space for removal of parts that require replacement or servicing.

D. Coordinate the installation of required supporting devices and sleeves with structural components.

E. Coordinate with other trades before installing equipment so that conflicts will be adjusted before installation. In general large mechanical equipment shall be given priority. Maintain, wherever practical, a minimum separation of 3" from water and waste piping and 12" from hot water and steam piping.

F. Electrical equipment, outlet boxes, conduits, etc shall not be attached or otherwise fastened to ductwork or other mechanical equipment unless noted otherwise.

G. Cutting and patching shall be performed in accordance with the provisions of the General Conditions.

H. Install systems, materials and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed in finished areas unless noted otherwise.

I. Coordinate to install all floor mounted equipment on a 4” minimum concrete pad. Pads shall be 2 inches larger than the footprint of the equipment. Concrete shall be sealed prior to installation of equipment on pad.

3.03 PROTECTION

A. Contractor shall be responsible for damage of electrical equipment or materials and shall keep clean materials installed by Contractor until final acceptance of the entire building by the Owner. Contractor shall touch-up equipment with chips or scratch marks.

B. When a portion of the building is to be occupied by the Owner prior to Substantial Completion of the entire Project, arrangements will be made to transfer responsibility for protection and housekeeping tasks from the Contractor to the Owner.

C. There shall be no interruptions of building systems during occupied times without prior arrangement.

D. Cover openings and equipment, where set, to prevent obstruction to conduits, breakage, misuse, or disfigurement of equipment. Cover openings in equipment immediately upon uncrating or receipt at the job site and keep covered until permanent connection is made.

3.04 FIRESTOPPING AND SEALANT

A. Refer to Division 07.

B. Provide firestopping around all penetrations, sleeves and openings through all partitions, walls and floors.

C. Provide sealant around electrical conduits penetrating exterior walls, sound rated partitions, or vapor-tight assemblies. Coordinate with requirements in Division 07.

D. Provide National Recognized Testing Laboratory (UL, ETL, Intertek, or other) listed components installed by certified and factory trained personnel.

3.05 CLEANING

A. Keep the premises free from accumulations of waste materials or rubbish caused by execution of the work. At the completion of the work, remove rubbish, tools, scaffolding and surplus materials from and about the premises. The premises shall be broom-cleaned or its equivalent, unless more exactly specified. In case of dispute, the Owner may remove the rubbish and charge the cost to the Contractor as the Engineer shall determine to be just.

B. After tests have been made and accepted clean luminaires, panels and other equipment installed by the Contractor, leaving the entire work area in a clean and complete working order.

3.06 PAINTING

A. Refinish equipment damaged during shipping or installation to its original condition. Remove rust, prime and paint per manufacturer’s recommendations for finish equal to original. Do not paint nameplates, labels, tags, stainless steel or items such as shafts, levels, handles, trim or terminal strips.

3.07 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.

END OF SECTION 260500

SECTION 260505
DEMOLITION FOR ELECTRICAL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electrical demolition.

B. Disposal of materials.

C. Storage of removed materials.

D. Protection of items to remain as indicated on drawings.

E. Relocate existing equipment to accommodate construction.

F. Include minor items, which are obviously and reasonably necessary to complete the installation and usually included in similar work even though not specifically mentioned in the Contract Documents.

1.02 RELATED REQUIREMENTS

A. Division 01: Additional requirements for alterations work.

B. Division 02: Removal of equipment and materials containing substances regulated under the Federal Toxic Substances Control Act (TSCA), including but not limited to those containing PCBs and mercury.

1.03 DEFINITIONS

A. Demolish: Perform all of the requirements of this specification and drawings in regard to demolition including but not limited to:
   1. Disconnecting circuit(s) as required.
   2. Maintaining existing to remain systems.
   3. Protection of items to remain.
   4. Circuit detection.
   5. Removing conduit, cabling, wiring, supports, junction boxes, etc... back to the source.
   6. Patching and painting.
   7. Covering and sealing openings.
   8. Salvaging items designated by the Owner.
   9. Cleaning and repair.
   10. Preserving integrity of fire, smoke, water, and acoustic ratings.
   11. Updating panel directories.
   12. Programming to remove devices from monitoring and operation (fire alarm, lighting controls, etc....).
   13. Replacement of items that were not supposed to be demolished or that were damaged.
   14. Storage of materials.
   15. Transport and disposal of items.

B. Remove: Same as Demolish.

1.04 SCHEDULING

A. Schedule work to coincide with new construction.

B. Perform noisy, malodorous, or dusty work.
   1. Coordinate with General Contractor and Owner.

C. Cease operations immediately when structure appears to be in danger and notify General Contractor and Owner. Do not resume operations until directed.

1.05 COORDINATION

A. Section Specifying - Administrative Requirements: Requirements for coordination.

B. Conduct demolition to minimize interference with adjacent and occupied building areas.

C. Coordinate demolition work with Other Contractors and Owner.

D. Coordinate and sequence demolition so as not to cause shutdown of operation of adjacent areas.

E. Shut-down Periods:
   1. Arrange timing of shutdown periods of in service panels with Owner. Do not shutdown any utility without prior written approval submitted 14 days prior to shutdown.
   2. Keep shutdown period to a minimum of four hours or use intermittent period as directed by Owner.
   3. Maintain life safety systems in full operation in occupied facilities or provide written notice a minimum of seven days in advance of outage.

F. Identify salvage items in cooperation with Owner.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Materials and equipment for patching and extending work: As specified in other sections.

B. Perform testing using test equipment specifically designed to safely test live circuits.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify any field measurements and circuiting arrangements shown on Drawings. Demolition drawings are based on casual field observations and existing record documents. Report discrepancies to Engineer before disturbing existing installation.

B. Consider minor circuit modifications and rerouting as included in the scope of this project. Major concealed conditions in which the contractor could not anticipate the effort level required shall be brought promptly to the engineer's attention. If the contractor will request a change in the contract amount or contract time due to condition, then the contractor shall submit digital photographs of the existing conditions with a proposed resolution. Failure to do so implies the contractor has assumed the work effort to be included in their bid. Engineer will promptly review information and make recommendations to the owner in an attempt to maintain construction schedule.

C. Verify that abandoned wiring and equipment serve only abandoned facilities.

D. Demolition drawings are based on casual field observation and existing record documents.

E. Report discrepancies to Engineer before disturbing existing installation.

F. Beginning of demolition means installer accepts existing conditions.

3.02 PREPARATION

A. Disconnect electrical systems in walls, floors, and ceilings to be removed.

B. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.

C. Erect and maintain temporary safeguards, including warning signs and lights, barricades, and similar measures, for protection of the public, Owner, Contractors' employees, and existing improvements to remain.

D. Provide temporary egress signage and emergency lighting.

E. Existing Electrical Service: Maintain existing system in service. Disable system only to make switchovers and connections. Minimize outage duration.

1. Obtain permission from Owner at least 48 hours before partially or completely disabling system.
2. Make temporary connections to maintain service in areas adjacent to work area.

3.03 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

A. Perform work for removal and disposal of equipment and materials containing toxic substances regulated under the Federal Toxic Substances Control Act (TSCA) in accordance with applicable federal, state, and local regulations. Applicable equipment and materials include, but are not limited to:
   1. PCB-containing electrical equipment, including transformers, capacitors, and switches.
   2. PCB- and DEHP-containing lighting ballasts.
   3. Mercury-containing lamps and tubes, including fluorescent lamps, high intensity discharge (HID), arc lamps, ultra-violet, high pressure sodium, mercury vapor, ignitron tubes, neon, and incandescent.
   4. Batteries.
   5. Detectors/sensors with radioactive materials (ionization-type).

B. Disconnect or shutoff service to areas where electrical work is to be removed.

C. Remove, relocate, and extend existing installations (including conduit, wiring, boxes, and fastening devices) to accommodate new construction.

D. Remove abandoned wiring to source of supply.

E. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.

F. Remove exposed abandoned grounding and bonding components, fasteners and supports, and electrical identification components, including abandoned components above accessible ceiling finish. Cut embedded support elements flush with walls and floors. Patch all surfaces.

G. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
   1. Equipment (VFDs, disconnects, motors, starters, panelboards, etc...) - Demolish conduit and wiring back to the switchboard or panelboard serving the device unless noted otherwise.

H. Repair adjacent construction and finishes damaged during demolition and extension work.
   1. Patch, paint, and restore finishes of walls, ceilings, floors damaged during construction.

I. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.

J. Where concealed conduits are uncovered within existing construction, reroute as required.

K. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

L. Existing work altered during the course of remodeling shall be placed in safe operating condition and shall remain in service, unless otherwise noted.

M. Existing conductors that have been removed shall not be reinstalled.

N. Wherever devices or equipment are removed from boxes remaining in walls or ceilings, provide blank plates as required.

O. Reconnect equipment being disturbed by renovation work and required for continued service to temporary panel or nearest available panel.

P. Remove electrical luminaires, equipment, and related switches, outlets, conduit and wiring back to source which are not part of the final project.

Q. Install temporary wiring and connections to maintain existing systems in service during construction.

R. In the event work is to be performed on energized equipment or circuits, it shall be performed by experienced and trained personnel.

S. Repair adjacent construction and finishes damaged during demolition and extension work.

T. Protect and retain power to existing active equipment remaining.

U. Cap empty conduit to remain at both ends.

V. 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. This shall include items scheduled or noted as being reused, salvaged, or demolished. Those materials and equipment not claimed by the Owner shall be removed from the site and shall be disposed of properly.
   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 Other Contractors.
   4. Review and coordinate work with all other contractors.

W. It shall be each subcontractor's sole responsibility for proper demolition of existing electrical systems including but not limited to the following. Under no circumstances shall improper demolition or cut cabling or damaged devices be the responsibility of the Owner. Any cabling or devices damaged that are outside the area of demolition or serving areas outside the area of demolition shall be replaced with new cabling/devices (not spliced, reinstalled, or relocated). Any cabling or devices demolished that are outside the area of demolition shall be replaced with new cabling/devices (not spliced, reinstalled, or relocated). Systems include but are not limited to the following:
   1. Electrical lighting & power systems - Electrical contractor

X. Contractor shall furnish all labor and materials needed to preserve the fire, smoke, and water containment ratings and integrity of floors, walls, ceilings, and partitions. In existing walls being changed in fire rating, provide firestopping to existing cabling, conduit, and other items in order to provide fire rating as per the code plans.

Y. Identify and provide new supporting means for existing electrical equipment such as low voltage cabling, conduits, boxes, pullboxes, conduit bodies, and conduit racks that will need additional support due to the demolition of the existing supports, including ceilings or ceiling supports.

Z. Maintain electrical service system throughout construction in service until new service is complete and ready for service. Disable system only to make switchovers and connections. Notify and obtain permission from Owner and Engineer at least 24 hours before partially or fully disabling the system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.

AA. If the building is occupied during construction, the Contractor shall schedule work and carry it out in such a manner as to least inconvenience the occupants due to interruptions of systems (power, lighting, fire alarm, security, phone/data, technology, etc…). Interruptions shall be confined to the smallest possible area at any one time and all interruptions shall be approved by the Owner and coordinated with all the trades. The normal use of the facility shall not be disturbed, except within the immediate construction area phased as decided between the Owner and Engineer. Walks, driveways, and entrances shall be kept clear and free of Contractor's equipment, materials, and debris. All materials and equipment shall be stored in such a place and such a manner that a minimum of congestion will result. The placing of such materials and equipment shall be subject to the approval of the Owner.

BB. Do not reuse materials (conduit, cabling, wiring, devices, supports, equipment, etc...) unless specifically indicated or approved by the Engineer. All conduit, pathways, and wiring shall be new unless specifically indicated as "existing to remain" or "existing to be reused".

CC. No portion of demolished electrical circuits, cabling, wiring, conduit, or equipment may be abandoned in place.

3.04 EXISTING PANELBOARDS/SWITCHBOARDS

A. Ring/trace out circuits in existing panelboards & switchboards affected by the work. Determine which panel and circuit breaker feeds each load/outlet in existing panelboards that have additional or demolished circuits/loads to the panelboard/switchboard.
   1. Where additional circuits are needed and existing circuit breakers are available, reuse spare circuit breakers.
   2. Where additional circuits are needed and existing circuit breakers are not available, provide new circuit breakers within prepared spaces (extend bus if required). Adjust existing circuit breaker arrangement if needed to combine spaces for two or three pole circuit breakers. Contractor shall provide circuit breakers or fused switches of the same manufacturer, AIC rating, and same type as existing.
   3. Provide new typed panelboard directory inside panelboard door.
   4. It is not the intent of this section to identify the actual routing of the building wiring or conduit, unless it is necessary to do so in order to identify the circuits.
   5. Provide a new switchboard/panelboard directory (and retain the old one) indicating all room numbers and type of branch circuit (example: “Receptacles Rms 2014, 2015, 2016”).
   6. Provide circuit number labels if they are absent from the existing switchboard/panelboard.

B. Tag unused circuits as spares.

C. Where existing circuits are indicated to be reused, use sensing measuring devices to verify circuits feeding project area or not in use.

D. Remove existing wire no longer in use from panel to equipment.

E. Provide new updated panelboard directories where any circuits have been modified or rewired.

3.05 SALVAGE ITEMS

A. Remove and protect items indicated on drawings and/or in Schedule to be salvaged and turnover to Owner. Obtain receipt from Owner as to quantity and type of items salvaged and given to Owner.

B. Items of salvageable value may be removed as work progresses. Transport salvaged items from site as they are removed to location designated by Owner.

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

D. Owner shall have the opportunity to access and perform the salvage work prior to the contractor’s demolition or during demolition work.

E. Those materials and equipment not claimed by the Owner shall be removed from the site and shall be disposed of properly.

3.06 REUSABLE ELECTRICAL EQUIPMENT

A. Carefully remove equipment, materials, or luminaires which are to be used.

B. Disconnect, remove, or relocate existing electrical material and equipment interfering with new installation.

C. Those materials and equipment not claimed by the Owner shall be removed from the site and shall be disposed of properly.

3.07 CLEANING AND REPAIR

A. See Division 01 for additional construction waste management and disposal requirements.

B. Clean and repair existing materials and equipment that remain or that are to be reused.

C. Clean and repair existing equipment to be reinstalled.

D. Clean and repair existing equipment that is affected by demolition.

E. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.

END OF SECTION 260505

SECTION 260519
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Single conductor building wire.

B. Wiring Accessories
   1. Wiring connectors.
   2. Electrical tape.
   3. Heat shrink tubing.
   4. Wire pulling lubricant.
   5. Cable ties.

1.02 RELATED REQUIREMENTS

A. Section 260505 - Demolition for Electrical: Disconnection, removal, and/or extension of existing electrical conductors and cables.

B. Section 260526 - Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.

C. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

D. Section 260573 - Power System Studies: Wire sizing increases due to selective coordination.

1.03 REFERENCE STANDARDS

A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire; 2013 (Reapproved 2018).

B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft; 2023.

C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010, with Editorial Revision (2020).

D. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation; 2004 (Reapproved 2020).

E. ASTM D3005 - Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape; 2017.

F. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

G. NEMA WC 70 - Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy; 2021.

H. NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems; 2021.

I. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

J. TIA-568 (SET) - Commercial Building Telecommunications Cabling Standard Set; 2023.

K. UL 2225 - Standard for Cables and Cable-Fittings For Use In Hazardous (Classified) Locations; 2013.

L. UL 44 - Thermoset-Insulated Wires and Cables; Current Edition, Including All Revisions.

M. UL 83 - Thermoplastic-Insulated Wires and Cables; Current Edition, Including All Revisions.

N. UL 267 - Outline of Investigation for Wire-Pulling Compounds; Current Edition, Including All Revisions.

O. UL 444 - Communications Cables; Current Edition, Including All Revisions.

P. UL 486A-486B - Wire Connectors; Current Edition, Including All Revisions.

Q. UL 486C - Splicing Wire Connectors; Current Edition, Including All Revisions.

R. UL 486D - Sealed Wire Connector Systems; Current Edition, Including All Revisions.

S. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape; Current Edition, Including All Revisions.

T. UL 1863 - Communications-Circuit Accessories; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop and other derating.
   2. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.

1.05 SUBMITTALS

A. After Installation:
   1. Field Quality Control Test Reports.
   2. Project Record Documents: Record actual installed circuiting arrangements. Record actual routing.

1.06 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

1.08 FIELD CONDITIONS

A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F, unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Engineer and obtain direction before proceeding with work.

PART 2 PRODUCTS

2.01 CONDUCTOR AND CABLE APPLICATIONS

A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.

B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, or required.

C. Nonmetallic-sheathed cable is not permitted.

D. Direct-Buried Underground feeder and branch-circuit cable is not permitted.

E. Service entrance cable is not permitted.

F. Armored cable is not permitted.

G. Metal-clad cable is not permitted.

H. Manufactured wiring systems are not permitted.

2.02 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

A. Provide products listed, classified, and labeled as suitable for the purpose intended.

B. Provide conductors and cables with lead content less than 300 parts per million.

C. Provide new conductors and cables manufactured not more than one year prior to installation.

D. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.

E. Comply with NEMA WC 70.

F. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.

G. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.

H. Conductors for Grounding and Bonding: Also comply with Section 260526.

I. Conductors and Cables Installed Where Exposed to Direct Rays of Sun: Listed and labeled as sunlight resistant.

J. Conductor Material:
   1. Provide copper conductors only. Aluminum conductors are not acceptable for this project. Conductor sizes indicated are based on copper.
   2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.
   3. Tinned Copper Conductors: Comply with ASTM B33.

K. Minimum Conductor Size:
   1. Branch Circuits: 12 AWG.
      a. Exceptions:
         1) 20 A, 120 V circuits longer than 75 feet: 10 AWG, for voltage drop.
         2) 20 A, 120 V circuits longer than 150 feet: 8 AWG, for voltage drop.

L. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

M. Conductor Color Coding:
   1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
   2. Color Coding Method: Integrally colored insulation.
      a. Conductors of all sizes shall be integral continuous color coded conductors.
   3. Color Code:
      a. 480Y/277 V, 3 Phase, 4 Wire System:
         1) Phase A: Brown.
         2) Phase B: Orange.
         3) Phase C: Yellow.
         4) Neutral/Grounded: Gray.
      b. 208Y/120 V, 3 Phase, 4 Wire System:
         1) Phase A: Black.
         2) Phase B: Red.
         3) Phase C: Blue.
         4) Neutral/Grounded: White.
      c. Equipment Ground, All Systems: Green.
      d. For control circuits, comply with manufacturer's recommended color code.

2.03 SINGLE CONDUCTOR BUILDING WIRE

A. Manufacturers:
   1. Copper Building Wire:
      a. Alan Wire Company: www.alanwire.com
      b. Cerro Wire LLC: www.cerrowire.com
      c. Encore Wire Corporation: www.encorewire.com
      d. General Cable Corporation: www.generalcable.com
      e. Service Wire Co: www.servicewire.com
      f. Southwire Company: www.southwire.com
      g. Substitutions: See 260500 - Common Work Results for Electrical.

B. Description: Single conductor insulated wire.

C. Conductor Stranding:
   1. Feeders and Branch Circuits:
      a. Size 10 AWG and Smaller (within flexible conduit to rotating, vibrating, or moveable equipment): Stranded.
      b. Size 10 AWG and Smaller (all other): Solid.
      c. Size 8 AWG and Larger (all): Stranded.
   2. Control Circuits: Stranded.

D. Insulation Voltage Rating: 600 V.

E. Insulation:
   1. Copper Building Wire: Type THHN/THWN, THHN/THWN-2, or XHHW-2, except as indicated below.
      a. Size 4 AWG and Larger: Type XHHW-2.

2.04 CONTROLS CABLING

A. Manufacturers
   1. Cabling:
      a. Belden: www.belden.com
      b. Berk-Tek/Nexans: www.berktek.us
      c. Commscope: www.commscope.com
      d. General Cable Technologies Corporation: www.generalcable.com
      e. Hitachi Cable America: www.hca.hitachi-cable.com
      f. Mohawk; a division of Belden: www.mohawk-cable.com
      g. Optical Cable Corporation: www.occfiber.com
      h. Panduit: www.panduit.com
      i. Prysmian: na.prysmiangroup.com
      j. Siemon Company: www.siemon.com
      k. Signamax: www.signamax.com
      l. Superior Essex: www.superioressex.com
      m. Systimax; a division of Commscope: www.systimax.com
      n. West Penn Wire: www.westpennwire.com
   2. Cable Hardware:
      a. Belden: www.belden.com
      b. Commscope: www.commscope.com
      c. Hubbell Premise Wiring: www.hubbell-premise.com
      d. Leviton: www.leviton.com
      e. Optical Cable Corporation: www.occfiber.com
      f. Ortronics: www.ortronics.com
      g. Panduit: www.panduit.com

h. Siemon Company: www.siemon.com
i. Signamax: www.signamax.com
j. Systimax; a division of Commscope: www.systimax.com
k. Substitutions: Not permitted.

B. Class 1 Control Circuits: Type THHN-THWN in raceway.

C. Class 2 Control Circuits: Type THHN-THWN, Power-limited (CL2) cable concealed in building finishes, and Power-limited plenum rated CL2P cable in conduit.

D. Tank Monitoring Controls Circuits:
1. 2-wire sensors: Indoor/Outdoor CMP Shielded 22-2 stranded Belden 88761 or equal by approved manufacturer (or cabling as required by fuel oil monitoring system)
2. 3-wire sensors: Indoor/Outdoor CMP Shielded 18-3 stranded Belden 8770 or equal by approved manufacturer (or cabling as required by fuel oil monitoring system)

E. Controls Category Cabling - Copper Horizontal Cable (UTP data):
1. Description: 100 ohm, balanced twisted pair cable complying with TIA-568 (SET) and listed and labeled as complying with UL 444.
2. Cable Type - Data: TIA-568 Category 6 UTP (unshielded twisted pair); 23 AWG; CMP-LP(0.6A) or greater.
3. Cable Capacity: 4-pair.
4. Category 6 Cable Outside Diameter: 0.240 inch maximum nominal.
5. Cable Applications: Use listed NFPA 70 Type CMP plenum cable unless otherwise indicated.
6. Cable Applications:
   a. Plenum Applications: Use listed NFPA 70 Type CMP plenum cable.
7. Cable Jacket Color -Data Cable: Verify Colors with Owner prior to submittals.
   a. See DEVICE/CABLE COLORS section in this spec for jack colors.
8. Jacks and Connectors: Modular RJ-45, non-keyed, terminated with 110-style insulation displacement connectors (IDC); high impact thermoplastic housing; suitable for and complying with same standard as specified horizontal cable; UL 1863 listed.
   a. Performance: 500 mating cycles.
   b. Voice and Data Jacks: 8-position modular jack, color-coded for both T568A and T568B wiring configurations.
   c. See DEVICE/CABLE COLORS section in this spec for jack colors.
   d. Hazardous (Classified) Location Outlets (where installed in classified locations): Listed and labeled as complying with UL 2225 for the classification of the installed location.
9. Copper Patch Cords:
   a. Description: Factory-fabricated 4-pair cable assemblies with 8-position modular connectors terminated at each end.
      1) Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
      2) Provide stranded patch cords for additional flexibility. Ensure installation meets permanent link requirements.
   b. Patch Cords for Patch Panels:
      1) Provided by contractor.
      2) Lengths:
         (a) 1 foot. - One for each patch panel port terminated.
   c. Patch Cords for Work Areas:
      1) Furnished by contractor. Installed by Owner.

2) Quantity: One for each work area outlet port.
3) Lengths:
(a) 1 foot - One for each work area data outlet.

d. Product(s):
1) Patch Cords shall be by same manufacturer as UTP cabling or same manufacturer of UTP Cable Hardware.

2.05 WIRING CONNECTORS

A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.

B. Connectors for Grounding and Bonding: Comply with Section 260526.

C. Wiring Connectors for Splices and Taps:
1. Copper Conductors Size 8 AWG and Smaller: Use twist-on insulated spring connectors.
2. Copper Conductors Size 6 AWG and Larger: Use mechanical connectors or compression connectors.

D. Wiring Connectors for Terminations:
1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
2. Provide compression adapters for connecting conductors to equipment furnished with mechanical lugs when only compression connectors are specified.
3. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.
4. Provide motor pigtail connectors for connecting motor leads in order to facilitate disconnection.
5. Copper Conductors Size 8 AWG and Larger: Use mechanical connectors or compression connectors where connectors are required.
6. Stranded Conductors Size 10 AWG and Smaller: Use compression type connectors or crimped terminals for connections to terminal screws. Stranded conductors under a plain screw is not allowed.
7. Conductors for Control Circuits: Use crimped terminals for all connections.

E. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.

F. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F for standard applications and 302 degrees F for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.
1. Manufacturers:
a. 3M: www.3m.com
b. Ideal Industries, Inc: www.idealindustries.com
c. NSI Industries LLC: www.nsiindustries.com
d. Or Approved Equal.

G. Push-in Wire Connectors: Rated 600 V, 221 degrees F.
1. Manufacturers:
a. Ideal Industries, Inc: www.idealindustries.com
b. NSI Industries LLC: www.nsiindustries.com
c. Wago Corporation: www.wago.us
d. Or Approved Equal.

H. Mechanical Connectors: Provide bolted type or set-screw type.

1. Manufacturers:
    a. Burndy LLC: www.burndy.com
    b. Ilsco: www.ilsco.com
    c. Thomas & Betts Corporation: www.tnb.com

I. Compression Connectors: Provide circumferential type or hex type crimp configuration.
1. Manufacturers:
    a. Burndy LLC: www.burndy.com
    b. Ilsco: www.ilsco.com
    c. Thomas & Betts Corporation: www.tnb.com

J. Crimped Terminals: Nylon-insulated, with insulation grip and terminal configuration suitable for connection to be made.
1. Hydraulic crimping tool dies shall impress the die's conductor size range into the crimp.
2. Manufacturers:
    a. Burndy LLC: www.burndy.com
    b. Ilsco: www.ilsco.com
    c. Thomas & Betts Corporation: www.tnb.com
    d. Or Approved Equal.

2.06 ACCESSORIES

A. Electrical Tape:
1. Manufacturers:
    a. 3M: www.3m.com
    b. Plymouth Rubber Europa: www.plymouthrubber.com
    c. Substitutions: See 260500 - Common Work Results for Electrical.
2. Vinyl Color Coding Electrical Tape: Integrally colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F.
3. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 8.5 mil; resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F and suitable for continuous temperature environment up to 221 degrees F.
4. Moisture Sealing Electrical Tape: Insulating mastic compound laminated to flexible, all-weather vinyl backing; minimum thickness of 90 mil.

B. Heat Shrink Tubing: Heavy-wall, split-resistant, with factory-applied adhesive; rated 600 V; suitable for direct burial applications; listed as complying with UL 486D.
1. Manufacturers:
    a. 3M: www.3m.com
    b. Burndy LLC: www.burndy.com
    c. Thomas & Betts Corporation: www.tnb.com
    d. Substitutions: See 260500 - Common Work Results for Electrical.

C. Wire Pulling Lubricant:
1. Manufacturers:
    a. 3M: www.3m.com
    b. American Polywater Corporation: www.polywater.com
    c. Ideal Industries, Inc: www.idealindustries.com
    d. Substitutions: See 260500 - Common Work Results for Electrical.
2. Listed and labeled as complying with UL 267.
3. Suitable for use with conductors/cables and associated insulation/jackets to be installed.
4. Suitable for use at installation temperature.

D. Cable Ties: Material and tensile strength rating suitable for application.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that interior of building has been protected from weather.

B. Verify that work likely to damage wire and cable has been completed.

C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.

D. Verify that field measurements are as indicated.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.03 INSTALLATION

A. Circuiting Requirements:
   1. Unless dimensioned, circuit routing indicated is diagrammatic.
   2. When circuit destination is indicated determine exact routing required.
   3. Arrange circuiting to minimize splices.
   4. Include circuit lengths required to install connected devices within 10 ft of location indicated.
   5. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
   6. Maintain separation of wiring for emergency systems in accordance with NFPA 70.
   7. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are indicated as separate, combining them together in a single raceway is permitted, under the following conditions:
      a. Provide no more than six current-carrying conductors in a single raceway. Dedicated neutral conductors are considered current-carrying conductors.
      b. Increase size of conductors as required to account for ampacity derating.
      c. Size raceways, boxes, etc. to accommodate conductors.
      d. Include all modifications made in accordance with Section 260573 studies:
         1) Are required as per the selective coordination requirements of this section.
            (a) All selective coordination required modifications shall be completed at no additional cost to the Owner. This includes but is not limited to:
               (1) Increased conduit and feeder sizes due to increased overcurrent protective device sizes.
      e. Conductor Sizing/Derating:
         1) Design documents are shown with attempts made to derate wiring as per the anticipated installation. It is the electrical contractor's responsibility to derate all cabling as required for the actual installed condition. In no case shall conductors used be smaller than as indicated on drawings or specifications without prior approval from Engineer.
         2) Regardless of insulation type, base sizing on 60 degree C ampacities up through size #1, and 75 degrees C ampacities for larger conductors. Provide not less than same ampacity as copper conductors indicated.
         3) Derate wiring as required for voltage drop to maintain the following at 100% load factor.

(a) 2% total voltage drop (maximum) from service or nearest upstream transformer down to each and every transformer.
(b) 2% total voltage drop (maximum) from nearest upstream transformer down to each and every branch circuit panelboard.
(c) 3% total voltage drop (maximum) from each and every branch circuit panel to the farthest outlet/loads on all circuits.
(d) These collectively shall provide a total of 5% voltage drop (maximum) from the nearest upstream transformer down to each and every branch circuit outlet/load.

4) Derate all wiring installed exposed to sunlight as per the NEC - article 310.
5) Derate as per the highest ambient temperature of all spaces that each conductor is installed in.
6) Derate as per quantity of current-carrying conductors within any raceway. Neutral shall be considered a current carrying conductor.

8. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among single phase branch circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.

B. Install products in accordance with manufacturer's instructions.

C. Perform work in accordance with NECA 1 (general workmanship).

D. Installation in Raceway:
1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
2. Pull all conductors and cables together into raceway at same time.
3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
4. Route raceways parallel or perpendicular to building structural members and surfaces.
5. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.

E. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.

F. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.
1. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conductors and cables to lay on ceiling tiles.

G. Terminate cables using suitable fittings.

H. Install conductors with a minimum of 12 inches of slack at each outlet.

I. Where conductors are installed in enclosures for future termination by others, provide a minimum of 5 feet of slack.

J. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.

K. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.

L. Make wiring connections using specified wiring connectors.

1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
3. Do not remove conductor strands to facilitate insertion into connector.
4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.
5. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
6. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
7. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

M. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.
1. Dry Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
2. Damp Locations: Use insulating covers specifically designed for the connectors or heat shrink tubing.
    a. For connections with insulating covers, apply outer covering of moisture sealing electrical tape.
    b. For taped connections, follow same procedure as for dry locations but apply outer covering of moisture sealing electrical tape.
3. Wet Locations: Use heat shrink tubing.

N. Insulate ends of spare conductors using vinyl insulating electrical tape.

O. Field-Applied Color Coding: Where vinyl color coding electrical tape is used in lieu of integrally colored insulation as permitted in Part 2 under "Color Coding", apply half overlapping turns of tape at each termination and at each location conductors are accessible.

P. Identify conductors and cables in accordance with Section 260553.

Q. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Division 07.

R. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

S. Controls Cabling:
1. Do not bend cable at radius less than manufacturer's recommended bend radius; for unshielded twisted pair use bend radius of not less than 4 times cable diameter.
2. Do not over-cinch or crush cables.
3. Do not exceed manufacturer's recommended cable pull tension.
4. When installing in conduit, use only lubricants approved by cable manufacturer and do not chafe or damage outer jacket.

T. Controls Cabling - Service Loops (Slack or Excess Length): Provide the following minimum extra length of cable, looped neatly using plenum rated hook & loop type (ie. Velcro) cable fastening cable ties:
1. At Racks/Cabinets: 10 ft.
2. At Devices - Building Automation System (BAS): 1 ft.
3. At Outlets - Copper (all other): 10 ft.

3.04 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Perform inspections and tests listed in NETA ATS, Section 7.3.2. The insulation resistance test is required for all conductors. The resistance test for parallel conductors listed as optional is required.
   1. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.

C. Correct deficiencies and replace damaged or defective conductors and cables.

D. Testing - Copper Data Cabling and Associated Equipment:
   1. Test up through 600 MHz (and include on graphs) with all pass/fail based on the standard requirement of 0-500MHz or 250MHz as applicable for Category standard.
   2. UTP Horizontal Cabling Performance Tests: Test for each outlet. Perform the following tests according to TIA-568 (SET):
      a. Wire map.
      b. Length (physical vs. electrical, and length requirements).
      c. Insertion loss.
      d. Near-end crosstalk (NEXT) loss.
      e. Power sum near-end crosstalk (PSNEXT) loss.
      f. Equal-level far-end crosstalk (ELFEXT).
      g. Power sum equal-level far-end crosstalk (PSELFEXT).
      h. ACR-N
      i. PSACR-N
      j. ACR-F
      k. PSACR-F
      l. Return loss.
      m. Propagation delay.
      n. Delay skew.
      o. UTP performance tests.
      p. DC Resistance
      q. DC Resistance Unbalance

E. Final Verification Tests: Perform verification tests for UTP systems after the complete communications cabling and workstation outlet/connectors are installed.
   1. Data Tests: These tests assume the Information Technology Staff has a network installed and is available to assist with testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.

F. End-to-end cabling will be considered defective if it does not pass tests and inspections.

END OF SECTION 260519

SECTION 260526
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Grounding and bonding requirements.

B. Conductors for grounding and bonding.

C. Connectors for grounding and bonding.

D. Ground rod electrodes.

1.02 RELATED REQUIREMENTS

A. Section 260519 - Low-Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.

B. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

C. Section 265600 - Exterior Lighting: Additional grounding and bonding requirements for pole-mounted luminaires.

D. Section {\id\#1000058} - {\t\#1000058}: Additional grounding and bonding requirements for cable tray systems.

E. Divisions 31-33 - Site Grounding and Utilities Grounding

1.03 REFERENCE STANDARDS

A. IEEE 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System; 2012.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

C. NEMA GR 1 - Grounding Rod Electrodes and Grounding Rod Electrode Couplings; 2022.

D. NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems; 2021.

E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

F. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not install ground rod electrodes until final backfill and compaction is complete.

1.05 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70 and IEEE 81.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 GROUNDING AND BONDING REQUIREMENTS

A. Existing Work: Where existing grounding and bonding system components are indicated to be reused, they may be reused only where they are free from corrosion, integrity and continuity are verified, and where acceptable to the authority having jurisdiction.

B. Do not use products for applications other than as permitted by NFPA 70 and product listing.

C. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.

D. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

E. Grounding System Resistance:
   1. Achieve specified grounding system resistance under normally dry conditions unless otherwise approved by Engineer. Precipitation within the previous 48 hours does not constitute normally dry conditions.
   2. Between Grounding Electrode System and Major Electrical Equipment Frames, System Neutral, and Derived Neutral Points: Not greater than 0.5 ohms, when tested using "point-to-point" methods.

F. Grounding Electrode System:
   1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system. Connect to existing grounding electrode system.
      a. Provide continuous grounding electrode conductors without splice or joint.
      b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.
   2. Ground Rod Electrode(s):
      a. Provide two electrodes unless otherwise indicated or required.
      b. Space electrodes not less than 10 feet from each other and any other ground electrode. Locate on opposite sides of the tank (180 degrees apart).
      c. Where location is not indicated, locate electrode(s) at least 5 feet outside fuel oil tank foundation.

G. Bonding and Equipment Grounding:
   1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
   2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
   3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
   4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
   5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
   6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.
   7. Provide bonding for interior metal piping systems in accordance with NFPA 70. This includes, but is not limited to:
      a. Metal gas piping.
      b. Metal process piping.

8. Provide bonding for interior metal air ducts.

2.02 GROUNDING AND BONDING COMPONENTS

A. General Requirements:
   1. Provide products listed, classified, and labeled as suitable for the purpose intended.
   2. Provide products listed and labeled as complying with UL 467 where applicable.

B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 260526:
   1. Use insulated copper conductors unless otherwise indicated.
   2. Factory Pre-fabricated Bonding Jumpers: Furnished with factory-installed ferrules; size braided cables to provide equivalent gauge of specified conductors.

C. Connectors for Grounding and Bonding:
   1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
   2. Unless otherwise indicated, use exothermic welded connections for underground, concealed, outdoors, and other inaccessible connections.
   3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections indoors.
      a. Exceptions:
         1) Use exothermic welded connections for connections to metal building frame.
   4. Manufacturers - Mechanical and Compression Connectors:
      a. Advanced Lightning Technology (ALT): www.altfab.com
      b. Burndy LLC: www.burndy.com
      c. Harger Lightning & Grounding: www.harger.com
      d. nVent ERICO: www.nvent.com
      e. Thomas & Betts Corporation: www.tnb.com
      f. Or Approved Equal.
   5. Manufacturers - Exothermic Welded Connections:
      a. Burndy LLC: www.burndy.com
      b. nVent ERICO; Cadweld: www.nvent.com
      c. ThermOweld, a brand of Continental Industries, Inc: www.thermoweld.com
      d. Or Approved Equal.

D. Ground Rod Electrodes:
   1. Comply with NEMA GR 1.
   2. Material: Copper-bonded (copper-clad) steel.
   3. Size: 3/4 inch diameter by 10 feet length, unless otherwise indicated.
   4. Manufacturers:
      a. Advanced Lightning Technology (ALT): www.altfab.com
      b. Galvan Industries, Inc: www.galvanelectrical.com
      c. Harger Lightning & Grounding: www.harger.com
      d. nVent ERICO: www.nvent.com
      e. Or Approved Equal.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that work likely to damage grounding and bonding system components has been completed.

B. Verify that field measurements are as indicated.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Perform work in accordance with NECA 1 (general workmanship).

C. Ground Rod Electrodes: Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70 or provide ground plates.
   1. Outdoor Installations: Unless otherwise indicated, install with top of rod 6 inches below finished grade.

D. Make grounding and bonding connections using specified connectors.
   1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
   2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
   3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
   4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
   5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

E. Identify grounding and bonding system components in accordance with Section 260553.

3.03 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS except Section 4.

B. Perform inspections and tests listed in NETA ATS, Section 7.13.

C. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.

D. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.

E. Include all ground electrode locations on as-built documentation. Provide GPS coordinates for items installed within the site.

END OF SECTION 260526

SECTION 260529
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Support and attachment requirements and components for equipment, conduit, cable, boxes, and other electrical work.

1.02 RELATED REQUIREMENTS

A. Section 260533.13 - Conduit for Electrical Systems: Additional support and attachment requirements for conduits.

B. Section 260533.16 - Boxes for Electrical Systems: Additional support and attachment requirements for boxes.

1.03 REFERENCE STANDARDS

A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.

B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.

C. MFMA-4 - Metal Framing Standards Publication; 2004.

D. UL 5B - Strut-Type Channel Raceways and Fittings; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate sizes and arrangement of supports and bases with actual equipment and components to be installed.
   2. Coordinate work to provide additional framing and materials required for installation.
   3. Coordinate compatibility of support and attachment components with mounting surfaces at installed locations.
   4. Coordinate arrangement of supports with ductwork, piping, equipment and other potential conflicts.
   5. Notify Engineer of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:

1.05 QUALITY ASSURANCE

A. Installer Qualifications for Field-Welding: As specified in Division 05.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:
   1. Provide required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for complete installation of electrical work.
   2. Provide products listed, classified, and labeled as suitable for purpose intended, where applicable.
   3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be

supported with a minimum safety factor of 1.2. Include consideration for vibration, equipment operation, and shock loads where applicable.

4. Do not use products for applications other than as permitted by NFPA 70 and product listing.
5. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
    a. Cable type or aircraft cable type supports (Gripple or similar) shall not be permitted.
    b. Indoor Dry Locations: Use galvanized steel unless otherwise indicated.
    c. Outdoor and Damp or Wet Indoor Locations: Use stainless steel, stainless steel, approved equivalent, or approved equivalent unless otherwise indicated.
6. Materials:
    a. Comply with MFMA-4 for all coatings.
    b. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

B. Materials for Metal Fabricated Supports: Comply with Division 05.

C. Conduit and Cable Supports: Straps and clamps suitable for conduit or cable to be supported.
1. Manufacturers:
    a. ABB: www.electrification.us.abb.com
    b. Eaton Corporation: www.eaton.com
    c. Emerson Electric Co; O-Z/Gedney: www.emerson.com
    d. HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com
2. Conduit Straps: One-hole or two-hole type; steel or malleable iron. See Applications above for materials per application.
3. Conduit Clamps: Bolted type unless otherwise indicated.

D. Outlet Box Supports: Hangers and brackets suitable for boxes to be supported.
1. Manufacturers:
    a. ABB: www.electrification.us.abb.com
    b. Eaton Corporation: www.eaton.com
    c. Emerson Electric Co; O-Z/Gedney: www.emerson.com
    d. HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com
    e. Substitutions: Not permitted.

E. Metal Channel/Strut Framing Systems:
1. Manufacturers:
    a. ABB: www.electrification.us.abb.com
    b. Atkore International Inc; Unistrut: www.unistrut.us
    c. Custom Strut and Roll Forming, LLC: www.customstrut.com.
    d. Eaton Corporation: www.eaton.com.
    e. Elgen Manufacturing Company, Inc: www.elgenmfg.com.
    f. Source Limitations: Furnish channel/strut and associated fittings, accessories, and hardware produced by single manufacturer.
2. Description: Factory-fabricated, continuous-slot, metal channel/strut and associated fittings, accessories, and hardware required for field assembly of supports.
3. Comply with MFMA-4.
4. Channel/Strut Used as Raceway, Where Indicated: Listed and labeled as complying with UL 5B.
5. Channel Material:
    a. See Applications above.
6. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch.
7. Minimum Channel Dimensions: 1-5/8 inch wide by 13/16 inch high.

F. Hanger Rods: Threaded, zinc-plated steel unless otherwise indicated.
   1. Minimum Size, Unless Otherwise Indicated or Required:
      a. Equipment Supports: 1/2-inch diameter.
      b. Single Conduit up to 1-inch (27 mm) Trade Size: 1/4-inch diameter.
      c. Single Conduit Larger than 1-inch (27 mm) Trade Size: 3/8-inch diameter.
      d. Trapeze Support for Multiple Conduits: 3/8-inch diameter.
      e. Outlet Boxes: 1/4-inch diameter.
      f. Luminaires: 1/4-inch diameter.

G. Anchors and Fasteners:
   1. Manufacturers - Mechanical Anchors:
      a. Dewalt: anchors.dewalt.com.
      b. Hilti, Inc: www.hilti.com.
      c. ITW Red Head, a division of Illinois Tool Works, Inc: www.itwredhead.com.
      d. Simpson Strong-Tie Company Inc: www.strongtie.com.
   2. Unless otherwise indicated and where not otherwise restricted, use anchor and fastener types indicated for specified applications.
   3. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
   4. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
   5. Hollow Masonry: Use toggle bolts.
   6. Hollow Stud Walls: Use toggle bolts.
   7. Steel: Use beam clamps, machine bolts, or welded threaded studs.
   8. Sheet Metal: Use sheet metal screws.
   9. Wood: Use wood screws.
   10. Plastic and lead anchors are not permitted.
   11. Powder-actuated fasteners are not permitted.
   12. Hammer-driven anchors and fasteners are not permitted.
   13. Existing buildings - Post-Installed Concrete and Masonry Anchors: Utilize expansion anchors or screw anchors. Provide anchors in all concrete slab that is existing and contains embedded reinforcing or embedded post-tensioning tendons.
      a. Provide as per manufacturer installation requirements.
      b. Install shell or flush type anchor in holes drilled with carbide tipped drill bits. Install in accordance with manufacturer's spacing requirements.
      c. Contractor shall provide a testing agency to scan (x-ray or ground penetrating radar) post tension structure prior to drilling for anchors. Adjust anchor location as required to avoid embedded structure.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive support and attachment components.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install hangers and supports in accordance with NECA 1.

C. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.

D. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

E. Unless specifically indicated or approved by Engineer, do not provide support from suspended ceiling support system or ceiling grid.

F. Unless specifically indicated or approved by Engineer, do not provide support from roof deck.

G. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

H. Field-Welding (where approved by Engineer): Comply with Division 05.

I. Equipment Support and Attachment:
   1. Use metal, fabricated supports or supports assembled from metal channel/strut to support equipment as required.
   2. Use metal channel/strut secured to studs to support equipment surface mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
   3. Use metal channel/strut to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
   4. Unless otherwise indicated, mount floor-mounted equipment on properly sized 3 inch minimum high concrete pad constructed in accordance with Division 03.
   5. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

J. Conduit Support and Attachment: See Section 260533.13 for additional requirements.

K. Box Support and Attachment: See Section 260533.16 for additional requirements.

L. Secure fasteners in accordance with manufacturer's recommended torque settings.

M. Remove temporary supports.

N. Identify independent electrical component support wires above accessible ceilings, where permitted, with color distinguishable from ceiling support wires in accordance with NFPA 70.

3.03 FIELD QUALITY CONTROL

A. Inspect support and attachment components for damage and defects.

B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

C. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION 260529

SECTION 260533.13
CONDUIT FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Galvanized steel rigid metal conduit (RMC).

B. Aluminum rigid metal conduit (RMC).

C. Galvanized steel intermediate metal conduit (IMC).

D. Liquidtight flexible metal conduit (LFMC).

1.02 RELATED REQUIREMENTS

A. Division 07 - Firestopping.

B. Division 09 - Interior and Exterior Painting.

C. Section 260526 - Grounding and Bonding for Electrical Systems.
   1. Includes additional requirements for fittings for grounding and bonding.

D. Section 260529 - Hangers and Supports for Electrical Systems.

E. Section 260533.16 - Boxes for Electrical Systems.

F. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

1.03 REFERENCE STANDARDS

A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2020.

B. ANSI C80.5 - American National Standard for Electrical Rigid Metal Conduit -- Aluminum (ERMC-A); 2020.

C. ANSI C80.6 - American National Standard for Electrical Intermediate Metal Conduit; 2018.

D. ASTM D1621 - Standard Test Method for Compressive Properties of Rigid Cellular Plastics; 2016 (Reapproved 2023).

E. ASTM D1623 - Standard Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics; 2017 (Reapproved 2023).

F. ASTM D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials; 2017.

G. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

H. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); 2020.

I. NECA 102 - Standard for Installing Aluminum Rigid Metal Conduit; 2004.

J. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2014.

K. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

L. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.

M. UL 6A - Electrical Rigid Metal Conduit-Aluminum, Red Brass, and Stainless Steel; Current Edition, Including All Revisions.

N. UL 360 - Liquid-Tight Flexible Metal Conduit; Current Edition, Including All Revisions.

O. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.

P. UL 1203 - Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations; Current Edition, Including All Revisions.

Q. UL 1242 - Electrical Intermediate Metal Conduit-Steel; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate minimum sizes of conduits with actual type and quantity of conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
   2. Coordinate arrangement of conduits with structural members, ductwork, piping, equipment, and other potential conflicts.
   3. Verify exact conduit termination locations required for boxes, enclosures, and equipment.
   4. Coordinate work to provide roof penetrations that preserve integrity of roofing system and do not void roof warranty.
   5. Notify Engineer of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:
   1. Do not begin installation of conductors and cables until installation of conduit between termination points is complete.

1.05 SUBMITTALS

A. After Installation:
   1. Project Record Documents: Record actual routing for conduits 3/4" trade size and larger.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 CONDUIT APPLICATIONS

A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70, manufacturer's instructions, and product listing.

B. Unless otherwise indicated and where not otherwise restricted, use conduit types indicated for specified applications. Where more than one listed application applies, comply with most restrictive requirements. Where conduit type for particular application is not specified, use galvanized steel rigid metal conduit.

C. Conduit and raceways shall not be exposed unless noted otherwise.
   1. See Part 3 Installation for clarification of locations where exposed conduit is allowed.
   2. Exposed, Interior: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or aluminum rigid metal conduit.
   3. Exposed, Exterior: Use galvanized steel rigid metal conduit or aluminum rigid metal conduit.

D. Hazardous (Classified) Locations Above Ground: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or aluminum rigid metal conduit. All conduit shall be threaded.

E. Flexible Connections to Vibrating Equipment:
   1. All Locations: Use liquidtight flexible metal conduit (LFMC) or liquidtight flexible metal conduit (LFMC).
   2. Maximum Length: 6 feet unless otherwise indicated.
   3. Vibrating equipment includes, but is not limited to:
      a. Transformers.
      b. Motors.

2.02 CONDUIT - GENERAL REQUIREMENTS

A. Comply with NFPA 70.

B. Existing Work: Where existing conduits are indicated to be reused, they may be reused only where they comply with specified requirements, are free from corrosion, and integrity is verified by pulling mandrel through them.

C. Fittings for Grounding and Bonding: See Section 260526 for additional requirements.

D. Provide conduit, fittings, supports, and accessories required for complete raceway system.

E. Provide products listed, classified, and labeled as suitable for purpose intended.

F. Minimum Conduit Size, Unless Otherwise Indicated:
   1. All Conduit: 3/4 inch (21 mm) trade size.

G. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.03 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Manufacturers:
   1. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.com
   2. Nucor Tubular Products: www.nucortubular.com
   3. Rymco USA: www.rymcousa.com
   4. Western Tube, a division of Zekelman Industries: www.westerntube.com
   5. Wheatland Tube, a division of Zekelman Industries: www.wheatland.com

B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.

C. Fittings:
   1. Manufacturers:
      a. ABB; T&B: www.electrification.us.abb.com
      b. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.us
      c. Bridgeport Fittings Inc; FRB Series: www.bptfittings.com.
      d. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com
      e. Or same as manufacturer of conduit or boxes to be connected.
   2. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 6.
   3. Hazardous/Classified Locations: Use fittings listed and labeled as complying with UL 1203 for classification of installed location.
   4. Material: Use steel or malleable iron.
      a. Do not use die cast zinc fittings.
   5. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.04 ALUMINUM RIGID METAL CONDUIT (RMC)

A. Manufacturers:
   1. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.com
   2. Nucor Tubular Products: www.nucortubular.com
   3. Rymco USA: www.rymcousa.com
   4. Western Tube, a division of Zekelman Industries: www.westerntube.com
   5. Wheatland Tube, a division of Zekelman Industries: www.wheatland.com

B. Description: NFPA 70, Type RMC aluminum rigid metal conduit complying with ANSI C80.5 and listed and labeled as complying with UL 6A.

C. Fittings:
   1. Manufacturers:
      a. ABB; T&B: www.electrification.us.abb.com
      b. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.us

c. Bridgeport Fittings Inc: www.bptfittings.com
d. O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com
e. Or same as manufacturer of conduit or boxes to be connected.

2. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 6A.
3. Hazardous/Classified Locations: Use fittings listed and labeled as complying with UL 1203 for classification of installed location.
4. Material: Use aluminum.
5. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.05 GALVANIZED STEEL INTERMEDIATE METAL CONDUIT (IMC)

A. Manufacturers:
1. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.com
2. Nucor Tubular Products: www.nucortubular.com
3. Rymco USA: www.rymcousa.com
4. Western Tube, a division of Zekelman Industries: www.westerntube.com
5. Wheatland Tube, a division of Zekelman Industries: www.wheatland.com

B. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.

C. Fittings:
1. Manufacturers:
a. ABB; T&B: www.electrification.us.abb.com
b. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.us
c. Bridgeport Fittings Inc: www.bptfittings.com
d. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com
e. Or same as manufacturer of conduit or boxes to be connected.
2. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 1242.
3. Hazardous/Classified Locations: Use fittings listed and labeled as complying with UL 1203 for classification of installed location.
4. Material: Use steel or malleable iron.
a. Do not use die cast zinc fittings.
5. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.06 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

A. Manufacturers:
1. AFC Cable Systems, Inc: www.afcweb.com
2. Electri-Flex Company: www.electriflex.com
3. International Metal Hose: www.metalhose.com

B. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.

C. Fittings:
1. Manufacturers:
a. ABB; T&B: www.electrification.us.abb.com
b. Bridgeport Fittings Inc: www.bptfittings.com
c. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com
d. Or same as manufacturer of conduit or boxes to be connected.
2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.

3. Material: Use steel or malleable iron.
    a. Do not use die cast zinc fittings.

2.07 ACCESSORIES

A. Pull Strings: Use nylon or polyester tape with average breaking strength of not less than 1,250 lbf.

B. Conduit Mechanical Seals:
1. Listed as complying with UL 514B.
2. Specifically designed for sealing conduit openings against water, moisture, gases, and dust.
3. Suitable for sealing around conductors/cables to be installed.

C. Sealing Compound for Hazardous/Classified Location Sealing Fittings: Listed for use with particular fittings to be installed.

D. Duct Seals for Conduit Penetrations: Suitable for the conduits to be installed.
1. Duct seal shall be used to seal around annullar space between cabling installed in a conduit and the inside wall of the conduit.
2. 2-part, 98% closed-cell urethane foam (NOT putty/compound based).
3. Sealant shall be capable of sealing 3/4" conduits up to 10" conduits with multiple cable configurations.
4. Sealant system shall be re-enterable.
5. Operating Temperatures: -40 degrees F to 200 degrees F
6. Chemically resistant to gasoline, oils, dilute acids, and bases.
7. Sealant shall not affect the physical or electrical properties of the wire, cable, or cable installation.
8. Sealant shall adhere to all duct/conduit, and cable jacket surfaces.
9. Compressive Strength: 120 psi minimum as per ASTM D1621.
10. Tensile Strength: 270 psi minimum as per ASTM D1623.
11. Flexural Strength: 460 psi minimum as per ASTM D790.
12. Water Pressure Continous: 22 ft water head minimum.
13. Water Pressure Short Term: 90 ft water head minimum.
14. Gas Pressure Continuous: 5 psig minimum.
15. Basis of Design Product: American Polywater Corporation; FST Foam Sealant.
    a. Or Equal by:
        1) 3M: www.3m.com
        2) Advanced Products and Systems, Inc.: www.apsonline.com
        3) GPT; an EnPro Industries company: www.gptindustries.com
        4) Holdrite; Reliance Worldwide Corporation: www.holdrite.com
        5) Metraflex: www.metraflex.com
        6) Rainbow Technology Corporation: www.rainbowtech.com
        7) RectorSeal: www.rectorseal.com
        8) Roxtec: www.roxtec.com

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive conduits.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install conduit in accordance with NECA 1.

C. Paint conduits to match surface where conduit is visible in finished areas or in exposed structure ceiling areas.
   1. Paint as per Division 09.

D. Galvanized Steel Rigid Metal Conduit (RMC): Install in accordance with NECA 101.

E. Aluminum Rigid Metal Conduit (RMC): Install in accordance with NECA 102.

F. Intermediate Metal Conduit (IMC): Install in accordance with NECA 101.

G. Conduit Routing:
   1. When conduit destination is indicated without specific routing, determine exact routing required.
   2. Conceal conduits unless specifically indicated to be exposed.
   3. Conduits in the following areas may be exposed, unless otherwise indicated:
      a. Electrical rooms.
      b. Mechanical equipment rooms.
      c. Within joists in areas with no ceiling.
   4. Unless otherwise approved, do not route exposed conduits:
      a. Across floors.
      b. Across roofs.
      c. Across building exterior surfaces.
   5. Arrange conduit to maintain adequate headroom, clearances, and access.
   6. Arrange conduit to provide no more than equivalent of four 90-degree bends between pull points.
   7. Arrange conduit to provide no more than 150 feet between pull points.
   8. Route conduits above water and drain piping where possible.
   9. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
   10. Maintain minimum clearance of 6 inches between conduits and piping for other systems.
   11. Maintain minimum clearance of 12 inches between conduits and hot surfaces. This includes, but is not limited to:
      a. Heaters.
      b. Hot water piping.
      c. Flues.
   12. Group parallel conduits in same area on common rack.
   13. Controls and telecom pathways shall be installed with the following minimum clearances:
      a. 48 inches from motors, generators, frequency converters, transformers, and uninterruptible power systems.
      b. 12 inches from power conduits and cables and panelboards.
      c. 5 inches from fluorescent and high frequency lighting fixtures.
      d. 6 inches from flues, hot water pipes, and steam pipes.

H. Conduit Support:
   1. Secure and support conduits in accordance with NFPA 70 using suitable supports and methods approved by authorities having jurisdiction; see Section 260529.
   2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
   3. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
   4. Use conduit strap to support single surface-mounted conduit.
   5. Use metal channel/strut with accessory conduit clamps to support multiple parallel surface-mounted conduits.
   6. Use conduit clamp to support single conduit from beam clamp or threaded rod.

7. Use trapeze hangers assembled from threaded rods and metal channel/strut with accessory conduit clamps to support multiple parallel suspended conduits.
8. Use of spring steel conduit clips for support of conduits is not permitted.
9. Use of wire for support of conduits is not permitted.
10. Where conduit support intervals specified in NFPA 70 and NECA standards differ, comply with most stringent requirements.

I. Connections and Terminations:
1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
3. Use suitable adapters where required to transition from one type of conduit to another.
4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
6. Where spare conduits stub up through concrete floors and are not terminated in box or enclosure, provide threaded couplings equipped with threaded plugs set flush with finished floor.
7. Provide insulating bushings, insulated throats, or listed metal fittings with smooth, rounded edges at conduit terminations to protect conductors.
8. Secure joints and connections to provide mechanical strength and electrical continuity.

J. Penetrations:
1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
2. Existing buildings - Post-Installed Concrete and Masonry Floors in all concrete slab that is existing and contains embedded reinforcing or embedded post-tensioning tendons.
   a. Contractor shall provide a testing agency to scan (x-ray or ground penetrating radar) post tension structure prior to core-drilling. Adjust locations as required to avoid embedded structure.
3. Make penetrations perpendicular to surfaces unless otherwise indicated.
4. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
5. Conceal bends for conduit risers emerging above ground.
6. Slope conduits away from building when penetrating through an exterior wall.
7. Provide suitable modular seal and duct seal where conduits penetrate exterior wall below grade.
8. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
9. Provide cover/finishes around conduit penetrations that are exposed to public view. Visible gaps in wall or opening are not acceptable.
10. Penetrations of the air barrier shall be caulked, gasketed or otherwise sealed in a manner compatible with the construction materials and location.
    a. Seal conduits going through building envelope air barrier.

K. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:

L. Conduit Sealing:
1. Use foam conduit sealant to prevent entry of moisture and gases. This includes, but is not limited to:

a. Where conduits enter building from outside.
b. Where conduits may transport moisture to contact live parts.

2. Where conduits cross barriers between areas of potential substantial temperature differential, use foam conduit sealant at accessible point near penetration to prevent condensation. This includes, but is not limited to:
   a. Where conduits pass from outdoors into conditioned interior spaces.
   b. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
3. Where conduits cross boundaries of hazardous/classified locations, provide identified/listed sealing fittings or conduit mechanical seals as approved by authorities having jurisdiction; locate as indicated or in accordance with NFPA 70.

M. Provide pull string in each empty conduit and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches at each end.

N. Provide grounding and bonding; see Section 260526.

O. Identify conduits; see Section 260553.

3.03 FIELD QUALITY CONTROL

A. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

B. Correct deficiencies and replace damaged or defective conduits.

3.04 CLEANING

A. Clean interior of conduits to remove moisture and foreign matter.

3.05 PROTECTION

A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

END OF SECTION 260533.13

SECTION 260533.16
BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.

B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.

C. Boxes for hazardous (classified) locations.

D. Accessories.

1.02 RELATED REQUIREMENTS

A. Section 260529 - Hangers and Supports for Electrical Systems.

B. Section 260533.13 - Conduit for Electrical Systems:
   1. Conduit bodies and other fittings.
   2. Additional requirements for locating boxes to limit conduit length and/or number of bends between pulling points.

1.03 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

B. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2016.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2020.

D. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2014.

E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

F. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.

G. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.

H. UL 508A - Industrial Control Panels; Current Edition, Including All Revisions.

I. UL 514A - Metallic Outlet Boxes; Current Edition, Including All Revisions.

J. UL 1203 - Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
   2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
   4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
   5. Coordinate the placement of boxes with devices, equipment, etc. installed under other sections or by others.
   6. Coordinate the work with other trades to preserve insulation integrity.

7. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 BOXES

A. General Requirements:
   1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
   2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
   3. Provide products listed, classified, and labeled as suitable for the purpose intended.
   4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
   5. Provide grounding terminals within boxes where equipment grounding conductors terminate.

B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:
   1. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
   2. Use cast iron boxes or cast aluminum boxes where exposed galvanized steel rigid metal conduit or exposed intermediate metal conduit (IMC) is used.
   3. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
   4. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
   5. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes unless specifically indicated or permitted.
   6. Minimum Box Size, Unless Otherwise Indicated:
      a. Wiring Devices (Other Than Communications Systems Outlets): 4 inch square by 1-1/2 inch deep (100 by 38 mm) trade size.
      b. Communications Systems Outlets: 4 inch square by 2-1/8 inch (100 by 54 mm) trade size.
   7. Manufacturers:
      a. Cooper Crouse-Hinds, a division of Eaton Corporation: www.cooperindustries.com
      b. Hubbell Incorporated; Bell Products: www.hubbell-rtb.com
      c. Hubbell Incorporated; RACO Products: www.hubbell-rtb.com
      d. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com
      e. Thomas & Betts Corporation: www.tnb.com

C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:
   1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
   2. NEMA 250 Environment Type, Unless Otherwise Indicated:
      a. Indoor Clean, Dry Locations: Type 1, painted steel.
      b. Outdoor Locations: Type 3R, painted steel.
   3. Junction and Pull Boxes Larger Than 100 cubic inches:

a. Provide hinged-cover enclosures unless otherwise indicated.
b. Boxes 6 square feet and Larger: Provide hinged-cover enclosures.

4. Cabinets and Hinged-Cover Enclosures, Other Than Junction and Pull Boxes:
   a. Provide lockable hinged covers, all locks keyed alike unless otherwise indicated.
   b. Back Panels: Painted steel, removable.
   c. Terminal Blocks: Provide voltage/current ratings and terminal quantity suitable for purpose indicated, with 25 percent spare terminal capacity.
5. Finish for Painted Steel Enclosures: Manufacturer's standard grey unless otherwise indicated.
6. Manufacturers:
   a. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com
   b. Hoffman, a brand of nVent: www.hoffmanonline.com
   c. Hubbell Incorporated; Wiegmann Products: www.hubbell-wiegmann.com

D. Boxes for Hazardous (Classified) Locations: Listed and labeled as complying with UL 1203 for the classification of the installed location.
1. Manufacturers:
   a. Appleton, a brand of Emerson Electric Co: www.emerson.com
   b. Cooper Crouse-Hinds, a division of Eaton Corporation: www.cooperindustries.com
   c. Hubbell Incorporated; Killark Products: www.hubbell-killark.com

2.02 ACCESSORIES

A. Flashing Panels for Exterior Wall Penetrations: Premanufactured components and accessories as required to preserve integrity of building envelope; suitable for boxes and facade materials to be installed.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive boxes.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install boxes in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.

E. Unless otherwise indicated, boxes may be surface-mounted where exposed conduits are indicated or permitted.

F. Box Locations:
1. Locate boxes to be accessible. Provide access panels in accordance with Division 08 as required.
2. Unless dimensioned, box locations indicated are approximate.
3. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.
4. Penetrations of the air barrier shall be caulked, gasketed or otherwise sealed in a manner compatible with the construction materials and location.

a. Seal junction boxes on the exterior face of the exterior wall/floor/ceiling (building envelope air barrier).
b. Where air barrier is the interior face of an exterior wall/floor/ceiling (and where it is not known where the air barrier is), seal junction boxes on the interior face of an exterior wall/floor/ceiling.

5. Locate junction and pull boxes as indicated, as required to facilitate installation of conductors, and to limit conduit length and/or number of bends between pulling points in accordance with Section 260533.13.

G. Box Supports:
1. Secure and support boxes in accordance with NFPA 70 and Section 260529 using suitable supports and methods approved by the authority having jurisdiction.
2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.
3. Installation Above Suspended Ceilings: Do not provide support from ceiling grid or ceiling support system.

H. Install boxes plumb and level.

I. Floor-Mounted Cabinets: Mount on properly sized 4 inch high concrete pad constructed in accordance with Division 03.

J. Install boxes as required to preserve insulation integrity.

3.03 CLEANING

A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

3.04 PROTECTION

A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

END OF SECTION 260533.16

SECTION 260553
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electrical identification requirements.

B. Identification nameplates and labels.

C. Wire and cable markers.

D. Floor marking tape.

1.02 RELATED REQUIREMENTS

A. Section 260519 - Low-Voltage Electrical Power Conductors and Cables: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.

1.03 REFERENCE STANDARDS

A. ANSI Z535.2 - American National Standard for Environmental and Facility Safety Signs; 2023.

B. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels; 2023.

C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.

B. Sequencing:
   1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.
   2. Do not install identification products until final surface finishes and painting are complete.

1.05 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. 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.

1.06 FIELD CONDITIONS

A. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

PART 2 PRODUCTS

2.01 IDENTIFICATION REQUIREMENTS

A. Existing Work: Unless specifically excluded, identify existing elements to remain whose designations are changed as part of the new work.

B. Identification for Equipment:
   1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
      a. Switchboards:
         1) Use identification nameplate to identify load(s) served for each branch device. Identify spares and spaces.
      b. Motor Control Centers:
         1) Identify ampere rating.

2) Use identification nameplate to identify load(s) served for each branch device. Identify spares and spaces.

c. Panelboards:
1) Use typewritten circuit directory or panel schedule to identify load(s) served for panelboards with a door. Identify spares and spaces using pencil.

d. Transformers:
1) Identify kVA rating.
2) Identify voltage and phase for primary and secondary.
3) Identify power source and circuit number. Include location when not within sight of equipment.
4) Identify load(s) served. Include location when not within sight of equipment.

e. Enclosed switches and motor controllers:
1) Identify voltage and phase.
2) Identify power source and circuit number. Include location when not within sight of equipment.
3) Identify load(s) served. Include location when not within sight of equipment.
4) Use identification label at each piece of equipment to identify the maximum available fault current (AFC) and the date calculations were performed.

2. Use identification nameplate to identify disconnect location for equipment with remote disconnecting means.
3. Use identification label on outside of door at each fused switch to identify required NEMA fuse class, replacement model number, and size.
4. Use identification label on outside of door at each motor controller to identify nameplate horsepower, and full load amperes of motor(s) controlled.
5. Use identification label or handwritten text using indelible marker on inside of door at each motor controller to identify nameplate horsepower, full load amperes, code letter, service factor, voltage, and phase of motor(s) controlled.
6. Use floor marking tape to identify required equipment working clearances.
7. Arc Flash Hazard Warning Labels: Comply with Section 260573.

C. Identification for Conductors and Cables:
1. Color Coding for Power Conductors 600 V and Less: Comply with Section 260519.
2. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.
3. Use wire and cable markers to identify circuit number or other designation indicated for power, control, and instrumentation conductors and cables at the following locations:
a. At each source and load connection.
b. Within boxes when more than one circuit is present.
c. Within equipment enclosures when conductors and cables enter or leave the enclosure.
4. Use wire and cable markers to identify connected grounding electrode system components for grounding electrode conductors.

D. Identification for Raceways:
1. Use identification labels, handwritten text using indelible marker, or plastic marker tags to identify circuits enclosed for accessible conduits at wall penetrations, at floor penetrations, and at equipment terminations when source is not within sight.

E. Identification for Boxes:
1. Use identification labels or handwritten text using indelible marker to identify circuits enclosed.

2.02 IDENTIFICATION NAMEPLATES AND LABELS

A. Identification Nameplates:
   1. Manufacturers:
      a. Brimar Industries, Inc: www.brimar.com
      b. Kolbi Pipe Marker Co: www.kolbipipemarkers.com
      c. Seton Identification Products: www.seton.com
   2. Materials:
      a. Indoor Clean, Dry Locations: Use plastic nameplates.
      b. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates suitable for exterior use.
   3. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/8 inch; engraved text.
      a. Exception: Provide minimum thickness of 1/8 inch when any dimension is greater than 4 inches.
   4. Stainless Steel Nameplates: Minimum thickness of 1/32 inch; engraved or laser-etched text.
   5. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text.
   6. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.
   7. Mechanical Fasteners shall be stainless steel screws.

B. Identification Labels:
   1. Manufacturers:
      a. Brady Corporation: www.bradyid.com.
      b. Brother International Corporation: www.brother-usa.com
      c. Panduit Corp: www.panduit.com
   2. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
      a. Use only for indoor locations.
   3. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.

C. Format for Equipment Identification:
   1. Minimum Size: 1 inch by 2.5 inches.
   2. Legend:
      a. Equipment designation or other approved description.
      b. Other information as indicated.
   3. Text: All capitalized unless otherwise indicated.
   4. Minimum Text Height:
      a. System Designation: 1 inch.
      b. Equipment Designation: 1/2 inch.
      c. Other Information: 1/4 inch.
      d. Exception: Provide minimum text height of 1 inch for equipment located more than 10 feet above floor or working platform.
   5. Color:
      a. Normal Power System: White text on black background.

D. Format for Caution and Warning Messages:
   1. Minimum Size: 2 inches by 4 inches.
   2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
   3. Text: All capitalized unless otherwise indicated.

4. Minimum Text Height: 1/2 inch.
5. Color: Black text on yellow background unless otherwise indicated.

E. Format for Receptacle Identification:
1. Minimum Size: 3/8 inch by 1.5 inches.
2. Legend: Power source and circuit number or other designation indicated.
a. Include voltage and phase for other than 120 V, single phase circuits.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 3/16 inch.
5. Color: Black text on clear background.

F. Format for Control Device Identification:
1. Minimum Size: 3/8 inch by 1.5 inches.
2. Legend: Load controlled or other designation indicated.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 3/16 inch.
5. Color: Black text on clear background.

2.03 WIRE AND CABLE MARKERS

A. Manufacturers:
1. Brady Corporation: www.bradyid.com
2. HellermannTyton: www.hellermanntyton.com
3. Panduit Corp: www.panduit.com

B. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.

C. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.

D. Legend: Power source and circuit number or other designation indicated.

E. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.

F. Minimum Text Height: 1/8 inch.

G. Color: Black text on white background unless otherwise indicated.

2.04 FLOOR MARKING TAPE

A. Manufacturers:
1. Brady Corporation: www.bradyid.com
2. Brimar Industries, Inc: www.brimar.com
3. Insite Solutions, LLC: www.stop-painting.com
4. Seton Identification Products: www.seton.com

B. Floor Marking Tape for Equipment Working Clearance Identification: Self-adhesive vinyl or polyester tape with overlaminate, 3 inches wide, with alternating black and white stripes.

PART 3 EXECUTION

3.01 PREPARATION

A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
1. Surface-Mounted Equipment: Enclosure front.

2. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
3. Elevated Equipment: Legible from the floor or working platform.
4. Interior Components: Legible from the point of access.
5. Conduits: Legible from the floor.
6. Boxes: Outside face of cover.
7. Conductors and Cables: Legible from the point of access.

C. Install identification products centered, level, and parallel with lines of item being identified.

D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.
1. Do not use adhesives on exterior surfaces.

E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.

F. Mark all handwritten text, where permitted, to be neat and legible.

3.03 FIELD QUALITY CONTROL

A. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

END OF SECTION 260553

SECTION 260573
POWER SYSTEM STUDIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Short-circuit study.

B. Arc flash and shock risk assessment.
   1. Includes arc flash hazard warning labels.

C. Criteria for the selection and adjustment of equipment and associated protective devices not specified in this section, as determined by studies to be performed.

1.02 SCOPE

A. The study shall include all new electrical equipment throughout the project building. Contractor shall coordinate collection of required data with Owner's staff for the existing electrical systems of the existing building.

B. The study shall include all of the voltages available to include but not be limited to:
   1. 208/120V (3 phase and 1 phase)
   2. 480/277V (3 phase and 1 phase)
   3. 480V (3 wire)

1.03 RELATED REQUIREMENTS

A. Section 260553 - Identification for Electrical Systems: Additional requirements for arc flash hazard warning labels.

B. Section 262413 - Switchboards.

C. Section 262416 - Panelboards.

D. Section 262813 - Fuses.

E. Section 262816.16 - Enclosed Switches.

F. Section 262913 - Enclosed Controllers.

1.04 REFERENCE STANDARDS

A. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels; 2023.

B. NEMA MG 1 - Motors and Generators; 2024.

C. NFPA 70E - Standard for Electrical Safety in the Workplace; 2024.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Existing Installations: Coordinate with equipment manufacturer(s) to obtain data necessary for completion of studies. A previous study was completed by Schneider Electric on 05/03/2021. Some additional data (existing equipment and conductor information) will be requested during construction in order to maintain a complete electrical study for the building, but generally information required is mostly only related to new construction only.
   2. Coordinate the work to provide equipment and associated protective devices complying with criteria for selection and adjustment, as determined by studies to be performed.
   3. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:
   1. Submit study reports prior to or concurrent with product submittals.
   2. Do not order equipment until matching study reports and product submittals have both been evaluated by Engineer.

3. Verify naming convention for equipment identification prior to creation of final drawings, reports, and arc flash hazard warning labels (where applicable).

1.06 POWER SYSTEM STUDIES

A. Data Collection:
   1. Compile information on project-specific characteristics of actual installed equipment, protective devices, feeders, etc. as necessary to develop single-line diagram of electrical distribution system and associated input data for use in system modeling.
      a. Motors: Include manufacturer/model, type (e.g. induction, synchronous), horsepower rating, voltage rating, full load amps, and locked rotor current or NEMA MG 1 code letter designation.
      b. Transformers: Include primary and secondary voltage ratings, kVA rating, winding configuration, percent impedance, and X/R ratio.
      c. Protective Devices:
         1) Circuit Breakers: Include manufacturer/model, type (e.g. thermal magnetic, electronic trip), frame size, trip rating, voltage rating, interrupting rating, available field-adjustable trip response settings, and features (e.g. zone selective interlocking).
         2) Fuses: Include manufacturer/model, type/class (e.g. Class J), size/rating, and speed (e.g. time delay, fast acting).
      d. Conductors: Include feeder size, material (e.g. copper, aluminum), insulation type, voltage rating, number per phase, raceway type, and actual length.

B. Short-Circuit Study:
   1. Completed by Engineer (Ever-Green Energy) using data gathered by Contractor.

C. Arc Flash and Shock Risk Assessment:
   1. Completed by Engineer (Ever-Green Energy) using data gathered by Contractor.

PART 2 PRODUCTS

2.01 ARC FLASH HAZARD WARNING LABELS

A. Provide warning labels complying with ANSI Z535.4 to identify arc flash hazards for each work location analyzed by the arc flash and shock risk assessment.
   1. Completed Label will be provided to contractor via PDF file. Contractor shall print and install labels as part of this project.
   2. Materials: Comply with Section 260553.
   3. Minimum Size: 4 by 6 inches.
   4. Legend: Provide custom legend in accordance with NFPA 70E based on equipment-specific data as determined by arc flash and shock risk assessment.
      a. Include orange header that reads "WARNING" unless otherwise indicated.
      b. Include the text "Arc Flash and Shock Hazard; Appropriate PPE Required" or approved equivalent.
      c. Include the following information:
         1) Arc flash boundary.
         2) Available incident energy and corresponding working distance.
         3) Site-specific PPE (personnel protective equipment) requirements.
         4) Nominal system voltage.
         5) Available fault current.
         6) Limited approach boundary.
         7) Restricted approach boundary.
         8) Equipment identification.
         9) Study preparer, report reference, and date calculations were performed.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install arc flash warning labels in accordance with Section 260553.

3.02 FIELD QUALITY CONTROL

A. Adjust equipment and protective devices for compliance with studies and recommended settings.

B. Notify Engineer of any conflicts with or deviations from studies. Obtain direction before proceeding.

END OF SECTION 260573

SECTION 260583
WIRING CONNECTIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electrical connections to and for equipment.

1.02 RELATED REQUIREMENTS

A. Section 260519 - Low-Voltage Electrical Power Conductors and Cables.

B. Section 260533.13 - Conduit for Electrical Systems.

C. Section 260533.16 - Boxes for Electrical Systems.

D. Section 260553 - Identification for Electrical Systems.

E. Section 260573 - Power System Studies.

F. Section 262726 - Wiring Devices.

G. Section 262816.16 - Enclosed Switches.

H. Section 262913 - Enclosed Controllers.

I. Section 262923 - Variable-Frequency Motor Controllers.

J. This section is a Division 26 Basic Electrical Materials and Methods section, and is part of each Division 10, 11, 12, 14, 21, 22, 23, 25, 26, 27, 28, 32, or any other section making reference to electrical connections for equipment specified or required therein.

1.03 DESCRIPTION OF WORK

A. Extent of electrical connections for equipment is indicated by drawings and schedules throughout the construction documents (not only electrical drawings and specifications). Electrical connections are hereby defined to include connections used for providing electrical power and other connections to equipment specified in any drawing or document within the construction documents.

B. Applications of electrical power connections specified in this section include the following:
   1. To mechanical equipment, controls, motor starters, variable frequency drives, and motors.
   2. To fuel oil equipment.

C. Make electrical connections to all motors, appliances and other equipment and the associated control devices in accordance with the schedules on the drawings and as hereinafter specified.
   1. In each case verify connections and physical data from approved shop drawing, manufacturers' wiring diagrams and/or detail drawings provided by relevant trade subcontractor.
   2. Make connections to all motors and equipment furnished and set in place by others. Provide starters, manual controls and auxiliary equipment where indicated in mechanical, architectural, or electrical schedules and specified herein. Provide all disconnect switches as indicated in schedules, specified herein and required by code.
   3. Provide interconnection wiring, conduit and connections between components where shown in shop drawings to be field wired.

D. Electrical connections for equipment, not furnished as integral part of equipment, are described in Division 10, 11, 12, 14, 21, 22, 23, 25, 26, 27, 28, and 32 sections, and are work of this section.

E. Motor starters and controllers, not furnished as integral part of equipment, shall be provided complying with Section 262913.

F. Refer to Divisions 21, 22, 23 and 25 sections for connection requirements for mechanical and control equipment.

G. Junction boxes and disconnect switches required for connecting motors and other electrical units of equipment are specified in applicable Division 26 sections.

H. Electrical identification for wire/cable conductors is specified in Section 260553.

I. Raceways and wires/cables required for connecting motors and other electrical units of equipment are specified in applicable Division 26 sections.

J. Refer to sections of other Divisions and drawings for specific individual equipment power requirements.

1.04 REFERENCE STANDARDS

A. NEMA WD 1 - General Color Requirements for Wiring Devices; 1999 (Reaffirmed 2020).

B. NEMA WD 6 - Wiring Devices - Dimensional Specifications; 2021.

C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

D. UL 486A-486B - Wire Connectors; Current Edition, Including All Revisions.

E. UL 486C - Splicing Wire Connectors; Current Edition, Including All Revisions.

F. UL 486D - Sealed Wire Connector Systems; Current Edition, Including All Revisions.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
   2. Determine connection locations and requirements.

B. Sequencing:
   1. Install rough-in of electrical connections before installation of equipment is required.
   2. Make electrical connections before required start-up of equipment.

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70. Comply with applicable requirements of NEC as to type products used and installation of electrical power connections (terminals and splices), for junction boxes, motor starters, and disconnect switches.

B. Products: Listed, classified, and labeled as suitable for the purpose intended.

C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

D. Comply with applicable requirements of ANSI/NEMA and ANSI/EIA standards pertaining to products and installation of electrical connections for equipment.

E. Comply with UL 486A-486B, UL 486C and UL 486D including, but not limited to, tightening of electrical connectors to torque values indicated. Provide electrical connection products and materials which are listed and labeled by nationally recognized testing laboratories.

PART 2 PRODUCTS

2.01 MATERIALS

A. Cords and Caps: NEMA WD 6; match receptacle configuration at outlet provided for equipment.
   1. Colors: Comply with NEMA WD 1.
   2. Cord Construction: NFPA 70, Type SO, multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.
   3. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.

4. Provide devices as per specifications in Section 262726.

B. Disconnect Switches: As specified in Section 262816.16 and in individual equipment sections.

C. Wiring Devices: As specified in Section 262726.

D. Flexible Conduit: As specified in Section 260533.13.

E. Wire and Cable: As specified in Section 260519.

F. Boxes: As specified in Section 260533.16.

G. Provide complete assembly of materials, including but not limited to, pressure connectors, terminals (lugs), electrical insulating tape, heat-shrinkable insulating tubing, cable ties, solderless wire-nuts, and other items and accessories as needed to complete splices and terminations for each electrical connection required.

H. All electrical equipment specified in Divisions 26, 27, and 28 as well as all other sections shall be selected, coordinated, and installed in such a manner that:
   1. The overcurrent protective devices, the total impedance, the equipment short-circuit current ratings, and other characteristics of the circuit to be protected permit the circuit protective devices used to clear a fault to do so without extensive damage to the electrical equipment of the circuit.
      a. This fault shall be assumed to be the worst condition of 3-phase, line-to-line, or line-to-line-to-ground fault.
   2. Short-circuit current ratings (SCCR) shall be coordinated and determined as per Section 260573.
   3. Label associated equipment and disconnects both as required by NRTL listing and as per Section 260553 including SCCR ratings and available fault current.
   4. Equipment shall be installed in accordance with the listing of that equipment.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.02 ELECTRICAL CONNECTIONS

A. Make electrical connections in accordance with equipment manufacturer's instructions.

B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.

C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.

D. Provide receptacle outlet to accommodate connection with attachment plug.

E. Provide cord and cap where field-supplied attachment plug is required.

F. Where loose electrical apparatus is supplied as part of an equipment item, install and interconnect it as required by the manufacturer's installation drawings. Such loose apparatus is indicated where known.

G. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.

H. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.

I. Install terminal block jumpers to complete equipment wiring requirements.

J. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

K. Install electrical connections as indicated; in accordance with equipment manufacturer's written instructions and with recognized industry practices, and complying with applicable requirements of UL, NEC and NECA's "Standard of Installation" to ensure that products fulfill requirements.

L. Coordinate the work, including wires/cables, raceway and equipment installation, as necessary to properly interface installation of electrical connections for equipment with other work.

M. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams. Mate and match conductors of electrical connections for proper interface between electrical power supplies and installed equipment.

N. Cover splices with electrical insulating material equivalent to, or of greater insulation resistivity rating, than electrical insulation rating of those conductors being spliced.

O. Prepare cables and wires, by cutting and stripping covering armor, jacket, and insulation properly to ensure uniform and neat appearance where cables and wires are terminated. Exercise care to avoid cutting through tapes which will remain on conductors. Also avoid "ringing" copper conductors while skinning wire.

P. Trim cables and wires as short as practicable and arrange routing to facilitate inspection, testing and maintenance.

Q. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturers published torque tightening values for equipment connectors. Accomplish tightening by utilizing proper torqueing tools, including torque screwdriver, beam-type torque wrench, and ratchet wrench with adjustable torque settings. Where manufacturer's torqueing requirements are not available, tighten connectors and terminals to comply with torqueing values contained in UL 486A-486B, UL 486C, and UL 486D.

R. Provide flexible conduit for connection of motors and other electrical equipment where subject to movement and vibration.

S. Regardless of panelboard schedule circuit breakers shown during design, coordinate with equipment supplier and provide circuit breaker sizes required for system.

T. Not all connection requirements are shown for each piece of system equipment. Beyond what is shown on drawings, provide additional junction boxes, wiring, conduit, outlets, circuit breakers, disconnect switches, and connections as required for each required system equipment installation. All work required by each system equipment submittals shall be provided at no additional cost to to the owner. Under no circumstances shall additional costs be paid by Owner due to lack of coordination between contractors/suppliers during construction.

U. Fasten identification markers to each electrical power supply wire/cable conductor in accordance with Section 260553. Affix markers on each terminal conductor, as close as possible to the point of connection.

3.03 CONNECTIONS TO MECHANICAL EQUIPMENT

A. Make electrical connections to mechanical equipment, devices, and building automation system (BAS) control devices according to the manufacturer’s written instructions. Coordinate with Divisions 21, 22, 23 and 25.

B. Provide 120V, 24V and 12V power connections, wiring, boxes, and raceway as required for valves. Coordinate with Division 22 and 23.

C. Provide 120V power connections, wiring, boxes, and raceway for building automation system (BAS) control panels and transformers. Coordinate with Divisions 23 and 25.

D. Provide 120V controls connections, wiring, boxes, and raceway for building automation system (BAS) and for standalone controls equipment. Coordinate with Divisions 21, 22, 23 and 25.

E. Provide 120V power connections, wiring, boxes, and raceway as required for accessory lights and power to mechanical equipment as required by manufacturers installation instructions. Coordinate with Division 23.

F. Refer to Section 262923 for the installation of variable frequency drives.

3.04 CONNECTIONS TO FUEL OIL EQUIPMENT

A. Make electrical connections as indicated in the plans and specifications to Owner's new and relocated fuel dispensing equipment according to the manufacturer's written instructions. Coordinate with Owner, existing relocated equipment, and shop drawings (if applicable).

B. Provide conduit seals for conduits as per NEC 500 at both ends of conduits to fuel oil pumps or to conduits passing through the classified location.

3.05 FIELD QUALITY CONTROL

A. Upon completion of installation of electrical connections, and after circuitry has been energized with rated power source, test connections to demonstrate capability and compliance with requirements. Ensure that direction of rotation of each motor and each piece of equipment fulfills requirement. Correct malfunctioning units at site, then retest to demonstrate compliance.

END OF SECTION 260583

SECTION 262413
SWITCHBOARDS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Low-voltage (600 V and less) switchboards and associated accessories for service and distribution applications.

B. Overcurrent protective devices for switchboards.

1.02 RELATED REQUIREMENTS

A. Section 260526 - Grounding and Bonding for Electrical Systems.

B. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

C. Section 260573 - Power System Studies: Additional criteria for the selection and adjustment of equipment and associated protective devices specified in this section.

1.03 REFERENCE STANDARDS

A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; 2013e, with Amendments (2022).

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

C. NECA 400 - Standard for Installing and Maintaining Switchboards; 2007.

D. NEMA PB 2.1 - General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards Rated 1000 Volts or Less; 2023.

E. NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems; 2021.

F. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
   2. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

A. Before Installation (Submit as a single package):
   1. Product Data: Provide manufacturer's data sheets for overcurrent protective devices, and other installed components and accessories.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store components in accordance with manufacturer's instructions, NECA 400, and NEMA PB 2.1.

B. Store in a clean, dry space having a uniform temperature to prevent condensation (including outdoor switchboards, which are not weatherproof until completely and properly installed).

Where necessary, provide temporary enclosure space heaters or temporary power for permanent factory-installed space heaters.

C. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

D. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.08 FIELD CONDITIONS

A. Maintain field conditions within required service conditions during and after installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Switchboards:
   1. Schneider Electric; Square D Products; Match existing: www.schneider-electric.us

B. Source Limitations: Provide switchboards and associated components produced by same manufacturer as other electrical distribution equipment used for project and obtained from single supplier.

2.02 OVERCURRENT PROTECTIVE DEVICES

A. Circuit Breakers:
   1. Interrupting Capacity:
      a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than specified minimum requirements.
      b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
   2. Molded Case Circuit Breakers:
      a. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers; listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
         1) Provide electronic trip circuit breakers for circuit breaker frame sizes 200 amperes and above.
      b. Minimum Interrupting Capacity:
         1) Matching withstand rating of switchboard.
      c. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
         1) Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.
         2) Provide interchangeable trip units for circuit breaker frame sizes 400 amperes and larger.
      d. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
         1) Provide the following field-adjustable trip response settings:
            (a) Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.
            (b) Long time delay.
            (c) Short time pickup and delay.
            (d) Instantaneous pickup.
      e. Provide the following circuit breaker types where indicated:
         1) 100 Percent Rated Circuit Breakers: Listed for application within the switchboard where installed at 100 percent of the continuous current rating.
      f. Provide the following features and accessories for a complete installation:

1) Pad-Lock Provision: For locking circuit breaker handle in OFF position.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the ratings and configurations of the switchboards and associated components are consistent with the indicated requirements.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install switchboard overcurrent protective devices in accordance with NECA 1 (general workmanship), NECA 400, and NEMA PB 2.1.

C. Arrange equipment to provide required clearances and maintenance access, including accommodations for any drawout devices.

D. Provide grounding and bonding in accordance with Section 260526.

E. Install all field-installed devices, components, and accessories.

F. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed in accordance with Section 260573.

G. Provide filler plates to cover unused spaces in switchboards.

H. Identify switchboards in accordance with Section 260553.

3.03 FIELD QUALITY CONTROL

A. Molded Case and Insulated Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for all main circuit breakers. Tests listed as optional are not required.

B. Correct deficiencies and replace damaged or defective switchboards or associated components.

3.04 CLEANING

A. Clean dirt and debris from switchboard enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred surfaces to match original factory finish.

3.05 PROTECTION

A. Protect installed switchboards from subsequent construction operations.

END OF SECTION 262413

SECTION 262416
PANELBOARDS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Overcurrent protective devices for panelboards.

1.02 REFERENCE STANDARDS

A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; 2013e, with Amendments (2022).

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

C. NECA 407 - Standard for Installing and Maintaining Panelboards; 2015.

D. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 1000 Volts or Less; 2023.

E. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
   2. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Source Limitations: Provide panelboards and associated components produced by the existing panelboard manufacturer and obtained from a single supplier.

2.02 PANELBOARDS - GENERAL REQUIREMENTS

A. Provide products listed, classified, and labeled as suitable for the purpose intended.

B. Short Circuit Current Rating:
   1. Listed series ratings are not acceptable.

C. Conductor Terminations: Suitable for use with the conductors to be installed.

2.03 OVERCURRENT PROTECTIVE DEVICES

A. Molded Case Circuit Breakers:
   1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
   2. Interrupting Capacity:
      a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating to match existing panelboard as indicated, but not less than:
         1) 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.
         2) 14,000 rms symmetrical amperes at 480 VAC.
      b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
   3. Conductor Terminations:
      a. Provide mechanical lugs unless otherwise indicated.
      b. Provide compression lugs where indicated.
      c. Lug Material: Copper, suitable for terminating copper conductors only.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).

B. Install products in accordance with manufacturer's instructions.

C. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.

D. Install all field-installed branch devices, components, and accessories.

3.03 CLEANING

A. Clean dirt and debris from panelboard enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 262416

SECTION 262419
MOTOR-CONTROL CENTERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Overcurrent protective devices for motor control centers and associated units, including overload relays.

1.02 RELATED REQUIREMENTS

A. Section 260526 - Grounding and Bonding for Electrical Systems.

B. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

C. Section 262913 - Enclosed Controllers.

1.03 REFERENCE STANDARDS

A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; 2013e, with Amendments (2022).

B. IEEE C37.20.7 - IEEE Recommended Practice for Testing Switchgear Rated up to 52 kV for Internal Arcing Faults; 2024.

C. NECA 402 - Standard for Installing and Maintaining Motor Control Centers; 2020.

D. NEMA ICS 2.3 - Industrial Control and Systems: Instructions for the Handling, Installation, Operation, and Maintenance of MCCs Rated Not More Than 600 Volts; 2019.

E. NEMA BS 31047 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); 2013 (Reaffirmed 2023).

F. NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems; 2021.

G. UL 98 - Enclosed and Dead-Front Switches; Current Edition, Including All Revisions.

H. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

I. UL 977 - Fused Power-Circuit Devices; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.
   2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
   4. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

A. Before Installation (Submit as a single package):
   1. Product Data: Provide manufacturer's data sheets for motor control centers, enclosures, units, overcurrent protective devices, and other installed components and accessories.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store motor control centers in accordance with manufacturer's instructions, NECA 402, and NEMA ICS 2.3.

B. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle carefully to avoid damage to internal components, enclosure, and finish.

1.07 FIELD CONDITIONS

A. Maintain field conditions within required service conditions during and after installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Motor Control Centers:
   1. Eaton Corporation; Freedom: www.eaton.com.

2.02 OVERCURRENT PROTECTIVE DEVICES

A. Circuit Breakers:
   1. Interrupting Capacity (not applicable to motor circuit protectors):
      a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than specified minimum requirements.
      b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
   2. Molded Case Circuit Breakers:
      a. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers; listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
      b. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
         1) Provide the following field-adjustable trip response settings:
            (a) Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.
            (b) Long time delay.
            (c) Short time pickup and delay.
            (d) Instantaneous pickup.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the ratings and configurations of the motor control centers and associated components are consistent with the indicated requirements.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install motor control centers in accordance with NECA 1 (general workmanship), NECA 402, and NEMA ICS 2.3.

C. Provide grounding and bonding in accordance with Section 260526.

D. Install all field-installed devices, components, and accessories.

E. Provide filler plates to cover unused spaces.

F. Identify motor control centers in accordance with Section 260553.

3.03 FIELD QUALITY CONTROL

A. Molded Case and Insulated Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for all main circuit breakers and circuit breakers larger than 200 amperes. Tests listed as optional are not required.

B. Correct deficiencies and replace damaged or defective motor control centers or associated components.

3.04 CLEANING

A. Clean dirt and debris from motor control center enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred surfaces to match original factory finish.

3.05 PROTECTION

A. Protect installed motor control centers from subsequent construction operations.

END OF SECTION 262419

SECTION 262813
FUSES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Fuses.

1.02 REFERENCE STANDARDS

A. NEMA FU 1 - Low Voltage Cartridge Fuses; 2012.

B. UL 248-1 - Low-Voltage Fuses - Part 1: General Requirements; Current Edition, Including All Revisions.

C. UL 248-12 - Low-Voltage Fuses - Part 12: Class R Fuses; Current Edition, Including All Revisions.

1.03 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Bussmann, a division of Eaton Corporation: www.cooperindustries.com

B. Littelfuse, Inc: www.littelfuse.com

C. Mersen: ep-us.mersen.com

2.02 APPLICATIONS

A. Provide fuse type as indicated on drawings. Where no type is indicated, apply the following:
   1. Individual Motor Branch Circuits: Class RK1, time-delay.

B. Provide current limiting for all fuses, unless noted otherwise

2.03 FUSES

A. Provide products listed, classified, and labeled as suitable for the purpose intended.

B. Unless specifically indicated to be excluded, provide fuses for all fusible equipment as required for a complete operating system.

C. Provide fuses of the same type, rating, and manufacturer within the same switch.

D. Comply with UL 248-1.

E. Unless otherwise indicated, provide cartridge type fuses complying with NEMA FU 1, Class and ratings as indicated.

F. Voltage Rating: Suitable for circuit voltage.

G. Class R Fuses: Comply with UL 248-12.
   1. Class RK1, Time-Delay Fuses:

H. Provide the following accessories where indicated or where required to complete installation:
   1. Fuseholders: Compatible with indicated fuses.
   2. Fuse Reducers: For adapting indicated fuses to permit installation in switch designed for fuses with larger ampere ratings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that fuse ratings are consistent with circuit voltage and manufacturer's recommendations and nameplate data for equipment.

B. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Do not install fuses until circuits are ready to be energized.

B. Install fuses with label oriented such that manufacturer, type, and size are easily read.

END OF SECTION 262813

SECTION 262816.16
ENCLOSED SWITCHES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Enclosed safety switches.

1.02 RELATED REQUIREMENTS

A. Section 260526 - Grounding and Bonding for Electrical Systems.

B. Section 260529 - Hangers and Supports for Electrical Systems.

C. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

D. Section 262813 - Fuses.

E. Section 262913 - Enclosed Controllers: Manual motor controllers.

1.03 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2020.

C. NEMA BS 31047 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); 2013 (Reaffirmed 2023).

D. NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems; 2021.

E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

F. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.

G. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.

H. UL 98 - Enclosed and Dead-Front Switches; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades. Avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and within working clearances for electrical equipment required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
4. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

A. Before Installation (Submit as a single package):

1. Product Data: Provide manufacturer's data sheets for enclosed switches and other installed components and accessories.
2. Shop Drawings: Indicate outline and support point dimensions, voltage and current ratings, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to enclosed switch internal components, enclosure, and finish.

1.08 FIELD CONDITIONS

A. Maintain ambient temperature between -22 degrees F and 104 degrees F during and after installation of enclosed switches.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Eaton Corporation: www.eaton.com

B. Schneider Electric; Square D Products: www.schneider-electric.us

C. Source Limitations: Provide enclosed switches and associated components produced by same manufacturer as other electrical distribution equipment used for project and obtained from single supplier.

2.02 ENCLOSED SAFETY SWITCHES

A. Description: Quick-make, quick-break enclosed safety switches listed and labeled as complying with UL 98; heavy duty; ratings, configurations, and features as indicated on the drawings.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
   1. Altitude: Less than 6,600 feet.
   2. Ambient Temperature: Between -22 degrees F and 104 degrees F.

D. Horsepower Rating: Suitable for connected load.

E. Voltage Rating: Suitable for circuit voltage.

F. Short Circuit Current Rating:
   1. Provide enclosed safety switches, when protected by the fuses or supply side overcurrent protective devices to be installed, with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
   2. Minimum Ratings:
      a. Heavy Duty Single Throw Switches Protected by Class R or Class J Fuses: 200,000 rms symmetrical amperes.

G. Provide with switch blade contact position that is visible when the cover is open.

H. Fuse Clips for Fusible Switches: As required to accept fuses indicated.
   1. Where NEMA Class R fuses are installed, provide rejection feature to prevent installation of fuses other than Class R.

I. Conductor Terminations: Suitable for use with the conductors to be installed.

J. Provide solidly bonded equipment ground bus in each enclosed safety switch, with a suitable lug for terminating each equipment grounding conductor.

K. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
   1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
      a. Indoor Clean, Dry Locations: Type 12.
   2. Finish for Painted Steel Enclosures: Manufacturer's standard, factory applied grey unless otherwise indicated.

L. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.

M. Heavy Duty Switches:
   1. Comply with NEMA BS 31047.
   2. Conductor Terminations:
      a. Provide compression lugs.
      b. Lug Material: Copper, suitable for terminating copper conductors only.
   3. Provide externally operable handle with means for locking in the OFF position, capable of accepting three padlocks.
   4. Provide the following features and accessories to complete installation:
      a. Hubs: As required for environment type; sized to accept conduits to be installed.
      b. Integral fuse pullers.
      c. Viewing Window: Positioned over switch blades for visual confirmation of contact position with door closed.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the ratings of the enclosed switches are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive enclosed safety switches.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Perform work in accordance with NECA 1 (general workmanship).

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Provide required support and attachment in accordance with Section 260529.

E. Install enclosed switches plumb.

F. Mount enclosed switches such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.

G. Provide grounding and bonding in accordance with Section 260526.

H. Provide fuses complying with Section 262813 for fusible switches as indicated or as required by equipment manufacturer's recommendations.

I. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

J. Identify enclosed switches in accordance with Section 260553.

3.03 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.

C. Correct deficiencies and replace damaged or defective enclosed safety switches or associated components.

3.04 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 CLEANING

A. Clean dirt and debris from switch enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 262816.16

SECTION 262913
ENCLOSED CONTROLLERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Enclosed NEMA controllers for low-voltage (600 V and less) applications:
   1. Magnetic motor starters.

B. Overcurrent protective devices for motor controllers, including overload relays.

C. Control accessories:
   1. Auxiliary contacts.
   2. Pilot devices.
   3. Control and timing relays.
   4. Control power transformers.

1.02 RELATED REQUIREMENTS

A. Section 260526 - Grounding and Bonding for Electrical Systems.

B. Section 260529 - Hangers and Supports for Electrical Systems.

C. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

D. Section 260573 - Power System Studies: Additional criteria for the selection and adjustment of equipment and associated protective devices specified in this section.

E. Section 262923 - Variable-Frequency Motor Controllers.

1.03 REFERENCE STANDARDS

A. IEEE C57.13 - IEEE Standard Requirements for Instrument Transformers; 2016.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2020.

D. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts; 2008 (Reaffirmed 2020).

E. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices; 2017.

F. NEMA ICS 6 - Industrial Control and Systems: Enclosures; 1993 (Reaffirmed 2016).

G. NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems; 2021.

H. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

I. UL 60947-1 - Low-Voltage Switchgear and Controlgear - Part 1: General Rules; Current Edition, Including All Revisions.

J. UL 60947-4-1 - Low-Voltage Switchgear and Controlgear - Part 4-1: Contactors and Motor-starters - Electromechanical Contactors and Motor-starters; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.
   2. Coordinate the work to provide motor controllers and associated overload relays suitable for use with the actual motors to be installed.

3. Coordinate the work to provide controllers and associated wiring suitable for interface with control devices to be installed.
4. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
5. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
6. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to internal components, enclosure, and finish.

1.07 FIELD CONDITIONS

A. Maintain field conditions within required service conditions during and after installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Eaton Corporation: www.eaton.com

B. Schneider Electric; Square D Products: www.schneider-electric.us

C. Source Limitations: Provide enclosed motor controllers and associated components produced by single manufacturer and obtained from single supplier.

2.02 ENCLOSED CONTROLLERS

A. Provide enclosed controller assemblies consisting of all required components, control power transformers, instrumentation and control wiring, accessories, etc. as necessary for a complete operating system.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Description: Enclosed controllers complying with NEMA ICS 2, and listed and labeled as complying with UL 60947-1 and UL 60947-4-1; ratings, configurations and features as indicated on the drawings.

D. Service Conditions:
1. Provide controllers and associated components suitable for operation under the following service conditions without derating:
   a. Ambient Temperature: Between 32 degrees F and 104 degrees F.
2. Provide controllers and associated components suitable for operation at indicated ratings under the service conditions at the installed location.

E. Short Circuit Current Rating:
1. Provide controllers with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
2. Listed series ratings are not acceptable.

F. Conductor Terminations: Suitable for use with the conductors to be installed.

G. Enclosures:
   1. Comply with NEMA ICS 6.
   2. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
      a. Indoor Clean, Dry Locations: Type 12.
   3. Finish: Manufacturer's standard unless otherwise indicated.

H. Instrument Transformers:
   1. Comply with IEEE C57.13.
   2. Select suitable ratio, burden, and accuracy as required for connected devices.
   3. Current Transformers: Connect secondaries to shorting terminal blocks.
   4. Potential Transformers: Include primary and secondary fuses with disconnecting means.

I. Magnetic Motor Starters: Combination type unless otherwise indicated.
   1. Combination Magnetic Motor Starters: NEMA ICS 2, Class A combination motor controllers with magnetic contactor(s), externally operable disconnect and overload relay(s).
   2. Configuration: Full-voltage non-reversing unless otherwise indicated.
   3. Minimum Starter Size: NEMA Size 0.
   4. Disconnects: Circuit breaker type.
      a. Circuit Breakers: Motor circuit protectors (magnetic-only) unless otherwise indicated or required.
      b. Provide externally operable handle with means for locking in the OFF position. Provide safety interlock to prevent opening the cover with the disconnect in the ON position with capability of overriding interlock for testing purposes.
      c. Provide auxiliary interlock for disconnection of external control power sources where applicable.
   5. Overload Relays: Bimetallic thermal type unless otherwise indicated.
   6. Pilot Devices Required:
      a. Furnish local pilot devices for each unit as specified below unless otherwise indicated on drawings.
      b. Single-Speed, Non-Reversing Starters:
         1) Pushbuttons: START-STOP.
         2) Selector Switches: HAND/OFF/AUTO.
         3) Indicating Lights: Red ON, Green OFF.

2.03 CONTROL ACCESSORIES

A. Auxiliary Contacts:
   1. Comply with NEMA ICS 5.
   2. Provide number and type of contacts indicated or required to perform necessary functions, including holding (seal-in) circuit and interlocking, plus one normally open (NO) and one normally closed (NC) spare contact for each magnetic motor starter, minimum.

B. Pilot Devices:
   1. Comply with NEMA ICS 5; heavy-duty type.
   2. Pushbuttons: Unless otherwise indicated, provide momentary, non-illuminated type with flush button operator; normally open or normally closed as indicated or as required.
   3. Selector Switches: Unless otherwise indicated, provide maintained, non-illuminated type with knob operator; number of switch positions as indicated or as required.
   4. Indicating Lights: Push-to-test type unless otherwise indicated.
   5. Provide LED lamp source for indicating lights and illuminated devices.

C. Control and Timing Relays:
   1. Comply with NEMA ICS 5.
   2. Provide number and type of relays indicated or required to perform necessary functions.

D. Control Power Transformers:
   1. Size to accommodate burden of contactor coil(s) and all connected auxiliary devices, plus 25 percent spare capacity.
   2. Include primary and secondary fuses.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that ratings of enclosed controllers are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive enclosed controllers.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install controllers in accordance with NECA 1 (general workmanship).

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Provide required support and attachment in accordance with Section 260529.

E. Install enclosed controllers plumb and level.

F. Provide grounding and bonding in accordance with Section 260526.

G. Install all field-installed devices, components, and accessories.

H. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

I. Set field-adjustable controllers and associated components according to installed motor requirements, in accordance with manufacturer's recommendations and NFPA 70.

J. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed in accordance with Section 260573.

K. Identify enclosed controllers in accordance with Section 260553.

3.03 FIELD QUALITY CONTROL

A. See Division 01 for additional requirements.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Motor Starters: Perform inspections and tests listed in NETA ATS, Section 7.16.1.1. Tests listed as optional are not required.

D. Correct deficiencies and replace damaged or defective enclosed controllers or associated components.

3.04 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 CLEANING

A. Clean dirt and debris from controller enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

3.06 CLOSEOUT ACTIVITIES

A. Demonstration: Demonstrate proper operation of controllers to Owner, and correct deficiencies or make adjustments as directed.

3.07 PROTECTION

A. Protect installed enclosed controllers from subsequent construction operations.

END OF SECTION 262913

SECTION 262923
VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Variable-frequency motor controllers for low-voltage (600 V and less) AC motor applications.

1.02 RELATED REQUIREMENTS

A. Division 03 - Cast-in-Place Concrete: Housekeeping pads.

B. Section 260526 - Grounding and Bonding for Electrical Systems.

C. Section 260529 - Hangers and Supports for Electrical Systems.

D. Section 260519 - Low-Voltage Electrical Power Conductors and Cables: For VFD cabling.

E. Section 260529 - Hangers and Supports for Electrical Systems.

F. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

1.03 REFERENCE STANDARDS

A. IEC 60529 - Degrees of Protection Provided by Enclosures (IP Code); 1989 (Corrigendum 2019).

B. IEEE C57.13 - IEEE Standard Requirements for Instrument Transformers; 2016.

C. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2020.

E. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts; 2008 (Reaffirmed 2020).

F. NEMA ICS 6 - Industrial Control and Systems: Enclosures; 1993 (Reaffirmed 2016).

G. NEMA ICS 7 - Industrial Control and Systems: Adjustable-Speed Drives; 2020.

H. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts; 2008 (Reaffirmed 2020).

I. NEMA ICS 7.1 - Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable-Speed Drive Systems; 2022.

J. NEMA ICS 7.2 - Application Guide for AC Adjustable Speed Drive Systems; 2021.

K. NEMA ICS 61800-2 - Adjustable Speed Electrical Power Drive Systems, Part 2: General Requirements-Rating Specifications for Low Voltage Adjustable Frequency AC Power Drive Systems; 2005.

L. NEMA MG 1 - Motors and Generators; 2024.

M. NEMA MG 1 - Motors and Generators; 2024.

N. NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems; 2021.

O. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

P. UL 508A - Industrial Control Panels; Current Edition, Including All Revisions.

Q. UL 61800-5-1 - Standard for Adjustable Speed Electrical Power Drive Systems - Part 5-1: Safety Requirements – Electrical, Thermal, and Energy (Ed. 2); Current Edition, Including All Revisions.

1.04 DEFINITIONS

A. The terms listed below are defined as follows:

1. VFC: Variable Frequency motor Controllers
2. VFD: Variable Frequency Drives (VFDs); Same as VFCs. VFDs and VFCs are interchangeable and refer to the same equipment in this project.

B. Before Installation (Submit as a single package):
   1. Product Data: Provide catalog pages and data sheets for motor controllers, enclosures, overcurrent protective devices, disconnects, and other installed components and accessories.
   2. Shop Drawings: Indicate dimensions, voltage, controller sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
      a. Include dimensioned plan and elevation views of controllers and adjacent equipment with required clearances indicated.

C. After Installation:
   1. Field quality control test reports.
   2. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
   3. Project Record Documents: Record actual installed locations of controllers and final equipment settings.
      a. Include nameplate data of actual installed motors and associated overload relay selections and settings.
      b. Motor Circuit Protectors: Include magnetic instantaneous trip settings.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
   1. Authorized service facilities located within 200 miles of project site.

B. Installer Qualifications: Company with minimum three years documented experience with variable-frequency motor control systems of similar size, type, and complexity; manufacturer's authorized installer.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to internal components, enclosure, and finish.

1.07 FIELD CONDITIONS

A. Maintain field conditions within required service conditions during and after installation.

1.08 WARRANTY

A. Provide minimum 18-month manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Variable-Frequency Motor Controllers:
   1. ABB; ACH580 series: www.abb.com
   2. Eaton Corporation; Prior Approved Equal: www.eaton.com
   3. Rockwell Automation, Inc.; Allen-Bradley Products; Prior Approved Equal: ab.rockwellautomation.com
   4. Toshiba; Prior Approved Equal: www.toshiba.com

B. Substitutions: By Prior Approval Only.

C. Source Limitations: Provide variable-frequency motor controllers and associated components produced by single manufacturer and obtained from single supplier.

2.02 VARIABLE-FREQUENCY MOTOR CONTROLLERS

A. Provide variable-frequency motor control system consisting of required controller assemblies, operator interfaces, control power transformers, instrumentation and control wiring, sensors, accessories, system programming, etc. as necessary for complete operating system.

B. Provide products listed, classified, and labeled as suitable for purpose intended.

C. Variable-Frequency Motor Controller:
   1. Configuration: Packaged controller, nonbypass.
   2. Power Conversion System: IGBT-based active front end type.
   3. Filtering: Provide input/line reactor and output/load reactor.

D. Description: NEMA ICS 2 and NEMA ICS 7, IGBT, PWM, VFC; listed and labeled as a complete unit and arranged to provide variable speed of an NEMA MG 1, Design B, 3-phase induction motor by adjusting output voltage and frequency.
   1. Employ microprocessor-based inverter logic isolated from power circuits.
   2. Employ pulse-width-modulated inverter system.
   3. Design for ability to operate controller with motor disconnected from output.

E. Controller Assemblies: Comply with NEMA ICS 7, NEMA ICS 7.1, and NEMA ICS 61800-2; list and label as complying with UL 61800-5-1 or UL 508A as applicable.

F. Provide controllers selected for actual installed motors and coupled mechanical loads in accordance with NEMA ICS 7.2, NEMA MG 1 Part 30, and recommendations of manufacturers of both controller and load, where not in conflict with specified requirements; considerations include, but are not limited to:
   1. Motor type (e.g., induction, reluctance, and permanent magnet); consider NEMA MG 1 design letter or inverter duty rating for induction motors.
   2. Motor load type (e.g., constant torque, variable torque, and constant horsepower); consider duty cycle, impact loads, and high inertia loads.
   3. Motor nameplate data.
   4. Requirements for speed control range, speed regulation, and braking.
   5. Motor suitability for bypass starting method, where applicable.

G. Devices on Load Side of Controller: Suitable for application across full controller output frequency range.

H. Operating Requirements:
   1. Input Voltage Tolerance: Plus/minus 10 percent of nominal.
   2. Input Frequency Tolerance: Plus/minus 5 percent of nominal.
   3. Efficiency: Minimum of 96 percent at full speed and load.
   4. Input Displacement Power Factor: Minimum of 0.96 throughout speed and load range.
   5. Overload Rating:
      a. Variable Torque Loads: Minimum of 110 percent of nominal for 60 seconds.
      b. Constant Torque Loads: Minimum of 150 percent of nominal for 60 seconds.

I. Power Conversion System: Microprocessor-based, pulse width modulation type.
   1. IGBT-based active front end type unless otherwise indicated.

J. Control System:
   1. Provide microprocessor-based control system for automatic control, monitoring, and protection of motors. Include sensors, wiring, and connections necessary for functions and status/alarm indications specified.

2. Provide integral operator interface for controller programming, display of status/alarm indications, fault reset, and local control functions including motor run/stop, motor forward/reverse selection, motor speed increase/decrease, and local/remote control selection.
3. Control Functions:
    a. Control Method: Selectable vector and scalar/volts per hertz unless otherwise indicated.
        1) Scalar/Volts per Hertz Control: Provide IR compensation for improved low-speed torque.
        2) Vector Control: Provide selectable autotuning function.
    b. Adjustable acceleration and deceleration time; linear and S-curve ramps; selectable coast to stop.
    c. Selectable braking control; DC injection or flux braking.
    d. Adjustable minimum/maximum speed limits.
    e. Adjustable pulse width modulation switching carrier frequency.
    f. Adjustable motor slip compensation.
    g. Selectable autorestart after noncritical fault; programmable number of time delay between restart attempts.
    h. Automatic catching of rotating motor.
    i. Energy-saving algorithms.
    j. Safety Interlock: Provide permissive run safety interlock capability where indicated or required; upon activation of designated input, stop and prevent operation of motor; operational in both drive and bypass modes where applicable.
4. Status Indications:
    a. Motor run/stop status.
    b. Motor forward/reverse status.
    c. Local/remote control status.
    d. Output voltage.
    e. Output current.
    f. Output frequency.
    g. DC bus voltage.
    h. Motor speed.
    i. Energy.
    j. Elapsed run time.
    k. Discrete input/output status.
    l. Analog input/output values.
5. Protective Functions/Alarm Indications:
    a. Overcurrent.
    b. Motor overload.
    c. Undervoltage.
    d. Overvoltage.
    e. Controller overtemperature.
    f. Input/output phase loss.
    g. Output short circuit protection.
    h. Output ground fault protection.
6. Inputs:
    a. Digital Input(s): Three.
    b. Analog Input(s): Two.
7. Outputs:
    a. Analog Output(s): One.
    b. Relay Output(s): Two.

8. Communications: Compatible with connected systems. Provide accessories necessary for proper interface.
    a. Serial Communications: RS-485; support for Modbus RTU protocol.
    b. Remote Monitoring Capabilities:
        1) Motor run/stop status.
        2) Hand-off-auto status.
        3) Fault information.
        4) Discrete input/output status.
        5) Analog input/output values.
    c. Remote Control Capabilities:
        1) Motor run/stop command.
        2) Hand-off-auto selection.
        3) Speed adjustment.
        4) Fault reset.
9. Features:
    a. Password-protected security access.
    b. Event log.

K. Power Conditioning/Filtering:
1. Provide DC link choke or input/line reactor for each controller unless otherwise indicated or required.
2. Provide LCL filter for IGBT-based active front end controllers.
3. Reactor Impedance: 3 percent, unless otherwise indicated or required.

L. Packaged Controllers: Controllers factory-mounted in separate enclosure with externally operable disconnect and specified accessories.
1. Disconnects: Circuit breaker or disconnect switch type.
    a. Disconnect Switches: Fusible type or nonfusible type with separate input fuses.
    b. Provide externally operable handle with means for locking in OFF position. Provide safety interlock to prevent opening cover with disconnect in ON position with capability of overriding interlock for testing purposes.
    c. Provide auxiliary interlock for disconnection of external control power sources where applicable.
2. Provide door-mounted remote operator interface.

M. Service Conditions:
1. Provide controllers and associated components suitable for operation under following service conditions without derating:
    a. Altitude: Less than 3,300 feet.
    b. Ambient Temperature: Between 32 degrees F and 104 degrees F.
2. Provide controllers and associated components suitable for operation at indicated ratings under service conditions at installed location.

N. Short Circuit Current Rating:
1. Provide controllers with listed short circuit current rating not less than available fault current at installed location as indicated on drawings.
2. Provide line/input reactors where specified by manufacturer for required short circuit current rating.

O. Conductor Terminations: Suitable for use with conductors to be installed.

P. Enclosures:
1. Comply with NEMA ICS 6.
2. NEMA 250 Environment Type or Equivalent IEC 60529 Rating: Unless otherwise indicated, as specified for following installation locations:
    a. Indoor Clean, Dry Locations: Type 1 or Type 12.

b. Hazardous/Classified Locations: Type 7/9, as required for classification of installed location.
3. Finish: Manufacturer's standard unless otherwise indicated.
4. Cooling: Forced air or natural convection as determined by manufacturer.

Q. Instrument Transformers:
1. Comply with IEEE C57.13.
2. Select suitable ratio, burden, and accuracy as required for connected devices.
3. Current Transformers: Connect secondaries to shorting terminal blocks.
4. Potential Transformers: Include primary and secondary fuses with disconnecting means.

R. Interface with Other Work:
1. Provide products compatible with other systems requiring interface with controllers.
2. Interface with building automation system.
a. Capable of remote monitoring and control of controllers.

S. Products:
1. ABB; ACH580: www.abb.com
2. or Prior Approved Equal.

2.03 SOURCE QUALITY CONTROL

A. Factory test controllers in accordance with NEMA ICS 61800-2.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that ratings of controllers are consistent with indicated requirements.

C. Verify that mounting surfaces are ready to accept controllers.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install controllers in accordance with NECA 1 (general workmanship).

C. Install in accordance with NEMA ICS 7.1 and manufacturer's instructions.

D. Do not exceed manufacturer's recommended maximum cable length between controller and motor.

E. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

F. Provide required support and attachment in accordance with Section 260529.

G. Install controllers plumb and level.

H. Provide grounding and bonding in accordance with Section 260526.

I. Install field-installed devices, components, and accessories.

J. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

K. Set field-adjustable settings of controllers and associated components according to installed motor requirements, in accordance with recommendations of manufacturers of controller and load.

L. Set field-adjustable circuit breaker tripping function settings as directed.

M. Coordinate layout and installation of VFCs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

N. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

O. Where space is available in the room, mount the VFD such that the top of the VFD is at 60 inches maximum above the floor or working platform. With approval from engineer due to no space available a VFD may be mounted such that the highest position of the operating handle does not exceed 79 inches maximum above the floor or working platform. For controllers not on walls, provide freestanding racks complying with Section 260529.

P. Provide VFD cabling from VFD to motor as per Section 260519 - Low-Voltage Electrical Power Conductors and Cables.

Q. Identify controllers in accordance with Section 260553.
   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each VFC with engraved nameplate.
   3. Label each enclosure-mounted control and pilot device.
   4. Operating Instructions: Provide frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

R. For disconnect switches installed between a VFD and a motor, connect disconnect switch electrical interlock to VFD. Coordinate with flying restart and power interruption protection functions and programming of the VFD to shut down VFD output prior to opening of disconnect switch.

3.03 CONTROL WIRING INSTALLATION

A. Install wiring between VFCs and remote devices.

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic control devices where applicable.
   1. Connect selector switches to bypass only those manual and automatic control devices that have no safety functions when switches are in manual-control position.
   2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.04 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.

B. Replace VFCs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.05 FIELD QUALITY CONTROL

A. Provide services of manufacturer's authorized representative to perform inspection and testing. Include manufacturer's reports with submittals.

B. Perform field inspection and testing in accordance with Division 26 and according to Manufacturer's requirements.

C. Inspect and test in accordance with NETA ATS, except Section 4.

D. Perform inspections and tests listed in NETA ATS, Section 7.17. Insulation-resistance test on control wiring listed as optional is not required.

E. Correct deficiencies and replace damaged or defective controllers or associated components.

3.06 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

B. Make final adjustments to installed controller to assure proper operation of load system. Obtain performance requirements from installer of driven loads.

C. Adjust the trip settings of instantaneous-only circuit breakers and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to 6 times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed 8 times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors). Where these maximum settings do not allow starting of a motor, notify Engineer before increasing settings.

D. Do not set any VFDs at greater than 70 Hz without written direction from the Engineer. VFDs shall never be installed (even as a result of TAB or commissioning) such that motors are set at greater than 90 Hz.

3.07 CLEANING

A. Clean dirt and debris from controller enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

3.08 CLOSEOUT ACTIVITIES

A. Demonstration: Demonstrate proper operation of controllers to Owner, and correct deficiencies or make adjustments as directed.

B. System functional performance testing is part of the Commissioning Process as detailed in Division 01. Functional performance testing shall be performed by the contractor and witnessed and documented by the Commissioning Professional.

3.09 PROTECTION

A. Protect installed controllers from subsequent construction operations.

3.10 TRAINING

A. Train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFCs.

END OF SECTION 262923

SECTION 312000
EARTH MOVING

PART 1 GENERAL

1.01 REFERENCE STANDARDS

A. AASHTO M 288 - Standard Specification for Geosynthetics for Highway Applications; 2024.

B. ASTM C618 - Standard Specification for Coal Ash and Raw or Calcined Natural Pozzolan for Use in Concrete; 2023, with Editorial Revision.

C. ASTM D448 - Standard Classification for Sizes of Aggregate for Road and Bridge Construction; 2012 (Reapproved 2022).

D. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)); 2012 (Reapproved 2021).

E. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System); 2017, with Editorial Revision (2020).

F. ASTM D2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth); 2001.

G. ASTM D3740 - Standard Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction; 2023.

H. ASTM D4751 - Standard Test Methods for Determining Apparent Opening Size of a Geotextile; 2021a.

I. ASTM E329 - Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection; 2023.

1.02 RELATED DOCUMENTS

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

1.03 SUMMARY

A. Section Includes:
   1. Excavating and backfilling for buildings and structures.
   2. Drainage course for concrete on grade.
   3. Subbase course for concrete on grade.
   4. Subsurface drainage backfill for walls and trenches.
   5. Excavating and backfilling trenches for utilities and pits for buried utility structures.

B. Related Sections:
   1. Division 01 for recording preexcavation and earth moving progress.
   2. Division 01 for temporary controls, utilities, and support facilities; also for temporary site fencing if not in another Section.
   3. Division 03 Section "Cast-in-Place Concrete" for granular course if placed over vapor retarder and beneath the slab-on-grade.

1.04 UNIT PRICES

A. Work of this Section is affected by unit prices for earth moving specified in Division 01 Section "Unit Prices."

B. Quantity allowances for earth moving are included in Division 01 Section "Allowances."

1.05 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.
   1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.

2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

C. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

D. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

E. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
   1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Owner. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices, changes in the Work.
   2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Owner. Unauthorized excavation, as well as remedial work directed by Owner, shall be without additional compensation.

F. Fill: Soil materials used to raise existing grades.

G. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

H. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

I. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

J. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.06 SUBMITTALS

A. Product Data: For each type of the following manufactured products required:
   1. Geotextiles.
   2. Controlled low-strength material, including design mixture.
   3. Warning tapes.

B. Samples for Verification: For the following products, in sizes indicated below:
   1. Geotextile: 12 by 12 inches.
   2. Warning Tape: 12 inches long; of each color.

C. Qualification Data: For qualified testing agency.

D. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:
   1. Classification according to ASTM D2487.
   2. Laboratory compaction curve according to ASTM D698.

1.07 QUALITY ASSURANCE

A. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E329 and ASTM D3740 for testing indicated.

1.08 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth moving operations.
   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.

2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Utility Locator Service: Notify utility locator service for area where Project is located before beginning earth moving operations.

C. Do not commence earth moving operations until temporary erosion- and sedimentation-control measures, specified in Division 01 Section "Temporary Facilities and Controls", are in place.

D. Do not commence earth moving operations until plant-protection measures specified in Division 01 Section "Temporary Tree and Plant Protection" are in place.

E. The following practices are prohibited within protection zones:
1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

F. Do not direct vehicle or equipment exhaust towards protection zones.

G. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

PART 2 PRODUCTS

2.01 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D2487 or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D2487, or a combination of these groups.
1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

E. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

F. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.

G. Drainage Course: Narrowly graded mixture of crushed stone, or crushed or uncrushed gravel; ASTM D448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

H. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and 0 to 5 percent passing a No. 4 sieve.

I. Sand: ASTM C 33; fine aggregate.

J. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.02 GEOTEXTILES

A. Subsurface Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
   1. Survivability: Class 2; AASHTO M 288.
   2. Grab Tensile Strength: 157 lbf; ASTM D 4632.
   3. Sewn Seam Strength: 142 lbf; ASTM D 4632.
   4. Tear Strength: 56 lbf; ASTM D 4533.
   5. Puncture Strength: 56 lbf; ASTM D 4833.
   6. Apparent Opening Size: No. 60 sieve, maximum; ASTM D4751.
   7. Permittivity: 0.2 per second, minimum; ASTM D 4491.
   8. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

B. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
   1. Survivability: Class 2; AASHTO M 288.
   2. Grab Tensile Strength: 247 lbf; ASTM D 4632.
   3. Sewn Seam Strength: 222 lbf; ASTM D 4632.
   4. Tear Strength: 90 lbf; ASTM D 4533.
   5. Puncture Strength: 90 lbf; ASTM D 4833.
   6. Apparent Opening Size: No. 60 sieve, maximum; ASTM D4751.
   7. Permittivity: 0.02 per second, minimum; ASTM D 4491.
   8. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

2.03 CONTROLLED LOW-STRENGTH MATERIAL

A. Controlled Low-Strength Material: Self-compacting, flowable concrete material produced from the following:
   1. Portland Cement: ASTM C 150, Type I.
   2. Fly Ash: ASTM C618, Class C or F.
   3. Normal-Weight Aggregate: ASTM C 33, 3/4-inch nominal maximum aggregate size.
   4. Foaming Agent: ASTM C 869.
   5. Water: ASTM C 94.
   6. Air-Entraining Admixture: ASTM C 260.

B. Produce conventional-weight, controlled low-strength material with 50 psi minimum, 1,200 psi maximum compressive strength when tested according to ASTM C 495.

2.04 ACCESSORIES

A. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility; colored as follows:
   1. Red: Electric.
   2. Yellow: Gas, oil, steam, and dangerous materials.
   3. Orange: Telephone and other communications.
   4. Blue: Water systems.
   5. Green: Sewer systems.

B. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

PART 3 EXECUTION

3.01 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.

B. Protect and maintain erosion and sedimentation controls during earth moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.02 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
   1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

3.03 EXPLOSIVES

A. Explosives: Do not use explosives.

3.04 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.
   1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
   2. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:
      a. 24 inches outside of concrete forms other than at footings.
      b. 12 inches outside of concrete forms at footings.
      c. 6 inches outside of minimum required dimensions of concrete cast against grade.
      d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
      e. 6 inches beneath bottom of concrete slabs-on-grade.
      f. 6 inches beneath pipe in trenches, and the greater of 24 inches wider than pipe or 42 inches wide.

3.05 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
   1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
   2. Excavate to final grade, leaving solid base to receive concrete pile caps.

3. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces.

B. Excavations at Edges of Tree- and Plant-Protection Zones:
   1. Excavate by hand to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
   2. Cut and protect roots according to requirements in Division 01 Section "Temporary Tree and Plant Protection."

3.06 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.07 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.
   1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.
   1. Clearance: 12 inches each side of pipe or conduit or as indicated on construction documents.

C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.
   1. For pipes and conduit less than 6 inches in nominal diameter, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
   2. For pipes and conduit 6 inches or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe or conduit circumference. Fill depressions with tamped sand backfill.
   3. For flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support conduit on an undisturbed subgrade.
   4. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

D. Trench Bottoms: Excavate trenches 4 inches deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe.
   1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

E. Trenches in Tree- and Plant-Protection Zones:
   1. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
   2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.
   3. Cut and protect roots according to requirements in Division 01 Section "Temporary Tree and Plant Protection."

3.08 SUBGRADE INSPECTION

A. Notify Owner when excavations have reached required subgrade.

B. If Owner determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

C. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.

D. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.09 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by Owner.
   1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Architect.

3.10 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
   1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.11 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:
   1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
   2. Surveying locations of underground utilities for Record Documents.
   3. Testing and inspecting underground utilities.
   4. Removing concrete formwork.
   5. Removing trash and debris.
   6. Removing temporary shoring and bracing, and sheeting.
   7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.12 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Trenches under Footings: Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Division 03 Section "Cast In Place Concrete".

D. Backfill voids with satisfactory soil while removing shoring and bracing.

E. Place and compact initial backfill of subbase material free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.
   1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

F. Controlled Low-Strength Material: Place initial backfill of controlled low-strength material to a height of 12 inches over the pipe or conduit. Coordinate backfilling with utilities testing.

G. Place and compact final backfill of satisfactory soil to final subgrade elevation.

H. Controlled Low-Strength Material: Place final backfill of controlled low-strength material to final subgrade elevation.

I. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.13 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:
   1. Under grass and planted areas, use satisfactory soil material.
   2. Under walks and pavements, use satisfactory soil material.
   3. Under steps and ramps, use engineered fill.
   4. Under building slabs, use engineered fill.
   5. Under footings and foundations, use engineered fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.14 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
   1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
   2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.15 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D698:
   1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.
   2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 92 percent.
   3. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 85 percent.
   4. For utility trenches, compact each layer of initial and final backfill soil material at 85 percent.

3.16 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
   1. Provide a smooth transition between adjacent existing grades and new grades.
   2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
   1. Turf or Unpaved Areas: Plus or minus 1 inch.

2. Walks: Plus or minus 1 inch.
3. Pavements: Plus or minus 1/2 inch.

C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.17 SUBSURFACE DRAINAGE

A. Subdrainage Pipe: As required and specified by Owner.

B. Subsurface Drain: Place subsurface drainage geotextile around perimeter of subdrainage trench. Place a 6-inch course of filter material on subsurface drainage geotextile to support subdrainage pipe. Encase subdrainage pipe in a minimum of 12 inches of filter material, placed in compacted layers 6 inches thick, and wrap in subsurface drainage geotextile, overlapping sides and ends at least 6 inches.
1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D698 with a minimum of two passes of a plate-type vibratory compactor.

C. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 12 inches of final subgrade, in compacted layers 6 inches thick. Overlay drainage backfill with one layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches.
1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D698 with a minimum of two passes of a plate-type vibratory compactor.
2. Place and compact impervious fill over drainage backfill in 6-inch- thick compacted layers to final subgrade.

3.18 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

A. Place subbase course and base course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place subbase course and base course under pavements and walks as follows:
1. Install separation geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
2. Place base course material over subbase course under hot-mix asphalt pavement.
3. Shape subbase course and base course to required crown elevations and cross-slope grades.
4. Place subbase course and base course 6 inches or less in compacted thickness in a single layer.
5. Place subbase course and base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
6. Compact subbase course and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D698.

C. Pavement Shoulders: Place shoulders along edges of subbase course and base course to prevent lateral movement. Construct shoulders, at least 12 inches wide, of satisfactory soil materials and compact simultaneously with each subbase and base layer to not less than 95 percent of maximum dry unit weight according to ASTM D698.

3.19 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

A. Place drainage course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:
1. Install subdrainage geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
2. Place drainage course 6 inches or less in compacted thickness in a single layer.

3. Place drainage course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
4. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D698.

3.20 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
   1. Determine prior to placement of fill that site has been prepared in compliance with requirements.
   2. Determine that fill material and maximum lift thickness comply with requirements.
   3. Determine, at the required frequency, that in-place density of compacted fill complies with requirements.

B. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.

C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

D. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.

E. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:
   1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq ft. or less of paved area or building slab, but in no case fewer than three tests.
   2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet or less of wall length, but no fewer than two tests.
   3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length, but no fewer than two tests.

F. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.21 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
   1. Scarify or remove and replace soil material to depth as directed by Architect; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
   1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.22 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

B. Transport surplus satisfactory soil to designated storage areas on Owner's property. Stockpile or spread soil as directed by Architect.
   1. Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 312000

SECTION 316223
FILLED STEEL PIPE PILES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Earthwork Section 31 2000.

C. Concrete Materials Section 03 3000.

1.02 SUMMARY:

A. Section includes driven steel pipe piles as shown on the drawings and as specified herein. Piles shall be driven to end bearing in the bedrock and develop a safe working capacity as noted on the drawings with a factor of safety of at least 2.00.

1.03 SUBMITTALS:

A. Except as noted, the contractor will provide the services of a qualified geotechnical testing agency to prepare test reports for items 1-3. The contractor shall coordinate the services of a testing agency to provide timely notification of all field activities to the architect and geotechnical engineer.

1. Test Pile Reports: Submit copies of reports for each test pile within two days after completion of tests.
2. Driving Records: Submit copies of driving record of each pile to Architect not later than two days after driving. Include project name and number, name of Contractor, pile location and number, computed pile capacity, type and size of hammer used, type of pile driving cap used, rate of operation of pile driving equipment, pile dimensions, elevation of tip, elevation of butt before and after cut-off, ground elevation, continuous record of number of blows for each foot of penetration, pile deviation, pile uplift and reaction, and any unusual occurrences during pile driving. Completed driving records shall be the basis for payment.
3. Physical Testing: Submit results of tests performed on at least 5% of production piles randomly selected by the owner's testing agency for tensile, yield, diameter and wall thickness. Acceptance criteria shall be in accordance with ASTM A36 and ASTM A252 and as modified for wall thickness within this specification.
4. Contractor shall submit current welding certificates in accordance with AWS for all welding mechanics.
5. Submit proposed pile type, driving system data as described in the geotechnical report for approval by the owner's testing agency, contractor and architect prior to mobilization. If required, submit technical data for commercially fabricated point reinforcement. Selected point reinforcement shall be paid for on the basis of unit prices and shall be approved by the owner's geotechnical engineer.
6. Submit concrete mix design information for pile fill in accordance with specification section 03 3000. Submit mill certificates for all new piling material.

1.04 QUALITY ASSURANCE:

A. Qualifications: Firm shall have a minimum of ten years successful experience on 10 similar projects in installing pile types and quantities similar to those required for this project and having sufficient production capacity to produce the required units without causing delay in work. Submit resumé of firm and projects with bid form.

B. Welder Qualifications: Qualified welders, welding processes and procedures shall be in accordance with American Welding Society (AWS) D1.1 "Structural Welding Code - Steel."

C. The contractor shall retain the services of a qualified professional land surveyor to perform initial layout and provide as-built measurements of each pile after driving to confirm compliance

with the contract documents. As-built data shall be recorded in a format acceptable to the architect and structural engineer.

D. The contractor shall retain the services of a qualified structural engineer licensed in the State of Minnesota to evaluate all piles that have not been driven in accordance with the contract documents and tolerances given herein. The engineer's work shall include evaluating required revisions to pile caps, grade beams and slabs supported by misplaced piles and shall submit complete certified calculations and proposed revisions needed to safely support all superimposed loads. It is understood that revisions could include additional piles, concrete and reinforcing steel.

1.05 DELIVERY, STORAGE, AND HANDLING:

A. Except for piles to be used for test purposes, materials ordered or delivered to project site prior to verification of acceptable performance of selected system or verification of assumed pile length, will be at Contractor's risk.

B. After the proposed system has been approved by the owner's testing agency and pile lengths are verified following the completion of the test pile program, deliver materials to project site in such quantities and at such times to assure continuity of pile driving operations to project schedule. All pipe piles shall be filled with concrete.

C. Store piles in orderly groups above ground and blocked during storage to prevent distortion of members. Piles exhibiting variations beyond tolerance limits will be considered distorted and may not be used in the work.

1.06 PROJECT CONDITIONS:

A. Site Information: Data on indicated subsurface conditions are not intended as representations or warranties of continuity of such conditions. It is expressly understood that the Owner will not be responsible for interpretations or conclusions drawn from by the Contractor. The data is made available for convenience of the Contractor. Additional test borings and other exploratory operations may be made by Contractor at no additional cost to Owner.

B. Protection: Protect structures, underground utilities and other construction from damage caused by pile driving operations. Pre-drill for piles (paid for on the basis of unit prices given on the bid form) if required or as directed by the owner's testing agency. Provide continuous seismic monitoring during driving operations as specified at Section 01 4000. It is the intent of seismic monitoring to limit vibrations caused by pile driving to an acceptable threshold determined for adjacent construction to minimize damage or disturbance to these facilities. If vibrations become excessive, the contractor shall modify the installation procedure as required. The contractor shall be responsible for the cost of repairing any damage to existing construction or utilities on or adjacent to the site.

C. Coordination: Coordinate pile driving schedule with earthwork, and placement of concrete for pile caps.

1.07 MEASUREMENT FOR PAYMENT:

A. Basis for Bids: Bids will be based on total aggregate length of piles indicated on the drawings from pile tip to cut-off.

B. Basis for Payment: From the data obtained for each pile as a result of driving, calculate actual total net length of all piles used. Contract price per lineal foot for selected pile type shall include all labor, materials, tools, equipment, and incidentals required for performing work for furnishing, driving, cutting-off, installing concrete fill and piles. This includes splicing and legally disposing of cut-offs and other waste materials.

C. Measurements will be based on actual length of piles in place, with fractional lengths measured to nearest foot. Payment for linear footage in excess of that indicated on drawings and credit for linear footage less than that indicated on drawings, shall be made at unit prices stated in the Contract, based on net addition or deduction. The add unit price shall not exceed the base bid

unit price amount by more than 15% and the deduct unit price shall not be less than 0.35 times the base bid unit price.

D. Successfully installed test piles that become part of the completed foundation system will be considered as an integral part of Work.

E. Except as noted elsewhere in this section, payment will be made for rejected piles which obstruct at a depth greater than fifteen feet. The contractor will not be paid for piles which do not meet the final driving criteria, experience failure of the welded splice or are driven beyond the specified tolerances.

1.08 CONDITION APPRAISAL REPORT

A. Prior to construction, the contractor shall retain the services of a qualified testing agency who shall prepare and submit a Condition Appraisal Report to the Owner, General Contractor, Architect and Structural Engineer. The document shall record the current condition of all existing adjacent buildings, structures and utilities that could be susceptible to damage or disturbance as a result of site clearing, excavation or pile driving activities. The report shall identify any areas that may require special protection prior to commencing construction. The testing agency shall include in their report recommendations for seismic monitoring including frequency, location and reporting conditions. The testing agency shall also provide seismic monitoring during construction.

B. The extent of the condition survey shall be determined by the contractor’s testing agency as deemed necessary to protect the owner and contractor against inappropriate claims of property damage and personal injury by anyone. However, the contractor shall be responsible for the cost of repairs to any adjacent existing facility, structure, utility or site improvement which is damaged by construction activity.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Steel Tubing: Hot-rolled carbon steel tubes, complying with ASTM A 252 Grade 3 and IBC 2018 having a minimum yield strength of 45KSI. Piling shall be continuous. Splices shall be full penetration. Material may be new or used.

B. Piling: minimum diameter 7” o.d. with minimum wall thickness of 0.493”, maximum diameter of 9 5/8” o.d. with minimum wall thickness of 0.395". The actual wall thickness may be greater than this value but not less than this value.

C. Fabrication: Provide minimum 1” thick bottom plates of same basic steel as pile sections. Fasten to piles with full penetration welded connection to develop full strength of plate and to prevent damage or displacement during driving. Provide appropriate point reinforcement when required and approved by the geotechnical engineer and architect (refer to unit prices).
   1. Concrete Materials: Refer to section 03 3000.
   2. Use admixtures in accordance with manufacturer's instructions for climatic conditions prevailing at time of placement.

2.02 DRIVING EQUIPMENT:

A. General: Provide pile driving equipment of type generally used in standard pile driving practice, operated at manufacturer's specified rate, to develop required rated energy per blow, in accordance with the geotechnical report for the project.

B. Hammer: Provide pile driving hammers of sufficient capacity, size and type able to deliver consistently effective dynamic energy, suitable for piles to be driven and to subgrade material into which they are to be driven, when operating at not less than 75% efficiency of rated driving energy. Piles shall be driven with a hammer having an energy rating of from 50,000 to 66,000 foot-pounds, subject to confirmation by wave equation analysis. Pile driving activities shall not over stress or damage pile. The contractor’s testing agency shall evaluate the proposed pile driving system using wave equation analysis prior to mobilization. The actual driving criteria for

the particular pile type and hammer shall be evaluated by means of the test pile program at the beginning of construction and approved by the owner's testing agency.

C. Driving Caps: Equip hammer with cast steel or structural steel driving cap, with grooved base conforming to pile shape. Keep bearing surfaces of grooves true and smooth.

D. Leads: Use fixed or rigid type pile driver leads that will hold pile firmly in position and alignment, and in axial alignment with hammer. Swinging leads may be used if approved by the geotechnical engineer and architect following the successful completion of the test pile program. Extend leads to within 2 feet of elevation at which the pile enters ground.

PART 3 - EXECUTION

3.01 PREPARATION:

A. PRE-DRIVING WORK:

1. Site Conditions: Do not drive piles until earthwork in area which piles are to occupy has been completed, as noted below. Coordinate/verify with the general contractor that subgrade preparations recommended by the geotechnical engineer has been completed prior to mobilization.
2. Cut off piles at scheduled or detailed elevation.
3. Excavations: Final excavation to the required bottom of pile cap, grade beam or slab elevation will be performed as part of earthwork for buildings, after piles have been driven and tested. Refer to section 31 2200.
4. Fills: Fills will be constructed and compacted to elevation of grade indicated.
5. Pile Length Markings: Mark each piles' length in a fashion approved by the owner's testing agency and the number of feet from pile tip in 5'-0" intervals.
6. Welding: Perform manual arc-welding using shielded metal arc or submerged arc method, complying with AWS Standards.
7. Use oxygen-gas or oxygen arc methods for field cutting of steel, complying with AWS recommendations.
8. Grind flame cut surfaces as required.
9. Welded Splices: Clean surfaces to be welded of rust, scale, oil, paint, and foreign material. Use only pile members with identical cross-sections for splicing. Only one splice per pile will be permitted, unless otherwise authorized by the Engineer. Make splices before starting driving operations wherever possible. If a welded splice is required during driving operation, make splice when top of driven pile portion is at least 3'-0" above ground to permit inspection of welded connection during welding and subsequent driving.
10. Splices shall be 100% full penetration welded, producing straight pile alignment through splice and developing full strength of the pile cross section in both bearing and bending. Use backer bar (chill ring) for making welds for pipe piles. Each weld shall be approved by the contractor’s testing agency. This approval will not relieve the contractor of the responsibility for pile replacement if driving is suspended due to splice failure. No more than one splice per pile.

3.02 EXECUTION:

A. DRIVING PILES:

1. General: Continuously drive piles at locations indicated, to required tip elevation and driving resistance established by the test pile program. Each pile shall be driven to the resistance determined by wave equation analysis and to bear on competent bedrock as identified in the soil borings. It is anticipated that final driving criteria will be 1 to 10 blows to generate 1” or less of additional penetration. If the penetration is not possible, the pile should be driven the number of blows equal to three times the required resistance. The geotechnical engineer will establish final production driving criteria.
2. Carefully maintain center of gravity for each group or cluster of piles to conform to locations shown on drawings.

3. Carefully plumb leads and pile before driving. Take care during driving to prevent and to correct any tendency of piles to twist or rotate.
4. When handling and driving long piles, take special precautions to ensure against over stress or leading away from a true position when driving.
5. Driving Tolerances: Drive piles within the following maximum tolerances:
    a. Location: 3" from location indicated on plan for individual piles that are part of a two pile group or more.
    b. 2" for individual piles below grade beams.
    c. 6" for individual piles below structural slab-on-grade.
    d. 2" for center of gravity of pile groups having three or more piles;
6. Plumbness:
    a. Maintain 1" in 10'-0" from vertical, or a maximum of 4", measured when the pile is above ground, in leads.
7. The contractor shall have each pile surveyed by a qualified, licensed surveyor to ensure that in- place pile locations are within placing tolerances. Submit survey information for all piles to the design team for their records.
8. The contractor shall submit engineering calculations for corrected in-place pile loads for all pile groups with individual piles or center of gravity of the pile group that are not within placing tolerances. Calculations shall be based on full capacity loading for dimensioned locations as shown on plan.
9. Backfill voids between pile and pre-excavated hole, using satisfactory soil materials.
10. Heaved Piles: Provide recorded instrument observations made during pile driving to determine whether driven pile has lifted from its original seat during driving of adjacent piles. If uplift or displacement occurs, redrive affected piles to a driving resistance consistent with previously established production driving criteria. Restriking shall be observed and approved by the geotechnical engineer.
11. Damaged or Miss-driven Piles: Obstructed piles will not be accepted if they have penetrated less than fifteen feet. If, in the opinion of the owners testing agency and the structural engineer, the pile can be driven to achieve the established driving criteria but will not comply with the specified tolerance, the contractor will be paid for the pile in accordance with contract requirements. The contractor will be paid for all piling which exceeds 15 feet in penetration, complies with the specified tolerance but obstructs before achieving the production driving criteria, except if the pile is rejected for splice failure.
12. Withdraw (applies to piles with less than 15 feet of penetration) or abandon piles rejected after driving, and replace with new piles as directed by the Architect/Engineer. Drive additional pile or piles where centerline deviation exceeds the specified tolerance and redesign indicates load on any pile exceeds 110% of design load.
13. Piles rejected after driving may be abandoned and cut-off, and additional piles driven to replace rejected units at designated locations as directed by the structural engineer. Fill abandoned pipe piles with concrete.
14. Solidly fill spaces left by withdrawn piles or predrilled piles that will not be filled by new piles, using cohesion-less soil material such as approved granular soils. Place and compact throughout length of space. Alternately, a low strength (500 psi at 28 days) concrete fill may be used.
15. Cutting-Off: Cut-off tops of driven piles, square with pile axis and at elevations indicated. Legally dispose of excess materials off site.
16. Pile Driving shall not occur during or within at least twenty-four hours following adjacent concrete placement. Pile driving activities shall not damage any concrete work.
17. Predrill piling as directed by the owner’s geotechnical engineer if required to minimized vibrations. Fill oversized hole with concrete as required. Submit unit price per lineal foot for predrilling on the bid form.

3.03 FIELD QUALITY CONTROL:

A. The contractor shall furnish the services of a qualified independent geotechnical testing agency who shall provide full time testing services during the installation of all piles. The testing agency shall be responsible for supervising load tests, preparing driving records for all piling and randomly sampling for physical testing, observing and testing splice installation and approving production pile material. The testing agency shall submit periodic summary reports of all activities to the owner, architect, contractor, building official and structural engineer. The testing agency shall certify that all accepted piling has achieved the required production driving criteria and will provide a safe load carrying capacity of as indicated elsewhere in this section and on the plans.

B. Test piles, furnished and driven by Contractor to determine lengths of piles, may be located, cut off, and become part of the foundation system provided they conform to contract requirements.

C. Test Piles Required: Verify quantity of test piles (as required) with owner’s geotechnical engineer.

D. Driving Test Piles: Use test piles of same weight and section as specified and drive with appropriate pile driving equipment operating at rated driving energy to be used in driving permanent piles. Piles shall be tested using the pile driving analyzer by the owner's testing agency. The results of the test pile program shall be used to accept or reject the contractor's proposed driving system and to establish production driving criteria for the approved system. The test pile program shall be successfully completed prior to ordering and shipping production piles.

E. Drive test piles at locations indicated to a point elevation below final cut- off as determined by wave equation analysis and the results of testing performed with the pile driving analyzer. It is anticipated that piles will be considered as driven to refusal when 5-20 blows of the hammer are required to produce a total penetration of 1" or less.

F. Concrete testing shall be paid for by the owner and shall comply with the requirements of Section 03 3000.

END OF SECTION 316223

SECTION 323113
CHAIN LINK FENCES AND GATES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Posts, rails, and frames.

B. Wire fabric.

C. Barbed wire.

D. Concrete.

E. Manual gates with related hardware.

1.02 RELATED REQUIREMENTS

A. Section 033000 - Cast-in-Place Concrete: Concrete anchorage for posts.

1.03 REFERENCE STANDARDS

A. ASTM A121 - Standard Specification for Metallic-Coated Carbon Steel Barbed Wire; 2022.

B. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.

C. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.

D. ASTM A392 - Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric; 2011a (Reapproved 2022).

E. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete; 2024.

F. ASTM F567 - Standard Practice for Installation of Chain-Link Fence; 2023.

G. CLFMI CLF-FIG0111 - Field Inspection Guide; 2014.

H. FS RR-F-191/1D - Fencing, Wire and Post Metal (Chain-Link Fence Fabric); 1990.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data on fabric, posts, accessories, fittings and hardware.

PART 2 PRODUCTS

2.01 COMPONENTS

A. Line Posts: 1.9 inch diameter.

B. Corner and Terminal Posts: 2.38 inch diameter.

C. Gate Posts: 3-1/2 inch diameter.

D. Top and Brace Rail: 1.66 inch diameter, plain end, sleeve coupled.

E. Bottom Rail: 1.66 inch diameter, plain end, sleeve coupled.

F. Gate Frame: 1.66 inch diameter for welded fabrication.

G. Fabric: 2 inch diamond mesh interwoven wire, 6 gauge, 0.1920 inch thick, top selvage knuckle end closed, bottom selvage twisted tight.

H. Tension Wire: 6 gauge, 0.1920 inch thick steel, single strand.

I. Tie Wire: Aluminum alloy steel wire.

2.02 MATERIALS

A. Posts, Rails, and Frames:

1. Line Posts: Type I round in accordance with FS RR-F-191/1D.

2. Terminal, Corner, Rail, Brace, and Gate Posts: Type I round in accordance with FS RR-F-191/1D.

B. Wire Fabric:
1. ASTM A392 zinc coated steel chain link fabric.

C. Barbed Wire:
1. Zinc-coated steel, complying with ASTM A121 Type Z Coating Class 1; 2 strands of 0.099 inch diameter wire, with 2-pointed barbs at 4 inches on center.

D. Concrete:
1. Ready-mixed, complying with ASTM C94/C94M; normal Portland cement; 2,500 psi strength at 28 days, 3 inch slump; 3/4 inch nominal size aggregate.

2.03 MANUAL GATES AND RELATED HARDWARE

A. Hardware for Single Swinging Gates: 180 degree hinges, 2 for gates up to 60 inches high, 3 for taller gates; fork latch with gravity drop and padlock hasp; keeper to hold gate in fully open position.

B. Hinges: Finished to match fence components.

2.04 FINISHES

A. Components (Other than Fabric): Galvanized in accordance with ASTM A123/A123M, at 1.7 ounces per square foot.

B. Hardware: Hot-dip galvanized to weight required by ASTM A153/A153M.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions: Verify that areas are clear of obstructions or debris and obstructions.

3.02 PREPARATION

A. Removal: Obstructions or debris.

3.03 INSTALLATION

A. Install framework, fabric, accessories and gates in accordance with ASTM F567.

B. Place fabric on outside of posts and rails.

C. Fasten fabric to top rail, line posts, braces, and bottom tension wire with tie wire at maximum 15 inches on centers.

D. Install hardware and gate with fabric and barbed wire overhang to match fence.

3.04 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Layout: Verify that fence installation markings are accurate to design, paying attention to gate locations, underground utilities, and property lines.

C. Gates: Inspect for level, plumb, and alignment.

D. Workmanship: Verify neat installation free of defects. See CLFMI CLF-FIG0111 for field inspection guidance.

3.05 CLEANING

A. Leave immediate work area neat at end of each work day.

B. Clean jobsite of excess materials; scatter excess material from post hole excavations uniformly away from posts. Remove excess material if required.

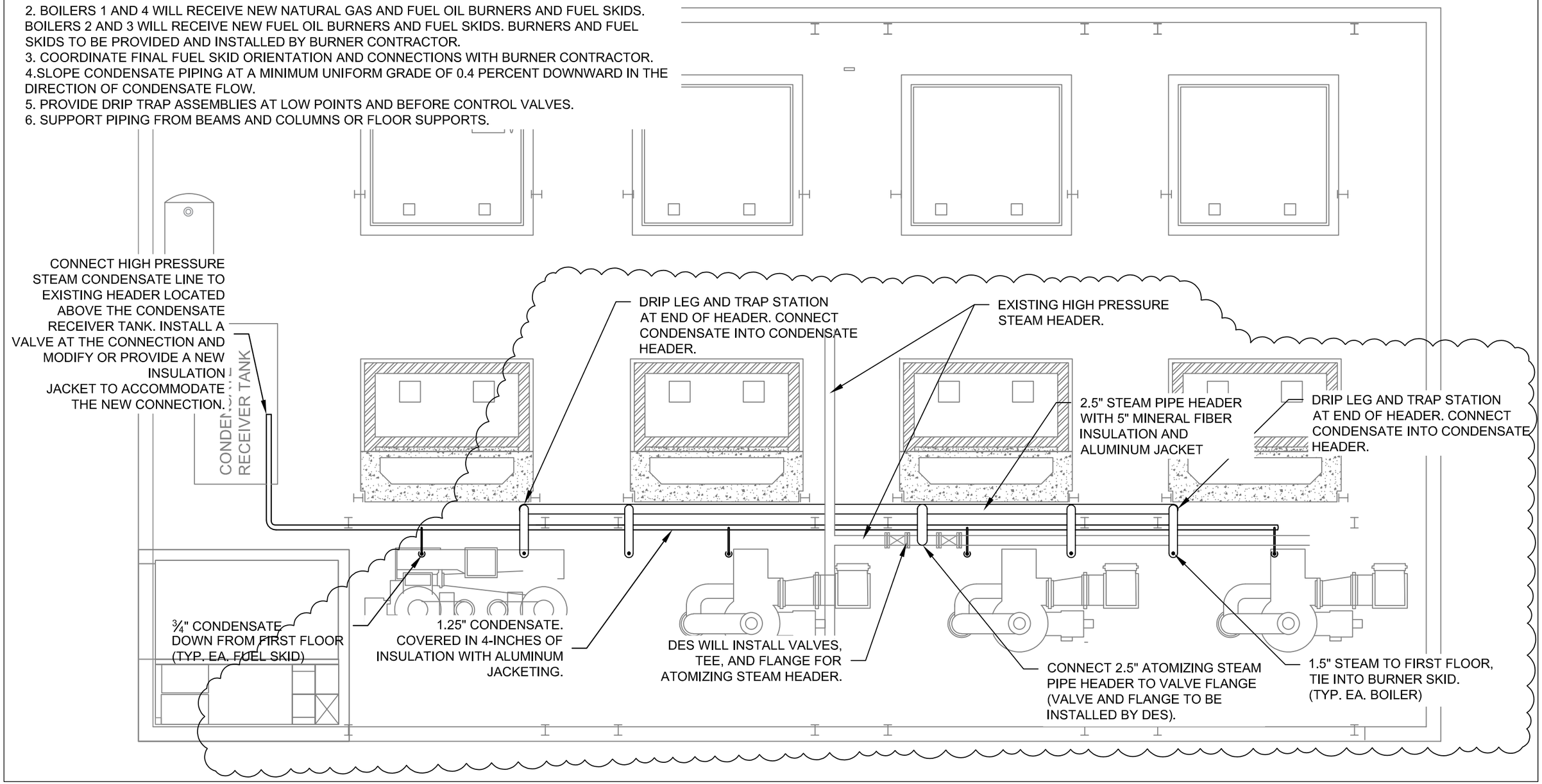
C. Clean fence with mild household detergent and clean water rinse well.

3.06 CLOSEOUT ACTIVITIES

A. Demonstrate proper operation of equipment to Owner's designated representative.

END OF SECTION 323113

NOTES:
1. ALL WORK ON THIS SHEET TO BE COMPLETED BY BALANCE OF PLANT CONTRACTOR. UNLESS NOTED OTHERWISE.
2. BOILERS 1 AND 4 WILL RECEIVE NEW NATURAL GAS AND FUEL OIL BURNERS AND FUEL SKIDS. BOILERS 2 AND 3 WILL RECEIVE NEW FUEL OIL BURNERS AND FUEL SKIDS. BURNERS AND FUEL SKIDS TO BE PROVIDED AND INSTALLED BY BURNER CONTRACTOR.
3. COORDINATE FINAL FUEL SKID ORIENTATION AND CONNECTIONS WITH BURNER CONTRACTOR.
4.SLOPE CONDENSATE PIPING AT A MINIMUM UNIFORM GRADE OF 0.4 PERCENT DOWNWARD IN THE DIRECTION OF CONDENSATE FLOW.
5. PROVIDE DRIP TRAP ASSEMBLIES AT LOW POINTS AND BEFORE CONTROL VALVES.
6. SUPPORT PIPING FROM BEAMS AND COLUMNS OR FLOOR SUPPORTS.



NOT FOR CONSTRUCTION - FOR BID ONLY

I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY REGISTERED PROFESSIONAL ENGINEER UNDER THE LAWS OF MINNESOTA.

RYAN JOHNSON

DATE _____ REG. NO. 49918

REV.	DATE	PREP. BY	CHK'D BY	DESCRIPTION
1	7/8/2025	RJJ	RJJ	ATOMIZING STEAM
IFB	4/30/2025	TJW	RJJ	ISSUED FOR BID

EVER-GREEN ENERGY™

DES COAL SUNSETTING

DESIGN BY: RJJ DATE: 4/25/25
DRAWN BY: TJW DATE: 4/25/25
HORZ: 1"=10'

GROUND FLOOR ATOMIZING STEAM AND CONDENSATE

Project No. EGE0103 Sheet No. M202

NOTES:
1. ALL WORK ON THIS SHEET TO BE COMPLETED BY BALANCE OF PLANT CONTRACTOR. UNLESS NOTED OTHERWISE.
2. BOILERS 1 AND 4 WILL RECEIVE NEW NATURAL GAS AND FUEL OIL BURNERS AND FUEL SKIDS. BOILERS 2 AND 3 WILL RECEIVE NEW FUEL OIL BURNERS AND FUEL SKIDS. BURNERS AND FUEL SKIDS TO BE PROVIDED AND INSTALLED BY BURNER CONTRACTOR.
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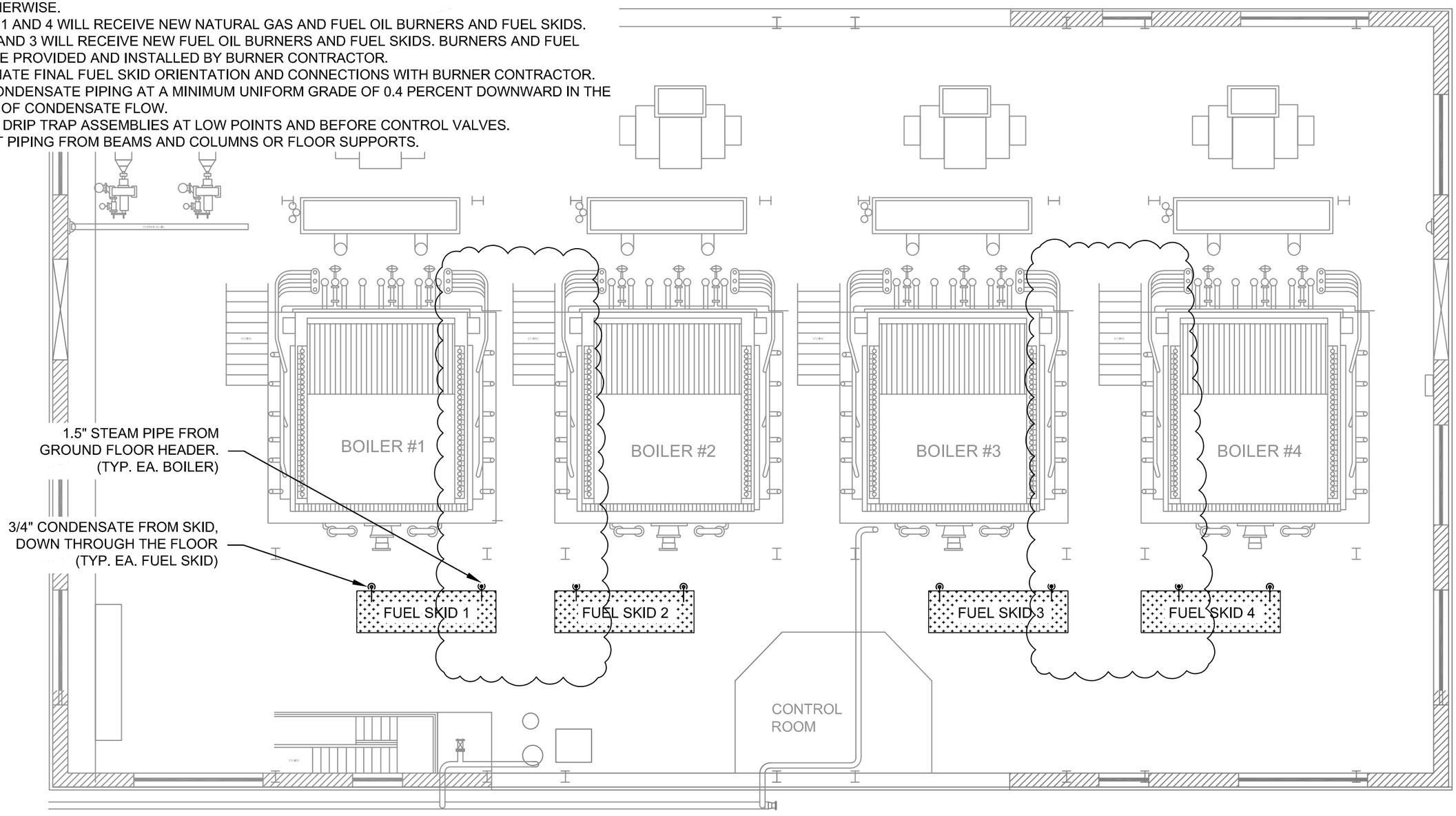

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RYAN JOHNSON

DATE _____ REG. NO. 49918

REV.	DATE	PREP. BY	CHK'D BY	DESCRIPTION
1	7/8/2025	RJJ	RJJ	ATOMIZING STEAM
IFB	4/25/2025	TJW	RJJ	ISSUED FOR BID

EVER-GREEN ENERGY™

DES COAL SUNSETTING

DESIGN BY: RJJ DATE: 4/25/25
DRAWN BY: TJW DATE: 4/25/25
HORZ: 1"=10'

FIRST FLOOR ATOMIZING STEAM

Project No. EGE0103

Sheet No. M203