LARAMIE COUNTY COMMUNITY COLLEGE

PHYSICAL PLANT HYDRONIC RENOVATIONS

FOR

Laramie County Community College (LCCC)
1400 East College Drive
Cheyenne, WY 82007

ENGINEERS

Cator, Ruma & Associates
420 West Lincolnway
Cheyenne, WY 82001

February 3, 2020
TABLE OF CONTENTS

BIDDING DOCUMENTS
   - By LCCC

DIVISION 01 – GENERAL REQUIREMENTS
   01 10 00  Summary
   01 23 00  Alternates
   01 25 00  Substitution Procedures
   01 31 00  Project Management and Coordination
   01 32 00  Construction Progress Documentation
   01 33 00  Submittal Procedures
   01 40 00  Quality Requirements
   01 50 00  Temporary Facilities and Controls
   01 60 00  Product Requirements
   01 73 00  Execution
   01 74 19  Construction Waste Management
   01 77 00  Close-out Procedures
   01 78 23  Operation and Maintenance Data
   01 78 39  Project Record Documents
   01 79 00  Demonstration and Training

DIVISION 02 – EXISTING CONDITIONS
   02 41 19  Selective Demolition

DIVISION 03 - CONCRETE

DIVISION 05 - METALS

DIVISION 06 – ROUGH CARPENTRY

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

DIVISION 08 - OPENINGS

DIVISION 09 - FINISHES

DIVISION 10 - SPECIALTIES

DIVISION 12 – FURNISHINGS

DIVISION 21 – FIRE SUPPRESSION

DIVISION 22 – PLUMBING

DIVISION 23 – HEATING, VENTILATING AND AIR CONDITIONING
   23 05 00  Common Work Results for Mechanical
   23 05 07  Motors, Drives, Motor Controllers and Electrical Requirements for Mechanical Equipment
   23 05 10  Basic Piping Materials and Methods
   23 05 18  Piping Specialties
   23 05 19  Meters and Gauges for Mechanical Piping

TABLE OF CONTENTS
<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>23 05 23</td>
<td>General Duty Valves for Mechanical Piping</td>
</tr>
<tr>
<td>23 05 29</td>
<td>Hangers and Supports for Mechanical Piping &amp; Equipment</td>
</tr>
<tr>
<td>23 05 40</td>
<td>Vibration Control for Mechanical Piping &amp; Equipment</td>
</tr>
<tr>
<td>23 05 53</td>
<td>Identification for Mechanical Systems</td>
</tr>
<tr>
<td>23 05 93</td>
<td>Testing, Adjusting &amp; Balancing for Mechanical Systems</td>
</tr>
<tr>
<td>23 07 00</td>
<td>Insulation for Mechanical Systems</td>
</tr>
<tr>
<td>23 09 00</td>
<td>Instrumentation and Control for Mechanical Systems</td>
</tr>
<tr>
<td>23 09 93</td>
<td>Sequences of Operation for Mechanical Systems</td>
</tr>
<tr>
<td>23 21 23</td>
<td>Hydronic Pumps</td>
</tr>
<tr>
<td>23 25 00</td>
<td>Water Treatment for Mechanical Systems</td>
</tr>
<tr>
<td>23 25 50</td>
<td>Glycol Systems</td>
</tr>
<tr>
<td>23 57 00</td>
<td>Heat Exchangers for HVAC</td>
</tr>
<tr>
<td>23 65 00</td>
<td>Air-Cooled Dry Coolers</td>
</tr>
</tbody>
</table>

**DIVISION 26 - ELECTRICAL**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>26 05 00</td>
<td>Common Work Results for Electrical</td>
</tr>
<tr>
<td>26 05 19</td>
<td>Electrical Conductors and Cables</td>
</tr>
<tr>
<td>26 05 26</td>
<td>Grounding and Bonding for Electrical Systems</td>
</tr>
<tr>
<td>26 05 29</td>
<td>Hangers and Supports for Electrical Systems</td>
</tr>
<tr>
<td>26 05 33</td>
<td>Raceways for Electrical Systems</td>
</tr>
<tr>
<td>26 05 34</td>
<td>Cabinets, Boxes and Fittings</td>
</tr>
<tr>
<td>26 05 53</td>
<td>Identification for Electrical Systems</td>
</tr>
<tr>
<td>26 05 83</td>
<td>Wiring Connections</td>
</tr>
<tr>
<td>26 24 19</td>
<td>Motor Control Centers</td>
</tr>
<tr>
<td>26 28 00</td>
<td>Electrical Circuit Protective Devices</td>
</tr>
</tbody>
</table>

**DIVISION 27 - COMMUNICATIONS**

**DIVISION 28 - ELECTRONIC SAFETY AND SECURITY**

**DIVISION 32 - SITE WORK**
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Project information.
2. Work covered by Contract Documents.
3. Phased construction.
4. Access to site.
5. Coordination with occupants.
6. Work restrictions.
7. Specification and Drawing conventions.
8. Miscellaneous provisions.

B. Related Requirements:

1. Section 015000 "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Owner's facilities.

1.3 PROJECT INFORMATION

A. Project Identification:

1. Project Name: LCCC – Physical Plant Hydronic Renovations
2. CRA Project Number: 2017-552 / 2018-632
3. Project Location:
   a. Laramie County Community College
      1400 E. College Dr.
      Cheyenne, WY 82007
4. Owner:
   a. Laramie County Community College
      1400 E. College Dr.
      Cheyenne, WY 82007
5. Owner's Representative:
   a. Bill Zink
      (307) 778-1121
      bzink@lccc.wy.edu
6. Engineer:
      Mark McGuire, PE
      (307) 274-3830
      mmcguire@catorruma.com

1.4 WORK COVERED BY CONTRACT DOCUMENTS

A. The Work of Project is defined by the Contract Documents and consists of the following:
   1. Purchase and install adiabatic fluid coolers, heat exchanger, pumps, glycol feeder, water
      softener and accessories to add water-side economizer to the chilled water plant in the Plant
      Operations Building.
   2. Purchase and install pumps, piping and accessories to upgrade the heating water distribution
      from the campus’s North Central Plant to the Health Sciences Building and Pathfinder
      Building.
   3. Other Work indicated in the Contract Documents.

B. Type of Contract:
   1. Project will be constructed under a single prime contract.

1.5 ACCESS TO SITE

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

B. Use of Site: Limit use of Project site to areas within the Contract limits indicated. Do not disturb
   portions of Project site beyond areas in which the Work is indicated.
   1. Limits: Confine construction operations to:
      a. Plant Operations Building Chiller Room and Mechanical Court.
      b. North Plant Building.
      c. Pathfinder Building Basement Mechanical Room.
      d. Health Sciences Building Basement Mechanical Room.
      e. Utility Tunnel interconnecting the three buildings above.
   2. Driveways, Walkways and Entrances: Keep driveways, loading areas and entrances serving
      premises clear and available to Owner, Owner's employees, and emergency vehicles at all
      times. Do not use these areas for parking or for storage of materials.
      a. Schedule deliveries to minimize use of driveways and entrances by construction
         operations.
      b. Schedule deliveries to minimize space and time requirements for storage of materials
         and equipment on-site.

C. Condition of Existing Building: Maintain portions of existing building affected by construction
   operations in a weathertight condition throughout construction period. Repair damage caused by
   construction operations.
D. Condition of Existing Grounds: Maintain portions of existing grounds, landscaping, and hardscaping affected by construction operations throughout construction period. Repair damage caused by construction operations.

1.6 COORDINATION WITH OCCUPANTS

A. Full Owner Occupancy: Owner will occupy site and building(s) during entire construction period. Cooperate with Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with Owner's day-to-day operations. Maintain existing exits unless otherwise indicated.

1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from Owner and approval of authorities having jurisdiction.

2. Notify Owner not less than 72 hours in advance of activities that will affect Owner's operations.

1.7 WORK RESTRICTIONS

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

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

B. On-Site Work Hours: Limit work in the existing building to normal business working hours of 8:00 a.m. to 5:00 p.m., Monday through Friday, unless otherwise approved by Owner.

C. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after providing temporary utility services according to requirements indicated:

1. Notify not less than three (3) days in advance of proposed utility interruptions.

D. Noise, Vibration, and Odors: Coordinate operations that may result in high levels of noise and vibration, odors, or other disruption to Owner occupancy with Owner.

1. Notify Owner not less than two (2) days in advance of proposed disruptive operations.

E. Restricted Substances: Use of tobacco products and other controlled substances on Project site is not permitted.

1.8 SPECIFICATION AND DRAWING CONVENTIONS

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

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

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

B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.
C. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:

1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
2. Abbreviations: Materials and products are identified by abbreviations scheduled on Drawings.
3. Keynoting: Materials and products are identified by reference keynotes referencing Specification Section numbers found in this Project Manual.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 011000
SECTION 012300
ALTERNATES

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section includes administrative and procedural requirements for alternates.

1.3 DEFINITIONS
A. Alternate: An amount proposed by bidders and stated on the Bid Form for certain work defined in the bidding requirements that may be added to or deducted from the base bid amount if the Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.

1. Alternate described in this Section are part of the Work only if enumerated in the Agreement.
2. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternates into the Work. No other adjustments are made to the Contract Sum.

1.4 PROCEDURES
A. Coordination: Revise or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.

1. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of alternate.

B. Execute accepted alternates under the same conditions as other work of the Contract.

C. Schedule: A schedule of alternates is included at the end of this Section. Specification Sections referenced in schedule contain requirements for materials necessary to achieve the work described under each alternate.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF ALTERNATES
A. Alternate No. 1: Upgrade of pumps at Health Sciences Building.

2. Alternate: Replace three end-suction pumps with vertical in-line pumps, their VFDs (as applicable) and accessories as indicated on plans and in specifications.
B. Alternate No. 2: MCC Maintenance on Individual Buckets at North Plant Building and Health Sciences Building.

2. Alternate: Inspect, Test and Service Existing MCC.

END OF SECTION 012300
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for substitutions.

B. Related Requirements:
   1. Section 012300 "Alternates" for products selected under an alternate.
   2. Section 016000 "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers.

1.3 DEFINITIONS

A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.

   1. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
   2. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

1.4 ACTION SUBMITTALS

A. Substitution Requests: Submit electronic copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

   1. Substitution Request Form: Bidder/Contractor developed request form shall indicate:
      a. Project Name
      b. Basis of Design Product/Fabrication/Installation Method
      c. Relevant Specification Section
      d. Requested Substitution

   2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
      a. Statement indicating why specified product or fabrication or installation method cannot be provided, if applicable.
      b. Coordination of information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.
      c. Detailed comparison of significant qualities of proposed substitutions with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes, such as performance, weight, size, durability, visual...
effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.

d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.

e. Samples, where applicable or requested.

f. Certificates and qualification data, where applicable or requested.

g. List of similar installations for completed projects, with project names and addresses as well as names and addresses of Engineers and owners.

h. Material test reports from a qualified testing agency, indicating and interpreting test results for compliance with requirements indicated.

i. Research reports evidencing compliance with building code in effect for Project, from ICC-ES, if applicable.

j. Detailed comparison of Contractor's construction schedule using proposed substitutions with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.

k. Cost information, including a proposal of change, if any, in the Contract Sum.

l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents, except as indicated in substitution request, is compatible with related materials and is appropriate for applications indicated.

m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

3. Engineer's Action: If necessary, Engineer will request additional information or documentation for evaluation within seven days of receipt of a request for substitution. Engineer will notify Contractor of acceptance or rejection of proposed substitution within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.

a. Forms of Acceptance:

   1) During Bidding: Addendum.

   2) After Award: Change Order, Construction Change Directive, or Engineer's Supplemental Instructions for minor changes in the Work.

b. Use product specified if Engineer does not issue a decision on use of a proposed substitution within time allocated.

1.5 QUALITY ASSURANCE

A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage a qualified testing agency to perform compatibility tests recommended by manufacturers.

1.6 PROCEDURES

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

1.7 SUBSTITUTIONS

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

B. Substitutions for Convenience: Engineer will consider requests for substitution if received within 60 days after the Notice to Proceed. Requests received after that time may be considered or rejected at discretion of Engineer.

1. Conditions: Engineer will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Engineer will return requests without action, except to record noncompliance with these requirements:
   
a. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Engineer for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
b. Requested substitution does not require extensive revisions to the Contract Documents.
c. Requested substitution is consistent with the Contract Documents and will produce indicated results.
d. Substitution request is fully documented and properly submitted.
e. Requested substitution will not adversely affect Contractor's construction schedule.
f. Requested substitution has received necessary approvals of authorities having jurisdiction.
g. Requested substitution is compatible with other portions of the Work.
h. Requested substitution has been coordinated with other portions of the Work.
i. Requested substitution provides specified warranty.
j. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012500
SECTION 013100
PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1. General coordination procedures.
2. RFIs.
3. Project meetings.

B. Each contractor shall participate in coordination requirements. Certain areas of responsibility are assigned to a specific contractor.

C. Related Requirements:
1. Section 013200 "Construction Progress Documentation" for preparing and submitting Contractor's construction schedule.
2. Section 017300 "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.

1.3 DEFINITIONS

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

1.4 INFORMATIONAL SUBMITTALS

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

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

B. Key Personnel Names: Within 15 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and cellular telephone numbers and e-mail addresses. Provide names, addresses, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.

1. Post copies of list in project meeting room, in temporary field office, and in prominent location in project area. Keep list current at all times.
1.5 GENERAL COORDINATION PROCEDURES

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

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

B. Coordination: Each contractor shall coordinate its construction operations with those of other contractors and entities to ensure efficient and orderly installation of each part of the Work. Each contractor shall coordinate its own operations with operations included in different Sections that depend on each other for proper installation, connection, and operation.

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

C. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.

1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.

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

1. Preparation of Contractor's construction schedule.
2. Preparation of the schedule of values.
3. Installation and removal of temporary facilities and controls.
4. Delivery and processing of submittals.
5. Progress meetings.
6. Preinstallation conferences.
7. Project closeout activities.
8. Startup and adjustment of systems.

1.6 REQUEST FOR INFORMATION (RFI)

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

1. Engineer will return without response those RFIs submitted to Engineer by other entities controlled by Contractor.
2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.
B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:

1. Project name.
2. Project number.
3. Date.
4. Name of Contractor.
5. Name of Engineer.
6. RFI number, numbered sequentially.
7. RFI subject.
8. Specification Section number and title and related paragraphs, as appropriate.
9. Drawing number and detail references, as appropriate.
10. Field dimensions and conditions, as appropriate.
11. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
12. Contractor's signature.
13. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
   a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.
   b. Attachments shall be electronic files in PDF format.

C. Engineer’s Action: Engineer will review each RFI, determine action required, and respond. Allow seven working days for Engineer's response for each RFI. RFIs received by Engineer after 1:00 p.m. will be considered as received the following working day.

1. The following Contractor-generated RFIs will be returned without action:
   a. Requests for approval of submittals.
   b. Requests for approval of substitutions.
   c. Requests for approval of Contractor's means and methods.
   d. Requests for coordination information already indicated in the Contract Documents.
   e. Requests for adjustments in the Contract Time or the Contract Sum.
   f. Requests for interpretation of Engineer's actions on submittals.
   g. Incomplete RFIs or inaccurately prepared RFIs.

2. Engineer's action may include a request for additional information, in which case Engineer's time for response will date from time of receipt by Engineer of additional information.

3. Engineer's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Section 012600 "Contract Modification Procedures."
   a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Engineer in writing within 10 days of receipt of the RFI response.

D. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly. Include the following:

1. Project name.
2. Name and address of Contractor.
3. Name and address of Engineer.
4. RFI number including RFIs that were returned without action or withdrawn.
5. RFI description.
6. Date the RFI was submitted.
7. Date Engineer's response was received.
8. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.

E. On receipt of Engineer's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Engineer within seven days if Contractor disagrees with response.

1.7 DIGITAL PROJECT MANAGEMENT PROCEDURES

A. Use of Engineer's Digital Data Files: Digital data files of Engineer's CAD drawings will be provided by Engineer for Contractor's use during construction if Contractor requests and signs the Engineer’s Electronic File Agreement.

1. Digital data files may be used by Contractor in preparing coordination drawings, Shop Drawings, and Project record Drawings.
2. Engineer makes no representations as to the accuracy or completeness of digital data files as they relate to Contract Drawings.
3. Digital Drawing Software Program: Contract Drawings are available in AutoCAD 2004 format.
4. Contractor shall execute a data licensing agreement in the form provided by Engineer upon request.
   a. Subcontractors, and other parties granted access by Contractor to Engineer's digital data files shall execute a data licensing agreement in the form of by the Engineer.

5. The following digital data files will be furnished for each appropriate discipline:
   a. Floor plans.

B. PDF Document Preparation: Where PDFs are required to be submitted to Engineer, prepare as follows:

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

1.8 PROJECT MEETINGS

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

1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Engineer of scheduled meeting dates and times a minimum of 10 working days prior to meeting.
2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Engineer, within three days of the meeting.
B. Preconstruction Conference: Schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner and Engineer, but no later than 15 days after execution of the Agreement.

1. Attendees: Authorized representatives of Owner, Engineer and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.

2. Agenda: Discuss items of significance that could affect progress, including the following:

   a. Responsibilities and personnel assignments.
   b. Tentative construction schedule.
   c. Phasing.
   d. Critical work sequencing and long lead items.
   e. Designation of key personnel and their duties.
   f. Lines of communications.
   g. Use of web-based Project software if applicable.
   h. Procedures for processing field decisions and Change Orders.
   i. Procedures for RFIs.
   j. Procedures for testing and inspecting.
   k. Procedures for processing Applications for Payment.
   l. Distribution of the Contract Documents.
   m. Submittal procedures.
   n. Preparation of Record Documents.
   o. Use of the premises and existing building.
   p. Work restrictions.
   q. Working hours.
   r. Owner's occupancy requirements.
   s. Responsibility for temporary facilities and controls.
   t. Procedures for moisture and mold control.
   u. Procedures for disruptions and shutdowns.
   v. Construction waste management and recycling.
   w. Parking availability.
   x. Office, work, and storage areas.
   y. Equipment deliveries and priorities.
   z. First aid.
   bb. Progress cleaning.

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

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

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

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

   b. Options.
c. Related RFIs.
d. Related Change Orders.
e. Purchases.
f. Deliveries.
g. Submittals.
h. Possible conflicts.
i. Compatibility requirements.
j. Time schedules.
k. Weather limitations.
l. Manufacturer's written instructions.
m. Warranty requirements.
n. Compatibility of materials.
o. Acceptability of substrates.
p. Temporary facilities and controls.
q. Space and access limitations.
r. Regulations of authorities having jurisdiction.
s. Testing and inspecting requirements.
t. Installation procedures.
u. Coordination with other work.
v. Required performance results.
w. Protection of adjacent work.
x. Protection of construction and personnel.

3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.
5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.

D. Project Closeout Conference: Schedule and conduct a project closeout conference, at a time convenient to Owner and Engineer, but no later than 10 days prior to the scheduled date of Substantial Completion.

1. Conduct the conference to review requirements and responsibilities related to Project closeout.
2. Attendees: Authorized representatives of Owner, Engineer and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:

   a. Preparation of Record Documents.
   b. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance.
   c. Procedures for completing and archiving web-based Project software site data files.
   d. Submittal of written warranties.
   e. Requirements for preparing operations and maintenance data.
   f. Requirements for delivery of material samples, attic stock, and spare parts.
   g. Requirements for demonstration and training.
   h. Preparation of Contractor's punch list.
   i. Procedures for processing Applications for Payment at Substantial Completion and for final payment.
j. Submittal procedures.
k. Owner's partial occupancy requirements.
l. Responsibility for removing temporary facilities and controls.

4. Minutes: Entity conducting meeting will record and distribute meeting minutes.

E. Progress Meetings: Conduct progress meetings at bimonthly intervals.

1. Coordinate dates of meetings with preparation of payment requests.
2. Attendees: In addition to representatives of Owner and Engineer, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
3. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.

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

   1) Review schedule for next period.

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

   1) Interface requirements.
   2) Sequence of operations.
   3) Resolution of BIM component conflicts.
   4) Status of submittals.
   5) Deliveries.
   6) Off-site fabrication.
   7) Access.
   8) Site use.
   9) Temporary facilities and controls.
   10) Progress cleaning.
   11) Quality and work standards.
   12) Status of correction of deficient items.
   13) Field observations.
   14) Status of RFIs.
   15) Status of Proposal Requests.
   16) Pending changes.
   17) Status of Change Orders.
   18) Pending claims and disputes.
   19) Documentation of information for payment requests.

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

a. Schedule Updating: Revise Contractor's construction schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.
F. Coordination Meetings: Conduct Project coordination meetings at weekly intervals. Project coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings and preinstallation conferences.

1. Attendees: Each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meetings shall be familiar with Project and authorized to conclude matters relating to the Work.

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

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

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

   c. Review present and future needs of each contractor present, including the following:

      1) Interface requirements.
      2) Sequence of operations.
      3) Resolution of component conflicts.
      4) Status of submittals.
      5) Deliveries.
      6) Off-site fabrication.
      7) Access.
      8) Site use.
      9) Temporary facilities and controls.
     10) Work hours.
     11) Hazards and risks.
     12) Progress cleaning.
     13) Quality and work standards.
     14) Status of RFIs.
     15) Proposal Requests.
     16) Change Orders.
     17) Pending changes.

3. Reporting: Record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:
   1. Contractor's Construction Schedule.
   2. Construction schedule updating reports.
   3. Material location reports.
   4. Site condition reports.
   5. Unusual event reports.

1.3 DEFINITIONS

A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction Project. Activities included in a construction schedule consume time and resources.
   1. Critical Activity: An activity on the critical path that must start and finish on the planned early start and finish times.
   2. Predecessor Activity: An activity that precedes another activity in the network.
   3. Successor Activity: An activity that follows another activity in the network.

B. Cost Loading: The allocation of the schedule of values for completing an activity as scheduled. The sum of costs for all activities must equal the total Contract Sum.

C. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Project.

D. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.

E. Event: The starting or ending point of an activity.

F. Float: The measure of leeway in starting and completing an activity.
   1. Float time is not for the exclusive use or benefit of either Owner or Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and Contract completion date.
   2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the successor activity.
   3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.
G. Resource Loading: The allocation of manpower and equipment necessary for completing an activity as scheduled.

1.4 INFORMATIONAL SUBMITTALS

A. Format for Submittals: Submit required submittals in the following format:

1. PDF file.

B. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.

1. Submit a working digital copy of schedule, using software indicated, and labeled to comply with requirements for submittals.

C. Construction Schedule Updating Reports: Submit with Applications for Payment.

D. Material Location Reports: Submit at Owner/Architect/Contractor meetings.

E. Site Condition Reports: Submit at time of discovery of differing conditions.

F. Unusual Event Reports: Submit at time of unusual event.

1.5 COORDINATION

A. Coordinate Contractor's Construction Schedule with the schedule of values, list of subcontracts, submittal schedule, progress reports, payment requests, and other required schedules and reports.

1. Secure time commitments for performing critical elements of the Work from entities involved.
2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

1.6 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

A. Time Frame: Extend schedule from date established for commencement of the Work to date of final completion.

1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.

B. Activities: Comply with the following:

1. Activity Duration: Define activities so no activity is longer than 30 days, unless specifically allowed by Architect.
2. Procurement Activities: Include procurement process activities for the following long lead items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
4. Startup and Testing Time: Include no fewer than 5 days for startup and testing per phase.
5. Commissioning Time: Include no fewer than 5 days for commissioning.
6. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Engineer's administrative procedures necessary for certification of Substantial Completion.

7. Punch List and Final Completion: Include not more than 15 days for completion of punch list items and final completion.

C. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.

1. Phasing: Arrange list of activities on schedule by phase.

2. Work under More Than One Contract: Include a separate activity for each contract.

3. Work by Owner: Include a separate activity for each portion of the Work performed by Owner.

4. Products Ordered in Advance: Include a separate activity for each product. Include delivery date indicated in Section 011000 "Summary." Delivery dates indicated stipulate the earliest possible delivery date.

5. Owner-Furnished Products: Include a separate activity for each product. Include delivery date indicated in Section 011000 "Summary." Delivery dates indicated stipulate the earliest possible delivery date.

6. Work Restrictions: Show the effect of the following items on the schedule:
   a. Coordination with existing construction.
   b. Limitations of continued occupancies.
   c. Uninterruptible services.
   d. Partial occupancy before Substantial Completion.
   e. Use-of-premises restrictions.
   g. Seasonal variations.
   h. Environmental control.

7. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:
   a. Subcontract awards.
   b. Submittals.
   c. Purchases.
   d. Mockups.
   e. Fabrication.
   f. Sample testing.
   g. Deliveries.
   h. Installation.
   i. Tests and inspections.
   j. Adjusting.
   k. Curing.
   l. Building flush-out.
   m. Startup and placement into final use and operation.
   n. Commissioning.

8. Construction Areas: Identify each major area of construction for each major portion of the Work. Indicate where each construction activity within a major area must be sequenced or integrated with other construction activities to provide for the following:
   a. Structural completion.
   b. Temporary enclosure and space conditioning.
   c. Permanent space enclosure.
   d. Completion of mechanical installation.
e. Completion of electrical installation.
f. Substantial Completion.

D. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and final completion.

E. Cost Correlation: Superimpose a cost correlation timeline, indicating planned and actual costs. On the line, show planned and actual dollar volume of the Work performed as of planned and actual dates used for preparation of payment requests.

1. See Section 012900 "Payment Procedures" for cost reporting and payment procedures.

F. Upcoming Work Summary: Prepare summary report indicating activities scheduled to occur or commence prior to submittal of next schedule update. Summarize the following issues:

1. Unresolved issues.
2. Unanswered Requests for Information.
3. Rejected or unreturned submittals.
4. Notations on returned submittals.
5. Pending modifications affecting the Work and the Contract Time.

G. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.

1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
3. As the Work progresses, indicate final completion percentage for each activity.

H. Recovery Schedule: When periodic update indicates the Work is 14 or more calendar days behind the current approved schedule, submit a separate recovery schedule indicating means by which Contractor intends to regain compliance with the schedule. Indicate changes to working hours, working days, crew sizes, equipment required to achieve compliance, and date by which recovery will be accomplished.

I. Distribution: Distribute copies of approved schedule to Engineer Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.

1. Post copies in Project meeting rooms and temporary field offices.
2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

1.7 REPORTS

A. Material Location Reports: At bi-weekly intervals, prepare and submit a comprehensive list of materials delivered to and stored at Project site. List shall be cumulative, showing materials previously reported plus items recently delivered. Include with list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from Project site. Indicate the following categories for stored materials:
1. Material stored prior to previous report and remaining in storage.
2. Material stored prior to previous report and since removed from storage and installed.
3. Material stored following previous report and remaining in storage.

B. Site Condition Reports: Immediately on discovery of a difference between site conditions and the Contract Documents, prepare and submit a detailed report. Submit with a Request for Information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

C. Unusual Event Reports: When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, responses by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise Owner in advance when these events are known or predictable.

1. Submit unusual event reports directly to Owner within one day of an occurrence. Distribute copies of report to parties affected by the occurrence.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013200
SECTION 013300
SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Submittal schedule requirements.
2. Administrative and procedural requirements for submittals.

B. Related Requirements:
1. Section 013100 "Project Management and Coordination" for submitting subcontract list and for requirements for web-based Project software.
2. Section 013200 "Construction Progress Documentation" for submitting schedules and reports, including Contractor's construction schedule.
3. Section 014000 "Quality Requirements" for submitting test and inspection reports, and schedule of tests and inspections.
4. Section 017700 "Closeout Procedures" for submitting closeout submittals and maintenance material submittals.
5. Section 017823 "Operation and Maintenance Data" for submitting operation and maintenance manuals.
6. Section 017839 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.
7. Section 017900 "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of Owner's personnel.

1.3 DEFINITIONS

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

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

1.4 SUBMITTAL SCHEDULE

A. Submittal Schedule: Submit, as an action submittal, a list of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Engineer and additional time for handling and reviewing submittals required by those corrections.

1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's construction schedule.
2. Initial Submittal: Submit concurrently with startup construction schedule. Include submittals required during the first 60 days of construction. List those submittals required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.

3. Final Submittal: Submit concurrently with the first complete submittal of Contractor's construction schedule.
   a. Submit revised submittal schedule to reflect changes in current status and timing for submittals.

4. Format: Arrange the following information in a tabular format:
   a. Scheduled date for first submittal.
   b. Specification Section number and title.
   c. Submittal Category: Action; informational.
   d. Name of subcontractor.
   e. Description of the Work covered.
   f. Scheduled date for Engineer’s final response.
   g. Scheduled dates for purchasing.
   h. Scheduled date of fabrication.
   i. Scheduled dates for installation.
   j. Activity or event number.

1.5 SUBMITTAL FORMATS

A. Submittal Information: Include the following information in each submittal:
   1. Project name.
   2. Date.
   3. Name of Engineer.
   4. Name of Construction Manager.
   5. Name of Contractor.
   6. Name of firm or entity that prepared submittal.
   7. Names of subcontractor, manufacturer, and supplier.
   8. Unique submittal number, including revision identifier. Include Specification Section number with sequential alphanumeric identifier; and alphanumeric suffix for resubmittals.
   9. Category and type of submittal.
   10. Submittal purpose and description.
   11. Number and title of Specification Section, with paragraph number and generic name for each of multiple items.
   12. Drawing number and detail references, as appropriate.
   13. Indication of full or partial submittal.
   14. Location(s) where product is to be installed, as appropriate.
   15. Other necessary identification.
   17. Signature of transmitter.

B. Options: Identify options requiring selection by Engineer.

C. Deviations and Additional Information: On each submittal, clearly indicate deviations from requirements in the Contract Documents, including minor variations and limitations; include relevant additional information and revisions, other than those requested by Engineer on previous submittals. Indicate by highlighting on each submittal or noting on attached separate sheet.
D. PDF Submittals: Prepare submittals as PDF package, incorporating complete information into each PDF file. Name PDF file with submittal number.

1. Place a permanent label or title block on each submittal item for identification; include name of firm or entity that prepared submittal.
2. Provide a space approximately 6 by 8 inches on label or beside title block to record Contractor's review and approval markings and action taken by Engineer.
3. Action Submittals: Submit electronic (PDF) copies of each submittal unless otherwise indicated. Engineer will return electronic (PDF) copies.
4. Informational Submittals: Submit electronic (PDF) copies of each submittal unless otherwise indicated. Engineer will not return copies.
5. Additional Copies: Unless additional copies are required for final submittal, and unless Engineer observes noncompliance with provisions in the Contract Documents, initial submittal may serve as final submittal.
6. Transmittal for Submittals: Assemble each submittal individually and appropriately for transmittal and handling. Transmit each submittal using Contractor's transmittal form.

1.6 SUBMITTAL PROCEDURES

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

1. Email: Prepare submittals as PDF package, and transmit to Engineer by sending via email or Contractor managed File Transfer Site. Include PDF transmittal form. Include information in email subject line.
   a. Engineer will return annotated file. Annotate and retain one copy of file as a digital Project Record Document file.

2. Web-Based Project Software: Prepare submittals in PDF form, and upload to web-based Project software website. Enter required data in web-based software site to fully identify submittal.

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

1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
4. Coordinate transmittal of submittals for related parts of the Work specified in different Sections so processing will not be delayed because of need to review submittals concurrently for coordination.
   a. Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Engineer’s receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
1. Initial Review: Allow 15 calendar days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Engineer will advise Contractor when a submittal being processed must be delayed for coordination.

2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.

3. Resubmittal Review: Allow 7 calendar days for review of each resubmittal.

4. Sequential Review: Where sequential review of submittals by Engineer's consultants, Owner, or other parties is indicated, allow 21 calendar days for initial review of each submittal.

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

1. Note date and content of previous submittal.
2. Note date and content of revision in label or title block and clearly indicate extent of revision.
3. Resubmit submittals until they are marked with “NO EXCEPTIONS TAKEN” or “MAKE CORRECTIONS NOTED” notation from Engineer's action stamp.

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

F. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with “NO EXCEPTIONS TAKEN” or “MAKE CORRECTIONS NOTED” notation from Engineer's action stamp.

1.7 SUBMITTAL REQUIREMENTS

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

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

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

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

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

5. Submit Product Data before Shop Drawings, and before or concurrent with Samples.
B. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data unless submittal based on Engineer's digital data drawing files is otherwise permitted.

1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
   a. Identification of products.
   b. Schedules.
   c. Compliance with specified standards.
   d. Notation of coordination requirements.
   e. Notation of dimensions established by field measurement.
   f. Relationship and attachment to adjoining construction clearly indicated.
   g. Seal and signature of professional engineer if specified.

2. PDF Sheet Size: Except for templates, patterns, and similar full-size Drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches, but no larger than 30 by 42 inches.

C. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:

1. Type of product. Include unique identifier for each product indicated in the Contract Documents or assigned by Contractor if none is indicated.
2. Manufacturer and product name, and model number if applicable.
3. Number and name of room or space.
4. Location within room or space.

D. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.

E. Design Data: Prepare and submit written and graphic information indicating compliance with indicated performance and design criteria in individual Specification Sections. Include list of assumptions and summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Number each page of submittal.

F. Certificates:

1. Certificates and Certifications Submittals: Submit a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity. Provide a notarized signature where indicated.
2. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
3. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
4. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
5. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
6. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure
G. Test and Research Reports:

1. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.

2. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.

3. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.

4. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.

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

6. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
   a. Name of evaluation organization.
   b. Date of evaluation.
   c. Time period when report is in effect.
   d. Product and manufacturers' names.
   e. Description of product.
   f. Test procedures and results.
   g. Limitations of use.

1.8 DELEGATED-DESIGN SERVICES

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.

1. If criteria indicated are insufficient to perform services or certification required, submit a written request for additional information to Architect.

B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF file copies of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.

1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.
1.9 CONTRACTOR'S REVIEW

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

B. Contractor's Approval: Indicate Contractor's approval for each submittal with a uniform approval stamp or indication in web-based Project software. Include name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

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

11.0 ENGINEER'S REVIEW

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

1. PDF Submittals: Engineer will indicate, via markup on each submittal, the appropriate action, as follows:

a. NO EXCEPTIONS TAKEN – does not require resubmission.

b. MAKE CORRECTIONS NOTED – does not require resubmission if Contractor agrees to make corrections noted.

c. REJECTED – submittal is not acceptable due to issues noted.

d. REVISE AND RESUBMIT – revise submittal as noted and resubmit.

e. SUBMIT SPECIFIED ITEM – Engineer generally takes no exception, but information is missing.

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

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

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

E. Engineer will discard submittals received from sources other than Contractor unless Engineer has agreed to preview the submittal for initial comment.

F. Submittals not required by the Contract Documents will be returned by Engineer without action.
PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013300
SECTION 014000
QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for quality assurance and quality control.

B. Testing and inspection services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.

1. Specific quality-assurance and quality-control requirements for individual work results are specified in their respective Specification Sections. Requirements in individual Sections may also cover production of standard products.

2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and quality-control procedures that facilitate compliance with the Contract Document requirements.

3. Requirements for Contractor to provide quality-assurance and quality-control services required by Engineer, Owner or authorities having jurisdiction are not limited by provisions of this Section.

4. Specific test and inspection requirements are not specified in this Section.

1.3 DEFINITIONS

A. Experienced: When used with an entity or individual, "experienced" unless otherwise further described means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

B. Field Quality-Control Tests: Tests and inspections that are performed on-site for installation of the Work and for completed Work.

C. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, assembly, and similar operations.

1. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade(s).

D. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria.

E. Product Tests: Tests and inspections that are performed by a nationally recognized testing laboratory (NRTL) according to 29 CFR 1910.7, by a testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program (NVLAP), or by a testing agency qualified to conduct
product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.

F. Source Quality-Control Tests: Tests and inspections that are performed at the source; for example, plant, mill, factory, or shop.

G. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.

H. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.

I. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Contractor's quality-control services do not include contract administration activities performed by Engineer.

1.4 DELEGATED-DESIGN SERVICES

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.

1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Engineer.

1.5 CONFLICTING REQUIREMENTS

A. Conflicting Standards and Other Requirements: If compliance with two or more standards or requirements are specified and the standards or requirements establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Engineer for direction before proceeding.

B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Engineer for a decision before proceeding.

1.6 ACTION SUBMITTALS

A. Delegated-Design Services Submittal: In addition to Shop Drawings, Product Data, and other required submittals, submit a statement signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

1.7 INFORMATIONAL SUBMITTALS

A. Contractor's Quality-Control Plan: For quality-assurance and quality-control activities and responsibilities.
B. Qualification Data: For Contractor's quality-control personnel.

C. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility submitted to authorities having jurisdiction before starting work on the following systems:

1. Seismic-force-resisting system, designated seismic system, or component listed in the Statement of Special Inspections.
2. Main wind-force-resisting system or a wind-resisting component listed in the Statement of Special Inspections.

D. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.

E. Schedule of Tests and Inspections: Prepare in tabular form and include the following:

1. Specification Section number and title.
2. Entity responsible for performing tests and inspections.
3. Description of test and inspection.
4. Identification of applicable standards.
5. Identification of test and inspection methods.
6. Number of tests and inspections required.
7. Time schedule or time span for tests and inspections.
8. Requirements for obtaining samples.
9. Unique characteristics of each quality-control service.

F. Reports: Prepare and submit certified written reports and documents as specified.

G. Permits, Licenses, and Certificates: For Owner's record, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents established for compliance with standards and regulations bearing on performance of the Work.

1.8 CONTRACTOR'S QUALITY-CONTROL PLAN

A. Quality-Control Plan, General: Submit quality-control plan within 10 working days of Notice to Proceed, and not less than five working days prior to preconstruction conference. Submit in format acceptable to Owner. Identify personnel, procedures, controls, instructions, tests, records, and forms to be used to carry out Contractor's quality-assurance and quality-control responsibilities. Coordinate with Contractor's Construction Schedule.

B. Quality-Control Personnel Qualifications: Engage qualified personnel trained and experienced in managing and executing quality-assurance and quality-control procedures similar in nature and extent to those required for Project.

1. Project quality-control manager may also serve as Project superintendent.

C. Submittal Procedure: Describe procedures for ensuring compliance with requirements through review and management of submittal process. Indicate qualifications of personnel responsible for submittal review.

D. Testing and Inspection: In quality-control plan, include a comprehensive schedule of Work requiring testing or inspection, including the following:
1. Contractor-performed tests and inspections including Subcontractor-performed tests and inspections. Include required tests and inspections and Contractor-elected tests and inspections. Distinguish source quality-control tests and inspections from field quality-control tests and inspections.

2. Special inspections required by authorities having jurisdiction and indicated on the Statement of Special Inspections.

E. Continuous Inspection of Workmanship: Describe process for continuous inspection during construction to identify and correct deficiencies in workmanship in addition to testing and inspection specified. Indicate types of corrective actions to be required to bring work into compliance with standards of workmanship established by Contract requirements and approved mockups.

F. Monitoring and Documentation: Maintain testing and inspection reports including log of approved and rejected results. Include work Engineer has indicated as nonconforming or defective. Indicate corrective actions taken to bring nonconforming work into compliance with requirements. Comply with requirements of authorities having jurisdiction.

1.9 REPORTS AND DOCUMENTS

A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:

1. Date of issue.
2. Project title and number.
3. Name, address, telephone number, and email address of testing agency.
4. Dates and locations of samples and tests or inspections.
5. Names of individuals making tests and inspections.
6. Description of the Work and test and inspection method.
8. Complete test or inspection data.
9. Test and inspection results and an interpretation of test results.
10. Record of temperature and weather conditions at time of sample taking and testing and inspection.
11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
12. Name and signature of laboratory inspector.
13. Recommendations on retesting and reinspecting.

B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:

1. Name, address, telephone number, and email address of technical representative making report.
2. Statement on condition of substrates and their acceptability for installation of product.
3. Statement that products at Project site comply with requirements.
4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
6. Statement whether conditions, products, and installation will affect warranty.
7. Other required items indicated in individual Specification Sections.
C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:

1. Name, address, telephone number, and email address of factory-authorized service representative making report.
2. Statement that equipment complies with requirements.
3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
4. Statement whether conditions, products, and installation will affect warranty.
5. Other required items indicated in individual Specification Sections.

1.10 QUALITY ASSURANCE

A. General: Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.

B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units. As applicable, procure products from manufacturers able to meet qualification requirements, warranty requirements, and technical or factory-authorized service representative requirements.

C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

D. Installer Qualifications: A firm or individual experienced in installing, erecting, applying, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar in material, design, and extent to those indicated for this Project.

F. Specialists: Certain Specification Sections require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.

1. Requirements of authorities having jurisdiction shall supersede requirements for specialists.

G. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspection indicated, as documented according to ASTM E329; and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.

H. Manufacturer’s Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
I. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

J. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:

1. Contractor responsibilities include the following:
   a. Provide test specimens representative of proposed products and construction.
   b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
   c. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
   d. Build laboratory mockups at testing facility using personnel, products, and methods of construction indicated for the completed Work.
   e. When testing is complete, remove test specimens and test assemblies, and laboratory mockups; do not reuse products on Project.

2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Engineer, with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.

K. Laboratory Mockups: Comply with requirements of preconstruction testing and those specified in individual Specification Sections.

1.11 QUALITY CONTROL

A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.

   1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspection they are engaged to perform.
   2. Payment for these services will be made from testing and inspection allowances, as authorized by Change Orders.
   3. Costs for retesting and reinspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor, and the Contract Sum will be adjusted by Change Order.

B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities, whether specified or not, to verify and document that the Work complies with requirements.

   1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
   2. Engage a qualified testing agency to perform quality-control services.
      a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
3. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspection will be performed.

4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.

5. Testing and inspection requested by Contractor and not required by the Contract Documents are Contractor's responsibility.

6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.

C. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.

D. Testing Agency Responsibilities: Cooperate with Engineer and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.

1. Notify Engineer and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.

2. Determine the locations from which test samples will be taken and in which in-situ tests are conducted.

3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.

4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.

5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.

6. Do not perform duties of Contractor.

E. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 013300 "Submittal Procedures."

F. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.

G. Associated Contractor Services: Cooperate with agencies and representatives performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:

1. Access to the Work.

2. Incidental labor and facilities necessary to facilitate tests and inspections.

3. Adequate quantities of representative samples of materials that require testing and inspection. Assist agency in obtaining samples.

4. Facilities for storage and field curing of test samples.

5. Delivery of samples to testing agencies.

6. Preliminary design mix proposed for use for material mixes that require control by testing agency.

7. Security and protection for samples and for testing and inspection equipment at Project site.
H. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspection.

1. Schedule times for tests, inspections, obtaining samples, and similar activities.

I. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents as a component of Contractor's quality-control plan. Coordinate and submit concurrently with Contractor's Construction Schedule. Update as the Work progresses.

1. Distribution: Distribute schedule to Owner, Engineer, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

1.12 SPECIAL TESTS AND INSPECTIONS

A. Special Tests and Inspections: Engage a qualified testing agency and/or special inspector to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of Owner, and as follows:

1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviewing the completeness and adequacy of those procedures to perform the Work.
2. Notifying Engineer and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
3. Submitting a certified written report of each test, inspection, and similar quality-control service to Engineer with copy to Contractor and to authorities having jurisdiction.
4. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
5. Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.
6. Retesting and reinspecting corrected work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:

1. Date test or inspection was conducted.
2. Description of the Work tested or inspected.
3. Date test or inspection results were transmitted to Engineer.
4. Identification of testing agency or special inspector conducting test or inspection.

B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Engineer's reference during normal working hours.

1. Submit log at Project closeout as part of Project Record Documents.

3.2 REPAIR AND PROTECTION

A. General: On completion of testing, inspection, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 017300 "Execution."

B. Protect construction exposed by or for quality-control service activities.

C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 014000
PART 1 - GENERAL

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

1.2 SUMMARY
A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.
B. Related Requirements:
   1. Section 011000 “Summary” for work restrictions and limitations on utility interruptions.
   2. Section 017419 “Construction Waste Management”
   3. Section 017700 “Closeout Procedures”

1.3 USE CHARGES
A. General: Installation and removal of and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities engaged in the Project to use temporary services and facilities without cost, including, but not limited to Engineer, occupants of Project, testing agencies, and authorities having jurisdiction.
B. Water and Sewer Service from Existing System: Water from Owner’s existing water system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.
C. Electric Power Service from Existing System: Electric power from Owner’s existing system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.

1.4 INFORMATIONAL SUBMITTALS
A. Site Utilization Plan: Show temporary facilities, temporary utility lines and connections, staging areas, construction site entrances, vehicle circulation, and parking areas for construction personnel.
B. Implementation and Termination Schedule: Within 15 working days of date established for commencement of the Work, submit schedule indicating implementation and termination dates of each temporary utility.
C. Project Identification and Temporary Signs: Show fabrication and installation details, including plans, elevations, details, layouts, typestyles, graphic elements, and message content.
D. Fire-Safety Program: Show compliance with requirements of NFPA 241 and authorities having jurisdiction. Indicate Contractor personnel responsible for management of fire-prevention program.
E. Moisture- and Mold-Protection Plan: Describe procedures and controls for protecting materials and construction from water absorption and damage and mold.

F. Dust- and HVAC-Control Plan: Submit coordination drawing and narrative that indicates the dust- and HVAC-control measures proposed for use, proposed locations, and proposed time frame for their operation. Include the following:

1. Locations of dust-control partitions at each phase of work.
2. HVAC system isolation schematic drawing.
3. Location of proposed air-filtration system discharge.
5. Other dust-control measures.

1.5 QUALITY ASSURANCE

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

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

1.6 PROJECT CONDITIONS

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

PART 2 - PRODUCTS

2.1 MATERIALS

A. Dust-Control Adhesive-Surface Walk-Off Mats: Provide mats minimum 36 by 60 inches (914 by 1524 mm).

2.2 TEMPORARY FACILITIES

A. Field Offices, General: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.
   1. Owner may provide conditioned interior space for field offices for duration of Project.

B. Common-Use Field Office: Of sufficient size to accommodate needs of Owner, Engineer, and construction personnel office activities and to accommodate Project meetings specified in other Division 01 Sections. Keep office clean and orderly. Unless provided by Owner, furnish and equip offices as follows:

   1. Furniture required for Project-site documents including file cabinets, plan tables, plan racks, and bookcases.
   2. Conference room of sufficient size to accommodate meetings of up to 10 individuals. Provide electrical power service and 120-V ac duplex receptacles, with no fewer than one receptacle on each wall. Furnish room with conference table, chairs, and 4-foot- (1.2-m-) square tack and marker boards.
   3. Heating and cooling equipment necessary to maintain a uniform indoor temperature of 68 to 72 deg F (20 to 22 deg C).
   4. Lighting fixtures capable of maintaining average illumination of 20 fc (215 lx) at desk height.
C. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.
   1. Store combustible materials apart from building.

2.3 EQUIPMENT

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

B. HVAC Equipment: Unless Owner authorizes use of permanent HVAC system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.
   1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
   2. Heating Units: Listed and labeled for type of fuel being consumed, by a qualified testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.
   3. Permanent HVAC System: If Owner authorizes use of permanent HVAC system for temporary use during construction, provide filter with MERV of 8 at each return-air grille in system and remove at end of construction.

PART 3 - EXECUTION

3.1 TEMPORARY FACILITIES, GENERAL

A. Conservation: Coordinate construction and use of temporary facilities with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.
   1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. See other Sections for disposition of salvaged materials that are designated as Owner's property.

3.2 INSTALLATION, GENERAL

A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.
   1. Locate facilities to limit site disturbance as specified in Section 011000 "Summary."

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

3.3 TEMPORARY UTILITY INSTALLATION

A. General: Install temporary service or connect to existing service.
   1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.

B. Toilets: Use of Owner's existing toilet facilities will be permitted, as long as facilities are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore these facilities to condition existing before initial use.
C. Temporary Heating and Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.

D. Isolation of Work Areas in Occupied Facilities: Prevent dust, fumes, and odors from entering occupied areas.
   1. Prior to commencing work, isolate the HVAC system in area where work is to be performed.
      a. Disconnect supply and return ductwork in work area from HVAC systems servicing occupied areas.
      b. Maintain negative air pressure within work area using air-filtration units, starting with commencement of temporary partition construction, and continuing until removal of temporary partitions is complete.

E. Perform daily construction cleanup and final cleanup using approved, HEPA-filter-equipped vacuum equipment.

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

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

3.4 SUPPORT FACILITIES INSTALLATION

A. Parking: Use designated areas of Owner's existing parking areas for construction personnel.

B. Project Signs: Provide Project signs as indicated. Unauthorized signs are not permitted.
   1. Temporary Signs: Provide other signs as indicated and as required to inform public and individuals seeking entrance to Project.
      a. Provide temporary, directional signs for construction personnel and visitors.
   2. Maintain and touch up signs so they are legible at all times.

C. Waste Disposal Facilities: Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."

D. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction. Comply with progress cleaning requirements in Section 017300 "Execution."

E. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.
   1. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.

F. Existing Stair Usage: Use of Owner's existing stairs will be permitted, provided stairs are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore stairs to condition existing before initial use.
1. Provide protective coverings, barriers, devices, signs, or other procedures to protect stairs and to maintain means of egress. If stairs become damaged, restore damaged areas so no evidence remains of correction work.

3.5 SECURITY AND PROTECTION FACILITIES INSTALLATION

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

B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.

1. Comply with work restrictions specified in Section 011000 "Summary."

C. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.

3.6 OPERATION, TERMINATION, AND REMOVAL

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

B. Maintenance: Maintain facilities in good operating condition until removal.

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

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

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

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

2. Remove temporary roads and paved areas not intended for or acceptable for integration into permanent construction. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at temporary entrances, as required by authorities having jurisdiction.

3. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 017700 "Closeout Procedures."

END OF SECTION 015000
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.

B. Related Requirements:
1. Section 012300 "Alternates" for products selected under an alternate.
2. Section 012500 "Substitution Procedures" for requests for substitutions.

1.3 DEFINITIONS

A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.

1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.
2. New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.
3. Comparable Product: Product that is demonstrated and approved by Engineer through submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.

B. Basis-of-Design Product Specification: A specification in which a single manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation. In addition to the basis-of-design product description, product attributes and characteristics may be listed to establish the significant qualities related to type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other special features and requirements for purposes of evaluating comparable products of additional manufacturers named in the specification.

C. Subject to Compliance with Requirements: Where the phrase "Subject to compliance with requirements" introduces a product selection procedure in an individual Specification Section, provide products qualified under the specified product procedure. In the event that a named product or product by a named manufacturer does not meet the other requirements of the specifications, select another named product or product from another named manufacturer that does meet the requirements of the specifications. Submit a comparable product request, if applicable.
1.4 ACTION SUBMITTALS

A. Comparable Product Request Submittal: Submit request for consideration of each comparable product. Identify basis-of-design product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

1. Include data to indicate compliance with the requirements specified in "Comparable Products" Article.
2. Bidders opting to bid comparable products are responsible for:
   a. Confirming the equipment they are bidding will fit in the space available, incorporating equipment’s clearance requirements.
   b. Coordination of any variance from basis-of-design in weight, electrical requirements, other utility requirements, etc. with other trades.
   c. Inclusion in the bid of any applicable costs for changes in prime bidder’s and their sub bidders’ work required to accommodate the utilization of the comparable product.

3. Engineer's Action: If necessary, Engineer will request additional information or documentation for evaluation within seven working days of receipt of a comparable product request. Engineer will notify Contractor of acceptance or rejection of proposed comparable product request within 15 working days of receipt of request, or seven working days of receipt of additional information or documentation, whichever is later.
   a. Form of Engineer's Approval of Submittal: As specified in Section 013300 "Submittal Procedures."
   b. Use product specified if Engineer does not issue a decision on use of a comparable product request within time allocated.


1.5 QUALITY ASSURANCE

A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.

1. Each contractor is responsible for providing products and construction methods compatible with products and construction methods of other contractors.
2. If a dispute arises between contractors over concurrently selectable but incompatible products, Engineer will determine which products shall be used.

B. Identification of Products: Except for required labels and operating data, do not attach or imprint manufacturer or product names or trademarks on exposed surfaces of products or equipment that will be exposed to view in occupied spaces or on the exterior.

1. Labels: Locate required product labels and stamps on a concealed surface, or, where required for observation following installation, on a visually accessible surface that is not conspicuous.
2. Equipment Nameplates: Provide a permanent nameplate on each item of service-connected or power-operated equipment. Locate on a visually accessible but inconspicuous surface. Include information essential for operation, including the following:
   a. Name of product and manufacturer.
   b. Model and serial number.
c. Capacity.
d. Speed.
e. Ratings.

3. See individual identification sections in Divisions 23 and 26 for additional identification requirements.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

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

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

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

1.7 PRODUCT WARRANTIES

A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer’s disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.

   1. Manufacturer's Warranty: Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
   2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner.

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

C. Submittal Time: Comply with requirements in Section 017700 "Closeout Procedures."

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

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

1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
3. Owner reserves the right to limit selection to products with warranties meeting requirements of the Contract Documents.
4. Where products are accompanied by the term "as selected," Engineer will make selection.
6. Or Equal: For products specified by name and accompanied by the term "or equal," or "or approved equal," or "or approved," comply with requirements in "Comparable Products" Article to obtain approval for use of an unnamed product.
   a. Submit additional documentation required by Engineer in order to establish equivalency of proposed products. Evaluation of "or equal" product status is by the Engineer, whose determination is final.

B. Product Selection Procedures:

1. Sole Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
   a. Sole product may be indicated by the phrase: "Subject to compliance with requirements, provide the following: ..."

2. Sole Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
   a. Sole manufacturer/source may be indicated by the phrase: "Subject to compliance with requirements, provide products by the following: ..."

3. Limited List of Products: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered unless otherwise indicated.
a. Limited list of products may be indicated by the phrase: "Subject to compliance with requirements, provide one of the following: ..."

4. Non-Limited List of Products: Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed, or an unnamed product, which complies with requirements.

a. Non-limited list of products is indicated by the phrase: "Subject to compliance with requirements, available products that may be incorporated in the Work include, but are not limited to, the following: ..."

5. Limited List of Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will be considered.

a. Limited list of manufacturers is indicated by the phrase: "Subject to compliance with requirements, provide products by one of the following: ..."

6. Non-Limited List of Manufacturers: Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed, or a product by an unnamed manufacturer, which complies with requirements.

a. Non-limited list of manufacturers is indicated by the phrase: "Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following: ..."

7. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.

a. For approval of products by unnamed manufacturers, comply with requirements in Section 012500 "Substitution Procedures" for substitutions for convenience.

C. Visual Matching Specification: Where Specifications require "match Engineer's sample," provide a product that complies with requirements and matches Engineer's sample. Engineer's decision will be final on whether a proposed product matches.

1. If no product available within specified category matches and complies with other specified requirements, comply with requirements in Section 012500 "Substitution Procedures" for proposal of product.

D. Visual Selection Specification: Where Specifications include the phrase "as selected by Engineer from manufacturer's full range" or similar phrase, select a product that complies with requirements. Engineer will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

2.2 COMPARABLE PRODUCTS

A. Conditions for Consideration of Comparable Products: Engineer will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Engineer may return requests without action, except to record noncompliance with these requirements:
1. Evidence that proposed product does not require revisions to the Contract Documents, is consistent with the Contract Documents, will produce the indicated results, and is compatible with other portions of the Work. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant product qualities include attributes such as type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other specific features and requirements.

2. Evidence that proposed product provides specified warranty.

3. List of similar installations for completed projects with project names and addresses and names and addresses of Engineers and owners, if requested.

4. Samples, if requested.

B. Submittal Requirements: Approval by the Engineer of Contractor's request for use of comparable product is not intended to satisfy other submittal requirements. Comply with specified submittal requirements.

PART 3 - EXECUTION (Not Used)

END OF SECTION 016000
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes general administrative and procedural requirements governing execution of the Work including, but not limited to, the following:

2. Field engineering and surveying.
3. Installation of the Work.
4. Cutting and patching.
5. Coordination of Owner-installed products.
6. Progress cleaning.
7. Starting and adjusting.
8. Protection of installed construction.

B. Related Requirements:

1. Section 011000 "Summary" for limits on use of Project site.
2. Section 013300 "Submittal Procedures" for submitting surveys.
3. Section 017700 "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, replacing defective work, and final cleaning.
4. Section 024119 "Selective Demolition" for demolition and removal of selected portions of the building.

1.3 DEFINITIONS

A. Cutting: Removal of in-place construction necessary to permit installation or performance of subsequent work.

B. Patching: Fitting and repair work required to restore construction to original conditions after installation of subsequent work.

1.4 PREINSTALLATION MEETINGS

A. Cutting and Patching Conference: Conduct conference at Project site.

1. Prior to commencing work requiring cutting and patching, review extent of cutting and patching anticipated and examine procedures for ensuring satisfactory result from cutting and patching work. Require representatives of each entity directly concerned with cutting and patching to attend, including the following:

a. Contractor's superintendent.

b. Trade supervisor responsible for cutting operations.

c. Trade supervisor(s) responsible for patching of each type of substrate.
d. Mechanical, electrical, and utilities subcontractors' supervisors, to the extent each trade is affecting by cutting and patching operations.

2. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

1.5 INFORMATIONAL SUBMITTALS

A. Cutting and Patching Plan: Submit plan describing procedures at least 10 working days prior to the time cutting and patching will be performed. Include the following information:

1. Extent: Describe reason for and extent of each occurrence of cutting and patching.
2. Changes to In-Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building appearance and other significant visual elements.
3. Products: List products to be used for patching and firms or entities that will perform patching work.
4. Dates: Indicate when cutting and patching will be performed.
5. Utilities and Mechanical and Electrical Systems: List services and systems that cutting and patching procedures will disturb or affect. List services and systems that will be relocated and those that will be temporarily out of service. Indicate length of time permanent services and systems will be disrupted.

a. Include description of provisions for temporary services and systems during interruption of permanent services and systems.

B. Landfill Receipts: Submit copy of receipts issued by a landfill facility, licensed to accept hazardous materials, for hazardous waste disposal.

1.6 QUALITY ASSURANCE

A. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.

1. Structural Elements: When cutting and patching structural elements, notify Engineer of locations and details of cutting and await directions from Engineer before proceeding. Shore, brace, and support structural elements during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection.

2. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety. Operational elements include the following:

a. Primary operational systems and equipment.
b. Fire-suppression systems.
c. Plumbing piping systems.
d. Mechanical systems piping and ducts.
e. Control systems.
f. Communication systems.
g. Fire-detection and -alarm systems.
h. Electrical wiring systems.
i. Operating systems of special construction.
3. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety. Other construction elements include but are not limited to the following:

   a. Water, moisture, or vapor barriers.
   b. Membranes and flashings.
   c. Equipment supports.
   d. Piping, ductwork, vessels, and equipment.
   e. Noise- and vibration-control elements and systems.

4. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Engineer's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

B. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of products and equipment.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Comply with requirements specified in other Sections.

B. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.

   1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Engineer for the visual and functional performance of in-place materials.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities, mechanical and electrical systems, and other construction affecting the Work.

   1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water-service piping; underground electrical services; and other utilities.
   2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.

B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.

   1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.

C. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:

1. Description of the Work.
2. List of detrimental conditions, including substrates.
3. List of unacceptable installation tolerances.
4. Recommended corrections.

D. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Existing Utility Information: Furnish information to local utility and Owner that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.

B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.

D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of Contractor, submit a request for information to Engineer according to requirements in Section 013100 "Project Management and Coordination."

3.3 CONSTRUCTION LAYOUT

A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify Engineer promptly.

3.4 INSTALLATION

A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.

1. Make vertical work plumb and make horizontal work level.
2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.

B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.

D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.

E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.

F. Tools and Equipment: Where possible, select tools or equipment that minimize production of excessive noise levels.

G. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other portions of the Work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.

H. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions.
   1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Engineer.
   2. Allow for building movement, including thermal expansion and contraction.
   3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

I. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.

J. Repair or remove and replace damaged, defective, or nonconforming Work.
   1. Comply with Section 017700 "Closeout Procedures" for repairing or removing and replacing defective Work.

3.5 CUTTING AND PATCHING

A. Cutting and Patching, General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
   1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.

B. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.

C. Temporary Support: Provide temporary support of work to be cut.
D. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.

E. Adjacent Occupied Areas: Where interference with use of adjoining areas or interruption of free passage to adjoining areas is unavoidable, coordinate cutting and patching according to requirements in Section 011000 "Summary."

F. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to minimize interruption to occupied areas.

G. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.

1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
4. Excavating and Backfilling: Comply with requirements in applicable Sections where required by cutting and patching operations.
5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
6. Proceed with patching after construction operations requiring cutting are complete.

H. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other work. Patch with durable seams that are as invisible as practicable. Provide materials and comply with installation requirements specified in other Sections, where applicable.

1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will minimize evidence of patching and refinishing.
   a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
   b. Restore damaged pipe covering to its original condition.
3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
   a. Where patching occurs in a painted surface, prepare substrate and apply primer and intermediate paint coats appropriate for substrate over the patch, and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.
4. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.

5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition and ensures thermal and moisture integrity of building enclosure.

I. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.6 OWNER-INSTALLED PRODUCTS

A. Site Access: Provide access to Project site for Owner's construction personnel.

B. Coordination: Coordinate construction and operations of the Work with work performed by Owner's construction personnel.

1. Construction Schedule: Inform Owner of Contractor's preferred construction schedule for Owner's portion of the Work. Adjust construction schedule based on a mutually agreeable timetable. Notify Owner if changes to schedule are required due to differences in actual construction progress.

2. Preinstallation Conferences: Include Owner's construction personnel at preinstallation conferences covering portions of the Work that are to receive Owner's work. Attend preinstallation conferences conducted by Owner's construction personnel if portions of the Work depend on Owner's construction.

3.7 PROGRESS CLEANING

A. General: Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.


2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F (27 deg C).

3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.

   a. Use containers intended for holding waste materials of type to be stored.

4. Coordinate progress cleaning for joint-use areas where Contractor and other contractors are working concurrently.

B. Site: Maintain Project site free of waste materials and debris.

C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.

1. Remove liquid spills promptly.

2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.

D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.
E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.

F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Comply with waste disposal requirements in Section 015000 "Temporary Facilities and Controls" and Section 017419 "Construction Waste Management and Disposal."

H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.

I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.

J. Limiting Exposures: Supervise construction operations to ensure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.8 STARTING AND ADJUSTING

A. Coordinate startup and adjusting of equipment and operating components with requirements in Section 019113 "General Commissioning Requirements."

B. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.

C. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.

D. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Manufacturer's Field Service: Comply with qualification requirements in Section 014000 "Quality Requirements."

3.9 PROTECTION OF INSTALLED CONSTRUCTION

A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.

B. Protection of Existing Items: Provide protection and ensure that existing items to remain undisturbed by construction are maintained in condition that existed at commencement of the Work.

C. Comply with manufacturer's written instructions for temperature and relative humidity.

END OF SECTION 017300
SECTION 017419
CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for the following:
   1. Salvaging nonhazardous demolition and construction waste.
   2. Recycling nonhazardous demolition and construction waste.
   3. Disposing of nonhazardous demolition and construction waste.

B. Related Requirements:
   1. Section 015000 "Temporary Facilities and Controls"
   2. Section 017300 "Execution"

1.3 DEFINITIONS

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

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

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

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

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

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

1.4 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition and construction waste becomes property of Contractor.

1.5 ACTION SUBMITTALS

A. Waste Management Plan: Submit plan within 30 calendar days of date established for the Notice to Proceed.
1.6 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with transportation and disposal regulations of authorities having jurisdiction.

B. Waste Management Conference(s): Conduct conference(s) at Project site to comply with requirements in Section 013100 "Project Management and Coordination." Review methods and procedures related to waste management including, but not limited to, the following:

1. Review and discuss waste management plan including responsibilities of each contractor and waste management coordinator.
2. Review and finalize procedures for materials separation and verify availability of containers and bins needed to avoid delays.
3. Review procedures for periodic waste collection and transportation to recycling and disposal facilities.
4. Review waste management requirements for each trade.

1.7 WASTE MANAGEMENT PLAN

A. General: Develop a waste management plan according to requirements in this Section. Plan shall distinguish between demolition and construction waste.

B. Waste Identification: Indicate anticipated types and quantities of demolition and construction waste generated by the Work.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General: Practice efficient waste management in the use of materials in the course of the Work. Use all reasonable means to divert construction and demolition waste from landfills and incinerators. Facilitate recycling and salvage of materials, including the following:

1. Demolition Waste:
   a. Miscellaneous steel.
   b. Insulation.
   c. Equipment.
   d. Piping.
   e. Supports and hangers.
   f. Valves.
   g. Mechanical equipment.
   h. Electrical conduit.
   i. Copper wiring.
   j. Electrical devices.
   k. Switchgear and panelboards.

2. Construction Waste:
   a. Metals.
   b. Insulation.
   c. Piping.
   d. Electrical conduit.
   e. Packaging: Regardless of salvage/recycle goal indicated in "General" Paragraph above, salvage or recycle 100 percent of the following uncontaminated packaging materials:

      1) Paper.
2) Cardboard.
3) Boxes.
4) Plastic sheet and film.
5) Polystyrene packaging.
7) Wood pallets.
8) Plastic pails.

f. Construction Office Waste: Regardless of salvage/recycle goal indicated in "General" Paragraph above, salvage or recycle 100 percent of the following construction office waste materials:

1) Paper.
2) Aluminum cans.
3) Glass containers.

PART 3 - EXECUTION

3.1 PLAN IMPLEMENTATION

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

1. Comply with operation, termination, and removal requirements in Section 015000 "Temporary Facilities and Controls."

B. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work.

1. Distribute waste management plan to everyone concerned within three days of submittal return.
2. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.

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

1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged and recycled.
2. Comply with Section 015000 "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.

3.2 SALVAGING DEMOLITION WASTE

A. Comply with requirements in Section 024119 "Selective Demolition" for salvaging demolition waste.

B. Salvaged Items for Reuse in the Work: Salvage items for reuse and handle as follows:

1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.
3. Store items in a secure area until installation.
4. Protect items from damage during transport and storage.
5. Install salvaged items to comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make items functional for use indicated.

C. Salvaged Items for Sale and Donation: Not permitted on Project site.

D. Salvaged Items for Owner's Use: Salvage items for Owner's use and handle as follows:

1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.
3. Store items in a secure area until delivery to Owner.
4. Transport items to Owner's storage area designated by Owner.
5. Protect items from damage during transport and storage.

E. Doors and Hardware: Brace open end of door frames. Except for removing door closers, leave door hardware attached to doors.

F. Equipment: Drain tanks, piping, and fixtures. Seal openings with caps or plugs. Protect equipment from exposure to weather.

G. Electrical Devices: Separate switches, receptacles, switchgear, transformers, meters, panelboards, circuit breakers, and other devices by type.

3.3 RECYCLING DEMOLITION AND CONSTRUCTION WASTE, GENERAL

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

B. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall be shared equally by Owner and Contractor.

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

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

1. Provide appropriately marked containers or bins for controlling recyclable waste until removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.
   a. Inspect containers and bins for contamination and remove contaminated materials if found.

2. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
3. Stockpile materials away from construction area. Do not store within drip line of remaining trees.
4. Store components off the ground and protect from the weather.
5. Remove recyclable waste from Owner's property and transport to recycling receiver or processor as often as required to prevent overfilling bins.
3.4 RECYCLING DEMOLITION WASTE

A. Metals: Separate metals by type.
   1. Structural Steel: Stack members according to size, type of member, and length.
   2. Remove and dispose of bolts, nuts, washers, and other rough hardware.

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

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

3.5 RECYCLING CONSTRUCTION WASTE

A. Packaging:
   1. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.
   3. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site, break down pallets into component wood pieces and comply with requirements for recycling wood.
   4. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.

3.6 DISPOSAL OF WASTE

A. General: Except for items or materials to be salvaged or recycled, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.
   1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
   2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

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

C. Burning: Do not burn waste materials.

D. Burning: Burning of waste materials is permitted only at designated areas on Owner's property, provided required permits are obtained. Provide full-time monitoring for burning materials until fires are extinguished.

END OF SECTION 017419
SECTION 017700
CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
   1. Substantial Completion procedures.
   2. Final completion procedures.
   3. Warranties.
   4. Final cleaning.
   5. Repair of the Work.

B. Related Requirements:
   1. Section 017823 "Operation and Maintenance Data" for additional operation and maintenance manual requirements.
   2. Section 017839 "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
   3. Section 017900 "Demonstration and Training" for requirements to train the Owner's maintenance personnel to adjust, operate, and maintain products, equipment, and systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of cleaning agent.

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

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

1.4 CLOSEOUT SUBMITTALS

A. Certificates of Release: From authorities having jurisdiction.

B. Certificate of Insurance: For continuing coverage.

C. Field Report: For pest control inspection.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Schedule of Maintenance Material Items: For maintenance material submittal items specified in other Sections.
1.6 SUBSTANTIAL COMPLETION PROCEDURES

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

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

1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
2. Submit closeout submittals specified in other Division 01 Sections, including project record documents, operation and maintenance manuals, damage or settlement surveys, property surveys, and similar final record information.
3. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
4. Submit maintenance material submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Engineer. Label with manufacturer's name and model number.
   a. Schedule of Maintenance Material Items: Prepare and submit schedule of maintenance material submittal items, including name and quantity of each item and name and number of related Specification Section. Obtain Owner's signature for receipt of submittals.
5. Submit testing, adjusting, and balancing records.
6. Submit changeover information related to Owner's use, operation, and maintenance.

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

1. Advise Owner of pending insurance changeover requirements.
2. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
3. Complete startup and testing of systems and equipment.
4. Perform preventive maintenance on equipment used prior to Substantial Completion.
5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings specified in Section 017900 "Demonstration and Training."
6. Advise Owner of changeover in utility services.
7. Terminate and remove temporary facilities from Project site, construction tools, and similar elements.
8. Complete final cleaning requirements.
9. Touch up paint and otherwise repair and restore marred exposed finishes to eliminate visual defects.

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

1. Request back-check observation when the Work identified in previous observations as incomplete is completed or corrected.
2. Results of completed observation will form the basis of requirements for final completion.

1.7 FINAL COMPLETION PROCEDURES

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

1. Submit a final Application for Payment according to Contract with Owner.
2. Certified List of Incomplete Items: Submit certified copy of Engineer's Substantial Completion observation list of items to be completed or corrected (punch list), endorsed and dated by Contractor. Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
3. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.

1.8 SUBMITTAL OF PROJECT WARRANTIES

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

B. Partial Occupancy: Submit properly executed warranties within 15 working days of completion of designated portions of the Work that are completed and occupied or used by Owner during construction period by separate agreement with Contractor.

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

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

1. Submit on digital media acceptable to Owner.

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

PART 2 - PRODUCTS

2.1 MATERIALS

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

1. Use cleaning products that comply with Green Seal's GS-37, or if GS-37 is not applicable, use products that comply with the California Code of Regulations maximum allowable VOC levels.
PART 3 - EXECUTION

3.1 FINAL CLEANING

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

B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.

1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:
   a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
   b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
   c. Rake grounds that are not planted, mulched, or paved to a smooth, even-textured surface.
   d. Remove tools, construction equipment, machinery, and surplus material from Project site.
   e. Remove snow and ice to provide safe access to building.
   f. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
   g. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
   h. Sweep concrete floors broom clean in unoccupied spaces.
   i. Remove labels that are not permanent.
   j. Wipe surfaces of mechanical and electrical equipment and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
   k. Leave Project clean and ready for occupancy.

C. Construction Waste Disposal: Comply with waste disposal requirements in Section 015000 "Temporary Facilities and Controls" and Section 017419 "Construction Waste Management and Disposal."

3.2 REPAIR OF THE WORK

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

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

1. Remove and replace chipped, scratched, and broken glass, reflective surfaces, and other damaged transparent materials.
2. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that that already show evidence of repair or restoration.
a. Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification.

3. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.

4. Replace burned-out bulbs, bulbs noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.

END OF SECTION 017700
SECTION 017823 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
   1. Operation and maintenance documentation directory manuals.
   2. Emergency manuals.
   3. Systems and equipment operation manuals.
   4. Systems and equipment maintenance manuals.
   5. Product maintenance manuals.

B. Related Requirements:
   1. Section 013300 "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.

1.3 DEFINITIONS

A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.

B. Subsystem: A portion of a system with characteristics similar to a system.

1.4 CLOSEOUT SUBMITTALS

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

   1. Engineer will comment on whether content of operation and maintenance submittals is acceptable.
   2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.

B. Format: Submit operation and maintenance manuals in the following format:

   1. Submit on digital media acceptable to Engineer by email to Engineer. Enable reviewer comments on draft submittals.

C. Initial Manual Submittal: Submit draft copy of each manual at least calendar days before commencing demonstration and training. Engineer will comment on whether general scope and content of manual are acceptable or if changes or required.

D. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 15 calendar days before commencing demonstration and training.
1. Correct or revise each manual to comply with Engineer's comments on Initial Manual Submittal.

2. Submit three paper copies of each corrected manual in format specified below, directly to Owner.

E. Comply with Section 017700 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

1.5 FORMAT OF OPERATION AND MAINTENANCE MANUALS

A. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.

1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.

2. File Names and Bookmarks: Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.

B. Manuals, Paper Copy: Submit manuals in the form of hard-copy, bound and labeled volumes.

1. Binders: Heavy-duty, three-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.

   a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.

   b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents. Indicate volume number for multiple-volume sets.

2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.


5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.

   a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.

   b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.
1.6 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

A. Organization of Manuals: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:

1. Title page.
2. Table of contents.

B. Title Page: Include the following information:

1. Subject matter included in manual.
2. Name and address of Project.
3. Name and address of Owner.
4. Date of submittal.
5. Name and contact information for Contractor.
6. Name and contact information for Engineer.
7. Names and contact information for major consultants to the Engineer that designed the systems contained in the manuals.
8. Cross-reference to related systems in other operation and maintenance manuals.

C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.

1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.

D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.

E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

1.7 EMERGENCY MANUALS

A. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.

B. Content: Organize manual into a separate section for each of the following:

1. Type of emergency.
2. Emergency instructions.
3. Emergency procedures.

C. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:

1. Fire.
2. Gas leak.
3. Water leak.
5. System, subsystem, or equipment failure.
6. Chemical release or spill.

D. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.

E. Emergency Procedures: Include the following, as applicable:
   1. Instructions on stopping.
   2. Shutdown instructions for each type of emergency.
   3. Operating instructions for conditions outside normal operating limits.
   4. Required sequences for electric or electronic systems.
   5. Special operating instructions and procedures.

1.8 SYSTEMS AND EQUIPMENT OPERATION MANUALS

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

   1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
   2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.

B. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:

   2. Performance and design criteria if Contractor has delegated design responsibility.
   3. Operating standards.
   4. Operating procedures.
   5. Operating logs.
   6. Wiring diagrams.
   7. Control diagrams.
   8. Piped system diagrams.
   9. Precautions against improper use.
   10. License requirements including inspection and renewal dates.

C. Descriptions: Include the following:

   1. Product name and model number. Use designations for products indicated on Contract Documents.
   2. Manufacturer's name.
   3. Equipment identification with serial number of each component.
   4. Equipment function.
   5. Operating characteristics.
   6. Limiting conditions.
   7. Performance curves.
   8. Engineering data and tests.
   9. Complete nomenclature and number of replacement parts.
D. Operating Procedures: Include the following, as applicable:
   1. Startup procedures.
   2. Equipment or system break-in procedures.
   3. Routine and normal operating instructions.
   4. Regulation and control procedures.
   5. Instructions on stopping.
   7. Seasonal and weekend operating instructions.
   8. Required sequences for electric or electronic systems.
   9. Special operating instructions and procedures.

E. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

F. Piped Systems: Diagram piping as installed, and identify color coding where required for identification.

1.9 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

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

   1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
   2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.

B. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranties and bonds as described below.

C. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

D. Manufacturers' Maintenance Documentation: Include the following information for each component part or piece of equipment:

   1. Standard maintenance instructions and bulletins; include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.

      a. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.
2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
3. Identification and nomenclature of parts and components.
4. List of items recommended to be stocked as spare parts.

E. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
   1. Test and inspection instructions.
   2. Troubleshooting guide.
   3. Precautions against improper maintenance.
   4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
   5. Aligning, adjusting, and checking instructions.
   6. Demonstration and training video recording, if available.

F. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
   1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
   2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.

G. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.

H. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.

I. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
   1. Include procedures to follow and required notifications for warranty claims.

J. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.
   1. Do not use original project record documents as part of maintenance manuals.

1.10 PRODUCT MAINTENANCE MANUALS

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

B. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.

C. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section.
number and title in Project Manual and drawing or schedule designation or identifier where applicable.

D. Product Information: Include the following, as applicable:

1. Product name and model number.
2. Manufacturer's name.
3. Color, pattern, and texture.
5. Reordering information for specially manufactured products.

E. Maintenance Procedures: Include manufacturer's written recommendations and the following:

1. Inspection procedures.
2. Types of cleaning agents to be used and methods of cleaning.
3. List of cleaning agents and methods of cleaning detrimental to product.
4. Schedule for routine cleaning and maintenance.
5. Repair instructions.

F. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.

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

1. Include procedures to follow and required notifications for warranty claims.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 017823
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for project record documents, including the following:

1. Record Drawings.
2. Record Specifications.
3. Miscellaneous record submittals.

B. Related Requirements:
1. Section 017300 "Execution" for final property survey.
2. Section 017700 "Closeout Procedures" for general closeout procedures.
3. Section 017823 "Operation and Maintenance Data" for operation and maintenance manual requirements.

1.3 CLOSEOUT SUBMITTALS

A. Record Drawings: Comply with the following:

1. Number of Copies: Submit one set(s) of marked-up as-built prints.
   a. Engineer will review indicate whether general scope of changes, additional information recorded, and quality of mark-ups are acceptable.
   b. Engineer will incorporate changes into the record CAD files and provide Owner with Record Drawings and Record CAD files.

B. Record Specifications: Submit one marked-up paper copy of as-built Project's Specifications, including addenda and contract modifications for Engineer's review and use in developing the Record Specifications.

1.4 RECORD DRAWINGS

A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.

1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up as-built prints.

   a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
   b. Accurately record information in an acceptable drawing technique.
   c. Record data as soon as possible after obtaining it.
   d. Record and check the markup before enclosing concealed installations.
   e. Cross-reference record prints to corresponding photographic documentation.
2. Content: Types of items requiring marking include, but are not limited to, the following:
   a. Dimensional changes to Drawings.
   b. Revisions to details shown on Drawings.
   c. Revisions to routing of piping and conduits.
   d. Revisions to electrical circuitry.
   e. Actual equipment locations.
   f. Duct size and routing.
   g. Locations of concealed internal utilities.
   h. Changes made by Change Order or Work Change Directive.
   i. Changes made following Engineer's written orders.
   j. Details not on the original Contract Drawings.
   k. Field records for variable and concealed conditions.
   l. Record information on the Work that is shown only schematically.

3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up as-built prints.

4. Mark record sets with erasable, pencil or pen. Use other colors to distinguish between changes as follows:
   a. Red shall indicate new items, deviations and routing.
   b. Green shall indicate items removed or deleted.
   c. Blue shall be used for relevant notes and descriptions.

5. Mark important additional information that was either shown schematically or omitted from original Drawings.

6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.

1.5 RECORD SPECIFICATIONS

A. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
4. For each principal product, indicate whether record Product Data has been submitted in operation and maintenance manuals instead of submitted as record Product Data.
5. Note related Change Orders and as-built Drawings where applicable.

B. Format: Submit as-built Specifications as marked-up paper copy of Specifications.

1.6 MAINTENANCE OF RECORD DOCUMENTS

A. Maintenance of Record Documents: Store record documents in the field office apart from the Contract Documents used for construction. Do not use project record documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project record documents for Engineer’s, Owner’s and authorities having jurisdiction reference during normal working hours.
PART 2 - PRODUCTS

PART 3 - EXECUTION

END OF SECTION 017839
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1. Instruction in operation and maintenance of systems, subsystems, and equipment.
2. Demonstration and training video recordings.

B. Allowances: Furnish demonstration and training instruction time under the demonstration and training allowance as specified in Section 012100 "Allowances."

C. Unit Price for Instruction Time: Length of instruction time will be measured by actual time spent performing demonstration and training in required location. No payment will be made for time spent assembling educational materials, setting up, or cleaning up. See requirements in Section 012200 "Unit Prices."

1.3 INFORMATIONAL SUBMITTALS

A. Instruction Program: Submit outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors’ names for each training module. Include learning objective and outline for each training module.

1. Indicate proposed training modules using manufacturer-produced demonstration and training video recordings for systems, equipment, and products in lieu of video recording of live instructional module.

B. Qualification Data: For instructor.

C. Attendance Record: For each training module, submit list of participants and length of instruction time.

D. Evaluations: For each participant and for each training module, submit results and documentation of performance-based test.

1.4 CLOSEOUT SUBMITTALS

A. Demonstration and Training Video Recordings: Submit two copies within seven days of end of each training module.

1. Identification: On each copy, provide an applied label with the following information:

   a. Name of Project.
   b. Name and address of videographer.
   c. Name of Engineer.
d. Name of Construction Manager.
e. Name of Contractor.
f. Date of video recording.

2. Transcript: Prepared and bound in format matching operation and maintenance manuals. Mark appropriate identification on front and spine of each binder. Include a cover sheet with same label information as the corresponding video recording. Include name of Project and date of video recording on each page.

3. Transcript: Prepared in PDF electronic format. Include a cover sheet with same label information as the corresponding video recording and a table of contents with links to corresponding training components. Include name of Project and date of video recording on each page.

4. At completion of training, submit complete training manual(s) for Owner's use prepared in same paper and PDF file format required for operation and maintenance manuals specified in Section 017823 "Operation and Maintenance Data."

1.5 QUALITY ASSURANCE

A. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.

B. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Section 014000 "Quality Requirements," experienced in operation and maintenance procedures and training.

C. Videographer Qualifications: A professional videographer who is experienced photographing demonstration and training events similar to those required.

D. Preinstruction Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination." Review methods and procedures related to demonstration and training including, but not limited to, the following:

1. Inspect and discuss locations and other facilities required for instruction.
2. Review and finalize instruction schedule and verify availability of educational materials, instructors' personnel, audiovisual equipment, and facilities needed to avoid delays.
3. Review required content of instruction.
4. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

1.6 COORDINATION

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

B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.

C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data have been reviewed and approved by Engineer.
INSTRUCTION PROGRAM

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

B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:

1. Basis of System Design, Operational Requirements, and Criteria: Include the following:
   a. System, subsystem, and equipment descriptions.
   b. Performance and design criteria if Contractor is delegated design responsibility.
   c. Operating standards.
   d. Regulatory requirements.
   e. Equipment function.
   f. Operating characteristics.
   g. Limiting conditions.
   h. Performance curves.

2. Documentation: Review the following items in detail:
   a. Emergency manuals.
   b. Systems and equipment operation manuals.
   c. Systems and equipment maintenance manuals.
   d. Product maintenance manuals.
   e. Project Record Documents.
   f. Identification systems.
   g. Warranties and bonds.
   h. Maintenance service agreements and similar continuing commitments.

3. Emergencies: Include the following, as applicable:
   a. Instructions on meaning of warnings, trouble indications, and error messages.
   b. Instructions on stopping.
   c. Shutdown instructions for each type of emergency.
   d. Operating instructions for conditions outside of normal operating limits.
   e. Sequences for electric or electronic systems.
   f. Special operating instructions and procedures.

4. Operations: Include the following, as applicable:
   a. Startup procedures.
   b. Equipment or system break-in procedures.
   c. Routine and normal operating instructions.
   d. Regulation and control procedures.
   e. Control sequences.
   f. Safety procedures.
   g. Instructions on stopping.
   h. Normal shutdown instructions.
   i. Operating procedures for emergencies.
   j. Operating procedures for system, subsystem, or equipment failure.
   k. Seasonal and weekend operating instructions.
   l. Required sequences for electric or electronic systems.
m. Special operating instructions and procedures.

5. Adjustments: Include the following:
   a. Alignments.
   b. Checking adjustments.
   c. Noise and vibration adjustments.
   d. Economy and efficiency adjustments.

6. Troubleshooting: Include the following:
   a. Diagnostic instructions.
   b. Test and inspection procedures.

7. Maintenance: Include the following:
   a. Inspection procedures.
   b. Types of cleaning agents to be used and methods of cleaning.
   c. List of cleaning agents and methods of cleaning detrimental to product.
   d. Procedures for routine cleaning.
   e. Procedures for preventive maintenance.
   f. Procedures for routine maintenance.
   g. Instruction on use of special tools.

8. Repairs: Include the following:
   a. Diagnosis instructions.
   b. Repair instructions.
   c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
   d. Instructions for identifying parts and components.
   e. Review of spare parts needed for operation and maintenance.

1.8 PREPARATION

A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Section 017823 "Operation and Maintenance Data."

B. Set up instructional equipment at instruction location.

1.9 INSTRUCTION

A. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Owner for number of participants, instruction times, and location.

B. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.

1. Furnish an instructor to describe basis of system design, operational requirements, criteria, and regulatory requirements.
2. Owner will furnish an instructor to describe Owner's operational philosophy.
3. Owner will furnish Contractor with names and positions of participants.
C. Scheduling: Provide instruction at mutually agreed-on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.

1. Schedule training with Owner with at least seven days' advance notice.

D. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.

E. Evaluation: At conclusion of each training module, assess and document each participant’s mastery of module by use of a demonstration performance-based test.

F. Cleanup: Collect used and leftover educational materials and give to Owner. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

1.10 DEMONSTRATION AND TRAINING VIDEO RECORDINGS

A. General: Engage a qualified commercial videographer to record demonstration and training video recordings. Record each training module separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice.

1. At beginning of each training module, record each chart containing learning objective and lesson outline.

B. Digital Video Recordings: Provide high-resolution, digital video in MPEG format, produced by a digital camera with minimum sensor resolution of 12 megapixels and capable of recording in full HD mode with vibration reduction technology.

1. Submit video recordings on CD-ROM or thumb drive.
2. File Hierarchy: Organize folder structure and file locations according to Project Manual table of contents. Provide complete screen-based menu.
3. File Names: Utilize file names based on name of equipment generally described in video segment, as identified in Project specifications.
4. Contractor and Installer Contact File: Using appropriate software, create a file for inclusion on the equipment demonstration and training recording that describes the following for each Contractor involved on the Project, arranged according to Project Manual table of contents:
   a. Name of Contractor/Installer.
   b. Business address.
   c. Business phone number.
   d. Point of contact.
   e. Email address.

C. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to adequately cover area of demonstration and training. Display continuous running time.

1. Film training session(s) in segments not to exceed 15 minutes.
   a. Produce segments to present a single significant piece of equipment per segment.
   b. Organize segments with multiple pieces of equipment to follow order of Project Manual table of contents.
   c. Where a training session on a particular piece of equipment exceeds 15 minutes, stop filming and pause training session. Begin training session again upon commencement of new filming segment.
D. Light Levels: Verify light levels are adequate to properly light equipment. Verify equipment markings are clearly visible prior to recording.

   1. Furnish additional portable lighting as required.

E. Narration: Describe scenes on video recording by audio narration by microphone while or dubbing audio narration off-site after video recording is recorded. Include description of items being viewed.

F. Transcript: Provide a transcript of the narration. Display images and running time captured from videotape opposite the corresponding narration segment.

G. Preproduced Video Recordings: Provide video recordings used as a component of training modules in same format as recordings of live training.

PART 2 - PRODUCTS

PART 3 - EXECUTION

END OF SECTION 017900
SECTION 024119
SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Demolition and removal of selected portions of building systems.
   2. Demolition and removal of selected site elements.
   3. Salvage of existing items to be reused or recycled.

B. Related Requirements:
   1. Section 011000 "Summary" for restrictions on use of the premises, Owner-occupancy requirements, and phasing requirements.
   2. Section 017300 "Execution" for cutting and patching procedures.

1.3 DEFINITIONS

A. Remove: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged or reinstalled.

B. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and deliver to Owner ready for reuse.

C. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage, prepare for reuse, and reinstall where indicated.

D. Existing to Remain: Leave existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.

E. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.

1.4 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition waste becomes property of Contractor.

1.5 PREINSTALLATION MEETINGS

A. Predemolition Conference: Conduct conference at Project site.
   1. Inspect and discuss condition of construction to be selectively demolished.
   2. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
3. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
4. Review areas where existing construction is to remain and requires protection.

1.6 INFORMATIONAL SUBMITTALS

A. Contractor Survey: Submit contractor survey of condition of existing boilers.

B. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property for dust control and for noise control. Indicate proposed locations and construction of barriers.

C. Schedule of Selective Demolition Activities: Indicate the following:
   1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's on-site operations are uninterrupted.
   2. Interruption of utility services. Indicate how long utility services will be interrupted.
   3. Coordination for shutoff, capping, and continuation of utility services.
   4. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.

D. Predemolition Photographs or Video: Show existing conditions of adjoining construction, including finish surfaces, that might be misconstrued as damage caused by demolition operations. Comply with Section 013233 “Photographic Documentation.” Submit before Work begins.

E. Warranties: Documentation indicating that existing warranties are still in effect after completion of selective demolition where applicable.

1.7 CLOSEOUT SUBMITTALS

A. Inventory: Submit a list of items that have been removed and salvaged.

1.8 FIELD CONDITIONS

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

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

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

D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
   1. If suspected hazardous materials are encountered, do not disturb; immediately notify Engineer and Owner. Hazardous materials will be removed by Owner under a separate contract.

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

F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
   1. Maintain fire-protection facilities in service during selective demolition operations.
1.9 WARRANTY

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

1. Existing warranties shall be verified with Owner prior to commencing selective demolition work.

B. Notify warrantor on completion of selective demolition, and obtain documentation verifying that existing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

1.10 COORDINATION

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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

B. Standards: Comply with ASSE A10.6 and NFPA 241.

PART 3 - EXECUTION

3.1 EXAMINATION

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

B. Review Project Record Documents of existing construction or other existing condition and hazardous material information provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.

C. Perform a contractor survey of condition of boilers to determine whether removing any element might result in operational deficiency or unplanned failure of any portion of boiler or adjacent boilers during selective demolition operations.

1. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

D. Verify that hazardous materials have been remediated before proceeding with building demolition operations.

E. Survey of Existing Conditions: Record existing conditions by use of measured drawings and/or preconstruction photographs or video.

1. Inventory and record the condition of items to be removed and salvaged. Provide photographs or video of conditions that might be misconstrued as damage caused by salvage operations.

2. Before selective demolition or removal of existing building elements that will be reproduced or duplicated in final Work, make permanent record of measurements, materials, and construction details required to make exact reproduction.
3.2 **UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS**

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

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

1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
2. Arrange to shut off utilities with utility companies.
3. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
4. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated on Drawings to be removed.
   a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
   b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material and leave in place.
   c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
   d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstallation, reconnect, and make equipment operational.
   e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
   f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
   g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material and leave in place.

3.3 **PROTECTION**

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

1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
4. Cover and protect furniture, furnishings, and equipment that have not been removed.
5. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Section 015000 "Temporary Facilities and Controls."

B. Remove temporary barricades and protections where hazards no longer exist.

3.4 **SELECTIVE DEMOLITION, GENERAL**

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.

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

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

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

5. Maintain fire watch during and for at least two hours after flame-cutting operations.


7. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.

8. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.

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

10. Dispose of demolished items and materials promptly. Comply with requirements in Section 017419 "Construction Waste Management and Disposal."

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

C. Removed and Salvaged Items:

1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers.
3. Store items in a secure area until delivery to Owner.
4. Transport items to Owner’s storage area designated by Owner.
5. Protect items from damage during transport and storage.

D. Removed and Reinstalled Items:

1. Clean and repair items to functional condition adequate for intended reuse.
2. Pack or crate items after cleaning and repairing. Identify contents of containers.
3. Protect items from damage during transport and storage.
4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

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

3.5 DISPOSAL OF DEMOLISHED MATERIALS

A. Remove demolition waste materials from Project site, dispose of them in an EPA-approved construction and demolition waste landfill acceptable to authorities having jurisdiction, and/or
recycle or dispose of them according to Section 017419 "Construction Waste Management and Disposal."

1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
4. Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."

B. Burning: Do not burn demolished materials.

3.6 CLEANING

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

END OF SECTION 024119
COMMON WORK RESULTS FOR MECHANICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. All drawings associated with the entire project, including general provisions of the Contract, including The General Conditions of the Contract for Construction, General and Supplementary Conditions and Division 1 Conditions specification sections shall apply to the Division 21, 22, and 23 specifications and drawings. The Contractor shall be responsible for reviewing and becoming familiar with the aforementioned and all other Contract Documents associated with the project.

B. Related Sections: Refer to all sections in Division 21, 22, and 23. Refer to Division 26 specification sections and Division 26 drawings.

C. Where contradictions occur between this section and Division 1, the more stringent requirement shall apply.

D. Contractor shall be defined as any and all entities involved with the construction of the project.

1.2 SUMMARY:

A. This Section specifies the basic requirements for mechanical installations and includes requirements common to more than one section of Divisions 21, 22, and 23. It expands and supplements the requirements specified in Division 1.

1.3 MECHANICAL INSTALLATIONS:

A. The Contract Documents are diagrammatic, showing certain physical relationships which must be established within the mechanical work and its interface with all other work. Such establishment is the exclusive responsibility of the Contractor. Drawings shall not be scaled for the purpose of establishing material quantities.

B. Drawings and specifications are complementary. Whatever is called for in either is binding as though called for in both. Report any discrepancies to the Engineer and obtain written instructions before proceeding. Where any contradictions occur between the specifications and the drawings the more stringent requirement shall apply. The contractor shall include pricing for the more stringent and expensive requirements.

C. Drawings shall not be scaled for rough-in measurements or used as shop drawings. Where drawings are required for these purposes or have to be made from field measurement, Contractor shall take the necessary measurements and prepare the drawings.

D. The exact location for some items in this specification may not be shown on the drawings. The location of such items may be established by the Engineer during the progress of the work.

E. The contract documents indicate required size and points of terminations of pipes, and suggest proper routes to conform to structure, avoid obstructions and preserve clearances. It is not intended that drawings indicate necessary offsets. The contractor shall make the installation in such a manner as to conform to the structure, avoid obstructions, preserve headroom and keep openings and passageways clear, without further instructions or costs to the Owner. All equipment shall be installed so access is maintained for serviceability.
F. Before any work is installed, determine that equipment will properly fit the space; that required piping grades can be maintained and that ductwork can be run as intended without interferences between systems, structural elements or work of other trades.

G. Verify all dimensions by field measurements.

H. Coordinate installation in chases, slots and openings with all other building components to allow for proper mechanical installations.

I. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing-in the building.

J. Where mounting heights are not detailed or dimensioned, install mechanical services and overhead equipment to provide the maximum headroom possible.

K. Install mechanical equipment to facilitate maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.

L. Make allowance for expansion and contraction for all building components and piping systems that are subject to such.

M. The ceiling space shall not be “layered”. It is the contractor’s responsibility to offset and system as required to allow installation within the identified ceiling cavity. The contractor shall include labor and material in the base bid to accommodate such offsets.

N. In general, all “static” piping systems shall be routed as high as possible, i.e. fire protection systems. Keep all equipment in accessible areas such as corridors and coordinate with systems and equipment from other sections.

O. The Contractor shall provide all labor and material necessary but not limited to the starting/stopping of all mechanical equipment, opening/closing of all valves, draining/refilling all mechanical systems and operating/verifying the operation of all mechanical systems controls as required to accomplish all work necessary to meet construction document requirements. Contractor shall submit records of such activities to engineer and include in the O & M manuals.

1.4 COORDINATION:

A. Work out all installation conditions in advance of installation. The Contractor shall be responsible for preparing coordination drawings, showing all work, in all areas. The Contractor shall be responsible for providing all labor and material, including but not limited to all fittings, isolation valves, offsets, hangers, control devices, etc., necessary to overcome congested conditions at no increase in contract sum. The Contractors base bid shall include any and all time and manpower necessary to develop such coordination efforts and drawings. Increases to contract sum or schedule shall not be considered for such effort.

B. Provide proper documentation of equipment, product data and shop drawings to all entities involved in the project. Coordination shall include, but not be limited to the following:

1. Fire Protection and Fire Alarm Contractor shall provide shop drawings to all other Division 21 and 23 Contractors.
2. Automatic Temperature Controls, Building Management and Testing, Adjusting and Balancing Contractors shall be provided with equipment product data and shop drawings from other...
Division 21, 22, 23 and 26 Contractors and shall furnish the same information involving control devices to the appropriate Division 21, 22, and 23 Contractor.

3. Furnish building equipment (elevator, food service, medical, technology, etc) in formation to Div 21, 22, and 23 contractors.

C. Coordination Drawings:

1. Coordination drawings shall be prepared by the Contractor for his utilization and are his responsibility to assure systems will be installed in a manner to allow all systems to function properly.

2. Submit drawings for all areas, pay special attention to those places where clearances are limited, where space problems exist, for places where several elements of work (or combinations of mechanical and other work) must be located with precision in order to fit into available space, where sequencing is of importance to the efficient flow of work and as specified, and required.

3. Coordination drawings are informational submittals. Submit coordination drawings to Engineer for information only to document proper coordination of all portions of work and that coordination issues have been identified and resolved prior to submitting to the Engineer and prior to commencing construction in each affected area. The review of the coordination drawings by the Engineer does not constitute a relief of responsibility of the Contractor or a change to the contract documents. The Contractor shall have sole responsibility in developing a fully coordinated and integrated ceiling cavity.

4. The Contractor shall take the lead in coordinating and drawing Division 26 and other Division 21, 22, and 23 components such as fire protection, plumbing, piping, sheet metal, etc. Where appropriate, the Contractor shall include medical gas, conduit, cable trays, pneumatic tube and any other system which may occupy the ceiling cavity.

5. Clearly indicate solutions to space problems. Identification of space problems without solutions is not acceptable. Only areas clearly identified will be reviewed.

6. All coordination drawings shall be 3D, with provision for collision check. The contractor is responsible for obtaining the architectural and structural files in 3D, if not available, the contractor shall develop them from the 2D architectural and structural drawings. All 3D drawing development, collision check, coordination, etc. shall be included as part of the Contractors base bid.

7. Prepare Coordination Drawings and other Shop Drawings at a suitable scale, showing the required dimensions. In addition to the mentioned areas and systems above, also submit the following:

a. All mechanical equipment rooms such as fan rooms, boiler rooms, fire protection system rooms, etc. (1/4"=1'-0" scale).

b. All building floor plans (1/8"=1'-0" scale). Include all shafts with clearances.

c. Air handling unit, etc. main duct connections and transitions in ceiling space and to shafts or horizontal ducts. (1/4"=1'-0").

d. Required access for all equipment requiring code or maintenance access.

e. All sections and elevations necessary for clarification.

f. Indicate all seismic restraint and support systems to be used for all mechanical equipment throughout the project.

g. Indicate duct and pipe elevations. Indicate clearances for installing and maintaining insulation.

h. Servicing and maintaining equipment, valve stem movement, and similar requirements.

i. Indicate movement and positioning of large equipment into the building during construction. Indicate pipe and duct size. Indicate equipment tags.

8. CADD Drawings: Electronic mechanical AutoCAD drawings are available for purchase by the Contractor from the Engineer. Contact Engineer for further information in acquiring CADD
CONSTRUCTION DOCUMENTS
LARAMIE COUNTY COMMUNITY COLLEGE
PHYSICAL PLANT HYDRONIC RENOVATIONS
Project No. 2017-552/2018-632

February 3, 2020

COMMON WORK RESULTS FOR MECHANICAL

drawings. The Engineers Construction documents cannot be used directly for coordination drawings. They are for information and initial coordination only.

D. Existing Conditions:

1. Carefully survey existing conditions prior to bidding work. In addition, Contractor shall complete a thorough ceiling cavity survey prior to developing 3D drawing.
2. Contractor shall be responsible for showing all existing conditions on the 3D coordination drawings.
3. Provide proper coordination of mechanical work with existing conditions.
4. Report any issues or conflicts immediately to Engineer before commencing with work and prior to purchasing equipment and materials.

1.5 COORDINATION WITH OTHER DIVISIONS:

A. General:

1. Coordinate all work to conform to the progress of the work of other trades.
2. Complete the entire installation as soon as the condition of the building will permit. No extras will be allowed for corrections of ill-timed work, when such corrections are required for proper installation of other work.

B. Coordinate ceiling cavity space carefully with all trades. In the event of conflict, install mechanical and electrical systems within the cavity space allocation in the following order of priority:

1. Equipment and required clearances
2. Plumbing waste, cooling coil drain piping and roof drain mains and leaders.
3. Pneumatic tube systems.
4. Ductwork mains
5. Plumbing vent piping
6. Medgas/lab gas systems
7. Low pressure ductwork and air devices.
8. Electrical and communication conduits, raceways and cabletray.
9. Domestic hot and cold water
10. Hydronic piping
11. Fire sprinkler mains, branch piping and drops (locate as tight to structure as possible).
12. DDC control wiring and other low voltage systems.
13. Fire alarm systems.

C. Chases, Inserts and Openings:

1. Provide measurements, drawings and layouts so that openings, inserts and chases in new construction can be built in as construction progresses.
2. Check sizes and locations of openings provided. Including the access panels for equipment in hard lid ceilings and wall cavities.
3. Any cutting and patching made necessary by failure to provide measurements, drawings and layouts at the proper time shall be done at no additional cost in contract sum.

D. Support Dimensions: Provide dimensions and drawings so that concrete basis and other equipment supports to be provided under other sections of the specifications can be built at the proper time.

E. Coordinate the installation of required supporting devices and sleeves to be set in poured in place concrete and other structural components, as they are constructed.
F. Coordinate the cutting and patching of building components to accommodate the installation of mechanical equipment and materials. Refer to Division 1 and Division 23.

G. Modifications required as result of failure to resolve interferences, provide correct coordination drawings or call attentions to changes required in other work as result of modifications shall be paid for by responsible Contractor/Subcontractor.

H. Coordination with Electrical Work: Refer to Division 1 and 26.

1.6 DESIGN WORK REQUIRED BY CONTRACTOR:

A. The construction of this project requires the Contractor to include the detailing and design of several systems and/or subsystems. All such design work associated with the development of the coordination drawings shall be the complete responsibility of the Contractor.

B. The Contractor shall take the full responsibility to develop and complete routing strategies which will allow fully coordinated system to be installed in a fully functional manner. The Engineers contract drawings shall be for system design intent and general configurations.

C. Systems or subsystems which require design responsibility by the contractor include but are not limited to:

1. Final coordinated distribution of duct, hydronic, plumbing and other systems within the ceiling cavity.
2. Any system not fully detailed
3. Fire protection systems
4. Equipment supports, hangers, anchors and seismic systems not fully detailed nor specified in these documents, or catalogued by the manufacturer.
5. Temperature controls systems
6. Refrigeration systems
7. Seismic restraint systems

D. Design Limitations:

1. The Contractor shall not modify the Engineers design intent in any way.
2. The Contractor shall not change any pipe size or equipment size without prior written approval from the Engineer.
3. The Contractor shall conform to the SMACNA Duct Construction Standards when modifying the ductwork layout to avoid collisions.
4. Back to back 90° fittings on duct system shall not be installed under any circumstance.
5. Bull nosed tees on piping systems shall not be installed under any circumstance.

1.7 PROJECT CONDITIONS:

A. The Contractor shall be required to attend a mandatory pre-bid walk-thru and shall make themselves familiar with the existing conditions. No additional costs to the Owner shall be accepted for additional work for existing conditions.

B. Field verify all conditions prior to submitting bids.

C. Report any damaged equipment or systems to the Owner prior to any work.

D. Protect all mechanical and electrical work against theft, injury or damage from all causes until it has been tested and accepted.
E. Be responsible for all damage to the property of the Owner or to the work of other contractors during the construction and guarantee period. Repair or replace any part of the work which may show defect during one year from the final acceptance of all work, provided such defect is, in the opinion of the Architect, due to imperfect material or workmanship and not due to the Owner's carelessness or improper use.

F. The Contractor shall coordinate and co-operate with Owner at all times for all new to existing connections, system shutdowns and start-ups, flushing and filling both new and existing systems.

G. Provide temporary ductwork and piping services, where required, to maintain existing areas operable.

H. Coordinate all services shut-down with the Owner; provide temporary services. Coordinate any required disruptions with Owner, one week in advance.

I. Minimize disruptions to operation of mechanical systems in occupied areas.

1.8 SAFETY:

A. Refer to Division 1.

1.9 EQUAL EMPLOYMENT OPPORTUNITY REQUIREMENTS:

A. Refer to Division 1 and conform with the Owners requirements.

1.10 REQUIREMENTS OF REGULATORY AGENCIES:

A. Refer to Division 1.

B. Execute and inspect all work in accordance with all Underwriters, local and state codes, rules and regulations applicable to the trade affected as a minimum, but if the plans and/or specifications call for requirements that exceed these rules and regulations, the greater requirement shall be followed. Follow recommendations of NFPA, SMACNA, EPA, OSHA and ASHRAE.

C. Comply with the local and state codes adopted by the Authorities Having Jurisdictions at the time of permit application, including referenced standards, amendments and policies. See code declaration information on the drawings.

D. Comply with standards in effect at the date of these Contract Documents, except where a standard or specific date or edition is indicated.

E. The handling, removal and disposal of regulated refrigerants and other materials shall be in accordance with U.S. EPA, state and local regulations.

F. The handling, removal and disposal of lead based paint and other lead containing materials shall comply with EPA, OSHA, and any other Federal, State, or local regulations.

G. After entering into contract, Contractor will be held to complete all work necessary to meet these requirements without additional expense to the Owner.

1.11 REQUIREMENTS OF LOCAL UTILITY COMPANIES:

A. Comply with rules and regulations of local utility companies. Include in bid the cost of all valves, valve boxes, meter boxes, meters and such accessory equipment which will be required but not provided by Local Utility Company for the project.
B. Utility Connections:

1. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies and controlling agencies. Provide required connection for each service.

2. The contract documents indicate the available information on existing utilities and services and on new services (if any) to be provided to the project by utility companies and agencies. Notify Engineer immediately if discrepancies are found.

3. Coordinate mechanical utility interruptions one week in advance with the Owner and the Utility Company. Plan work so that duration of the interruption is kept to a minimum.

1.12 PERMITS AND FEES:

A. Refer to Division 1.

B. The Contractor shall pay all tap, development, meter, etc., fees required for connection to municipal and public utility facilities, unless directed otherwise by the General Contractor/Owner – IN WRITING.

C. Contractor shall arrange for and pay for all inspections, licenses and certificates required in connection with the work.

1.13 PROJECT SEISMIC REQUIREMENTS:

A. Installation shall comply with the local seismic requirements for the area of installation. Provide restraints, bracing, anchors, vibration isolation, seismic snubbers, and all other components required for the installation.

B. All systems shall be installed to meet NFPA and IBC Seismic requirements.

1. Where any conflicts arise the more stringent requirements shall be applicable.

2. The design of the seismic requirements shall be the full responsibility of the Contractor.

1.14 TEMPORARY FACILITIES:

A. Light, Heat, Power, Etc.: Responsibility for providing temporary electricity, heat and other facilities shall be as specified in Division 1.

B. Use of Permanent Building Equipment for Temporary Heating or Cooling: Permanent building equipment shall not be used without written permission from the Owner. If this equipment is used for temporary heating or cooling, it shall be adequately maintained per manufacturer's instructions and protected with filters, strainers, controls, reliefs, etc. Steam and hydronic systems shall be flushed and chemically treated. Ductwork and air moving equipment shall be cleaned to an “AS New” condition. All filters required for the construction period shall be equivalent to the filters required for the final installation. All filters shall be replaced at the time of substantial completion. The guarantee period of all equipment used shall not start until the equipment is turned over to the Owner for his use. A written record of maintenance, operation and servicing shall be turned over to the owner prior to final acceptance.

1.15 PRODUCT OPTIONS AND SUBSTITUTIONS:

A. Refer to the Instructions to Bidders and Division 1.

B. The burden of proof that proposed equipment is equal in size, capacity, performance, and other pertinent criteria for this specific installation, or superior to that specified is up to the Contractor. Substituted equipment will only be allowed where specifically listed in a written addendum. If
substitutions are not granted, the specified materials and equipment must be installed. Where substituted equipment is allowed, it shall be the Contractor's responsibility to notify all related trades of the accepted substitution and to assume full responsibility for all costs caused as a result of the substitution.

C. Materials and equipment of equivalent quality may be submitted for substituted prior to bidding. This may be done by submitting to the Architect/Engineer at least ten (10) working days prior to the bid date requesting prior review. This submittal shall include all data necessary for complete evaluation of the product.

1. Substitutions shall be allowed only upon the written approval of the Architect/Engineer NO EXCEPTIONS.
2. The Contractor shall be responsible for removal, replacement and remedy of any system or equipment which has been installed which does not meet the specifications or which does not have prior approval.

1.16 MECHANICAL SUBMITTALS:

A. General

1. Refer to the Conditions of the Contract (General and Supplementary), Division 1.
2. Contractor shall provide a submittal schedule appropriate for the size and schedule of the project. Limit the number of large submittals being reviewed at one time and coordinate timing of sections that are dependent on each other.
3. The Contractor shall identify any "long lead time" items which may impact the overall project schedule. If these submittal requirements affect the schedule, the Contractor shall identify the impacts and confer with the Engineer within two weeks of entering into the contract.
4. The front of each submittal package shall be identified with the specification section number, job name, Owner's project number, date, Prime Contractor and Sub-Contractor's names, addresses, and contact information, etc. Each Specification Section shall be submitted individually and submittal shall be tabbed for the equipment/materials/etc. within the section. Submittals that are not complete with the required information will not be reviewed and will be sent back to be corrected.
5. Submittals shall be provided electronically. All electronic submittals need to be complete with all design information and stamped for conformity by the contractor. Submittals will be reviewed, marked appropriately and returned by the same means received.
6. An index shall be provided which includes:
   a. Product
   b. Plan Code (if applicable)
   c. Specification Section
   d. Manufacturer and Model Number
7. Submittal schedule shall be provided for review within four (4) working weeks from award of contract to successful bidder.

B. Basis of Design: The manufacturer's material or equipment listed in the schedule or identified by name on the drawings are the basis of design and provided for the establishment of size, capacity, grade and quality. If alternates are used in lieu of the scheduled names, the cost of any changes in construction required by their use shall be borne by Contractor.

C. All equipment shall conform to the State and/or local Energy Conservation Standards.

D. Contractor Review: Submittal of shop drawings, product data and samples will be accepted only when submitted by and stamped by the General Contractor. Each submittal shall be reviewed by the
contractor for general conformance with contract requirements and stamped by the respective contractor prior to submittal to the Architect/Engineer. Any submittal not stamped or complete will be sent back. Data submitted from Subcontractors and material suppliers directly to the Engineer will not be processed unless prior written approval is obtained by the Contractor.

E. Submittal Review Process: Before starting work, prepare and submit to the Architect/Engineer shop drawings and descriptive equipment data required for the project. Continue to submit in the stated format after each Architect/Engineer's action until a "No Exception Taken" or "Make Correction Noted" action is received. When a "Make Corrections Noted" is received, make the required corrections for inclusion in the Operating and Maintenance Manual (O&M). Submittals marked "Make Corrections Noted" shall not be resubmitted during the submittal process. Unless each item is identified with specification section and sufficient data to identify its compliance with the specifications and drawings, the item will be returned "Revise and Resubmit". Where an entire submittal package is returned for action by the Contractor, the Engineer may summarize comments in letter format and return the entire set. Submittals shall be prepared per the MECHANICAL SUBMITTAL CHECKLIST, at the end of this section; supplemental requirements are listed in each Division 21, 22, and 23 Sections.

F. The Design Professional's review and appropriate action on all submittals and shop drawings is only for the limited purpose of checking for conformance with the design concept and the information expressed in the contract documents. This review shall not include:

1. Accuracy or completeness of details, such as quantities, dimensions, weights or gauges, fabrication processes
2. Construction means or methods
3. Coordination of the work with other trades
4. Construction safety precautions

G. The Design Professional's review shall be conducted with reasonable promptness while allowing sufficient time in the Design Professional's judgment to permit adequate review. Review of a specific item shall not indicate that the Design Professional has reviewed the entire assembly of which the item is a component.

H. The Design Professional shall not be responsible for any deviations from the contract documents not brought specifically to the attention of the Design Professional in writing by the Contractor. This shall clearly identify the design and the specific element which vary from the Design. The Contractor shall be responsible for all remedy for lack of strict conformance associated with this criteria.

I. The Design Professional shall not be required to review partial submissions or those for which submissions of correlated items have not been received.

J. If more than two submittals (either for product data, shop drawings, record drawings, or test and balance reports) are made by the Contractor, the Owner reserves the right to charge the Contractor for subsequent reviews by their consultants. Such extra fees shall be deducted from payments by the Owner to the Contractor.

K. The contractor shall cloud all changes made on submittals that are marked “Revise and Resubmit.”

L. Required Submittals: Provide submittals for each item of equipment specified or scheduled in the contract documents. See table at the end of this section.

1.17 SPECIFIC CATEGORY SUBMITTAL REQUIREMENTS:

A. Product Listing:
1. Prepare listing of major mechanical equipment and materials for the project, within (2) two weeks of signing the Contract Documents and transmit to the Architect. A sample schedule is included at the end of this section to complete this requirement.
   a. Provide all information requested.
   b. Submit this listing as a part of the submittal requirement specified in Division 1, "PRODUCTS AND SUBSTITUTION."

2. Unless otherwise specified, all materials and equipment shall be of domestic (USA) manufacture and shall be of the best quality used for the purpose in commercial practice.

3. When two or more items of same material or equipment are required (plumbing fixtures, pumps, valves, air conditioning units, etc.) they shall be of the same manufacturer. Product manufacturer uniformity does not apply to raw materials, bulk materials, pipe, tube, fittings (except flanged and grooved types), sheet metal, wire, steel bar stock, welding rods, solder, fasteners, motors for dissimilar equipment units and similar items used in work, except as otherwise indicated.
   a. Provide products which are compatible within systems and other connected items.

B. Schedule of Values

1. Provide preliminary schedule of values with product data submittal, within three (3) weeks from award of contract to successful bidder. Provide according to the following descriptions:
   a. HVAC
      1) Equipment
      2) Piping
      3) Insulation
      4) Test and Balancing
      5) Temperature Controls
   b. Demolition
   c. Miscellaneous

2. Provide a final Schedule of Values at close-out of project including updated values based on actual installation.

C. Product Data:

1. Where pre-printed data covers more than one distinct product, size, type, material, trim, accessory group or other variation, mark submitted copy with black pen to indicate which of the variations is to be provided.
2. Delete or mark-out portions of pre-printed data which are not applicable.
3. Where operating ranges are shown, mark data to show portion of range required for project application.
4. For each product, include the following:
   a. Sizes.
   b. Weights.
   c. Speeds.
   d. Capacities.
   e. Piping and electrical connection sizes and locations.
   f. Statements of compliance with the required standards and regulations.
   g. Performance data.
h. Manufacturer's specifications.

D. Shop Drawings:
   1. Shop Drawings are defined as mechanical system layout drawings prepared specifically for this project, or fabrication and assembly type drawings of system components to show more detail than typical pre-printed materials.
   2. Prepare Mechanical Shop Drawings, except diagrams, to accurate scale, min 1/8"-1'-0", unless otherwise noted.
      a. Show clearance dimensions at critical locations.
      b. Show dimensions of spaces required for operation and maintenance.
      c. Show interfaces with other work, including structural support.

E. Coordination Drawings: See separate paragraph of this specification section.

F. Test Reports:
   1. Submit test reports which have been signed and dated by the accredited firm or testing agency performing the test.
   2. Prepare test reports in the manner specified in the standard or regulation governing the test procedure (if any) as indicated.
   3. Submit test reports as required for O & M manuals.

G. Operation and Maintenance Data: See separate paragraph of this specification section.

H. Software Licenses: Provide documentation of ownership under the owner’s corporate name (coordinate with owner’s representative for exact ownership wording) for Software Licenses provided as part of the work. Include information for updates, subscription requirements if applicable, backup, support, login, passwords, date when purchased, expiration date if applicable, version, etc. Include in the O & M Manual after review and "No Exceptions Taken" has been accomplished.

I. Record Drawings: See separate paragraph of this specification section.

1.18 DELIVERY, STORAGE, AND HANDLING:

A. Refer to Division 1 Sections on Transportation and Handling and Storage and Protection.

B. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels and similar information needed for distinct identifications; adequately packaged and protected to prevent damage or contamination during shipment, storage, and handling.

C. Check delivered equipment against contract documents and submittals.

D. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage, dirt, dust, freezing, heat and moisture.

E. Coordinate deliveries of mechanical materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.

F. Provide factory-applied plastic end-caps on each length of pipe and tube, except for concrete, corrugated metal, hub-and-spigot, clay pipe. Maintain end-caps through shipping, storage and handling to prevent pipe-end damage and prevent entrance of dirt, debris and moisture.
G. Protect stored ductwork, pipes and tubes. Elevate above grade and enclose with durable, waterproof wrapping. When stored inside, do not exceed structural capacity of the floor.

H. Protect flanges, fittings and specialties from moisture and dirt by inside storage and enclosure, or be packaging with durable, waterproof wrapping.

I. Protect sheet metal ductwork and fittings. Elevate and store above grade and cover ends with waterproof wrapping.

1.19 DEMOLITION:

A. Refer to Division 1. The following paragraphs supplement the requirements of Division 1.

B. During the demolition phase of this contract it is the responsibility of this Contractor to carefully remove existing equipment, piping or ductwork and related items either as shown on the demolition drawings as being removed, or as required for the work. These items shall be tagged, protected from damage and stored as directed by the Owner. A list of all items stored shall be turned over to the Architect/Engineer. At the completion of the remodeling work or when directed by the Architect, all stored items not reused or wanted by the Owner shall be removed from the premises.

1. Return existing thermostats and humidistats to the owner.
2. Return all demolished control valves and devices to the Owner.

C. The location of existing equipment, pipes, ductwork, etc., shown on the drawings has been taken from existing drawings and is, therefore, only as accurate as that information. All existing conditions shall be verified from field measurements with necessary adjustment being made to the drawing information.

D. Hazardous Material: If suspected hazardous material, in any form, is discovered by this Contractor in the process of his work, he shall report such occurrence to the Owner immediately. The Owner will determine the action to be taken for the hazardous material removal, which is not a part of the work to be done under this Division.

1.20 CUTTING AND PATCHING:

A. This Article specifies the cutting and patching of mechanical equipment, components and materials to include removal and legal disposal of selected materials, components and equipment. Coordinate the cutting and patching of building components to accommodate the installation of mechanical equipment and materials.

B. Refer to Division 1.

C. Do not endanger or damage installed work through procedures and processes of cutting and patching.

D. Arrange for repairs required to restore other work, because of damage caused as a result of mechanical installations.

E. No additional compensation will be authorized for cutting and patching work that is necessitated by ill-timed, defective or non-conforming installations.

F. Perform cutting, fitting and patching of mechanical equipment and materials required to:

1. Uncover work to provide for installation of ill-timed work;
2. Remove and replace defective work;
3. Remove and replace work not conforming to requirements of the Contract Documents;
4. Remove samples of installed work as specified for testing;
5. Install equipment and materials in existing structures;
6. Upon written instructions from the Architect/Engineer, uncover and restore work to provide for Architect /Engineer observation of concealed work.

G. Cut, remove and legally dispose of selected mechanical equipment, components, and materials as indicated, including, but not limited to removal of mechanical piping, heating units, plumbing fixtures and trim and other mechanical items made obsolete by the new work.

H. Protect the structure, furnishings, finishes and adjacent materials not indicated or scheduled to be removed.

I. Locate identify, and protect mechanical and electrical services passing through remodeling or demolition area and serving other areas required to be maintained operational. When services must be interrupted, provide temporary services for the affected areas and notify the Owner prior to changeover. Cover openings in ductwork to remain. Protect equipment and systems to remain.

1.21 ROUGH-IN:

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Refer to equipment shop drawings and manufacturer's requirements for actual provided equipment for rough-in requirements.

C. Work through all coordination before rough-in begins.

1.22 ACCESSIBILITY:

A. Install equipment and materials to provide required access for servicing and maintenance. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors. Allow ample space for removal of all parts that require replacement or servicing.

B. Extend all grease fittings to an accessible location.

C. Furnish hinged steel access doors with concealed latch, whether shown on drawings or not, in all walls and ceilings for access to all concealed valves, shock absorbers, air vents, motors, fans, balancing cocks, and other operating devices requiring adjustment or servicing. Refer to Division 1 for access door specification and Division 23 for duct access door requirements.

D. The minimum size of any access door shall not be less than the size of the equipment to be removed or 12 inches x 12 inches if used for service only.

E. Furnish doors to trades performing work in which they are to be built, in ample time for building-in as the work progresses. Whenever possible, group valves, cocks, etc., to permit use of minimum number of access doors within a given room or space.

F. Factory manufactured doors shall be of a type compatible with the finish in which they are to be installed. In lieu of these doors, approved shop fabricated access doors with DuroDyne hinges may be used.

G. Access doors in fire-rated walls and ceilings shall have equivalent U.L. label and fire rating.
H. Final installed conditions shall accommodate accessibility and replacement of system components that regularly require service and replacement. This includes control devices, sensors, motors, etc. Such devices shall not be permanently obstructed by building systems such as piping, ductwork, insulation, drywall, etc.

1.23 BELTS, SHEAVES, IMPELLERS:
A. The Mechanical Contractor shall coordinate with the Test and Balance Contractor and supply correctly-sized drive belts, sheaves, and trimmed impellers.

1.24 NAMEPLATE DATA:
A. Provide permanent operational data nameplate, refer to the section on Mechanical Identification, on each item of mechanical equipment, indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data. Locate nameplates in an accessible location. Coordinate with Owner for specific requirements.

1.25 LUBRICATION OF EQUIPMENT:
A. Refer to Division 1. The following paragraphs supplement the requirements of Division 1.
B. Contractor shall properly lubricate all mechanical pieces of equipment which he provided before turning the building over to the Owner. He shall attach a linen tag or heavy duty shipping tag on the piece of equipment showing the date of lubrication and the type and brand of lubricant used.
C. Furnish the Engineer with a typewritten list included in the O&M manuals of each item lubricated and type of lubricant used, no later than two (2) weeks before completion of the project, or at time of acceptance by the Owner of a portion of the building and the mechanical systems involved.

1.26 CLEANING:
A. Refer to Division 1.
B. Refer to Division 23, "TESTING, ADJUSTING AND BALANCING" for requirements for cleaning strainers, and mechanical systems prior to final acceptance.

1.27 RECORD DOCUMENTS:
A. Refer to Division 1. The following paragraphs supplement the requirements of Division 1.
B. Keep a complete set of record document prints in custody during entire period of construction at the construction site. Documents shall be updated on a weekly basis.
C. Mark Drawing Prints to indicate revisions to piping and ductwork, size and location both exterior and interior; including locations of coils, dampers and other control devices, filters, boxes, and similar units requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned to column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.); Change Orders; concealed control system devices. Changes to be noted on the drawings shall include final location of any piping or ductwork relocated more than 1 foot-0 inches from where shown on the drawings.
D. Mark shop drawings to indicate approved substitutions; Change Orders; actual equipment and materials used.

E. Mark equipment and fixture schedules on drawings to indicate manufacturer and model numbers of installed equipment and fixtures.

F. Revisions to the Contract Documents shall be legible and shall be prepared using the following color scheme:

1. Red shall indicate new items, deviations and routing.
2. Green shall indicate items removed or deleted.
3. Blue shall be used for relevant notes and descriptions.

G. At the completion of the project, obtain from the Architect a complete set of the Mechanical Contract Documents in a read-only electronic format (.pdf unless otherwise noted). This set will include all revisions officially documented through the Architect/Engineer. Using the above color scheme, transfer any undocumented revisions from the construction site record drawings to this complete set. Submit completed documents to the Architect/Engineer. This contract will not be considered completed until these record documents have been received and reviewed by the Architect/Engineer.

H. Contractor may propose methods of maintaining record documents on electronic media. Obtain approval of Engineer and Owner prior to proceeding. Marked-up .pdf format readable by Bluebeam is preferred.

1.28 OPERATION AND MAINTENANCE DATA:

A. Refer to Division 1.

B. No later than four (4) weeks prior to the completion of the project provide one complete set of Operating and Maintenance Manuals, or as specified in Sections of Division 1 (whichever is more stringent).

C. The testing and balancing report shall be submitted and received by the Engineer at least fifteen calendar days prior to the contractor's request for final observation time frame requirements. Include in the O & M Manual after review with "No Exceptions Taken" has been accomplished.

D. In addition to the information required by Division 1 for Maintenance Data, include the following information:

1. The job name and address and contractor's name and address shall be identified at the front of the electronic submittal.
2. Description of mechanical equipment, function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of all replaceable parts.
3. Manufacturer's printed operating procedures to include start-up, break-in, routine and normal operating instructions; regulation, control, stopping, shut-down, and emergency instructions; and summer and winter operating instructions. Provide any test reports and start-up documents.
4. Maintenance procedures for routine preventative maintenance and troubleshooting: disassembly, repair, and reassembly; aligning and adjusting instructions.
5. Servicing instructions, lubrication charts and schedules, including Contractor lubrication reports.
6. Manufacturer's service manuals for all mechanical equipment provided under this contract.
7. Include the valve tag list.
8. Name, Address and Telephone numbers of the Sub-contractors and local company and party to be contacted for 24-hour service and maintenance for each item of equipment.
9. Starting, stopping, lubrication, equipment identification numbers and adjustment clearly indicated for each piece of equipment.
10. Complete recommended spare parts list.
11. Mechanical System and Equipment Warranties.
12. Copies of all test reports shall be included in the manuals.
13. Provide manuals with dividers for major sections and special equipment. Mark the individual equipment when more than one model or make is listed on a page. Provide detailed table of contents.
14. Final schedule of values with all mechanical change order costs included and identified.
15. Contractor may propose methods of maintaining record documents on electronic media. Obtain approval of Engineer and Owner prior to proceeding. Marked-up PDF format readable by Bluebeam is preferred.

E. This contract will not be considered completed nor will final payment be made until all specified material, including test reports, and final Schedule of Values with all Electrical and Information Technology change order costs included and identified is provided and the manual is reviewed by the Architect/Engineer.

1.29 PROJECT CLOSEOUT LIST:
A. In addition to the requirements specified in Division 1, complete the requirements listed below.
B. The Contractor shall be responsible for the following Mechanical Submittal Checklist either by performing and/or coordinating such items prior to applying for certification of substantial completion. Refer to individual specification sections for additional requirements. (Checklist is located at the end of this section.)

1.30 WARRANTIES:
A. Refer to the Division 1 for procedures and submittal requirements for warranties. Refer to individual equipment specifications for warranty requirements. In any case the entire mechanical system shall be warranted no less than one year from the time of acceptance by the Owner.
B. Compile and assemble the warranties specified in Division 21, 22, and 23, and include in the Operating and Maintenance Manuals.
C. Provide complete warranty information for each item to include product or equipment to include date or beginning of warranty or bond; duration of warranty or bond; and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

1.31 CONSTRUCTION REQUIREMENTS:
A. The contractor shall maintain and have available at the jobsite current information on the following at all times:
   1. Up to date record drawings.
   2. Submittals
   3. Site observation reports with current status of all action items.
   4. Test results; including recorded values, procedures, and other findings.
   5. Outage information.
1.32 EQUIPMENT HOUSEKEEPING PADS:

A. Provide 4" concrete housekeeping pad for all floor mounted equipment including, but not limited to: heating water systems pumps. Fabricate pads as follows:

1. Coordinate size of equipment bases with actual unit sizes provided. Fabricate base 4" larger in both directions than the overall dimensions of the supported unit.
2. Form concrete pads with framing lumber with form release compounds. Chamfer top edge and corners of pad.
3. Place concrete and allow to cure before installation of units. Use Portland cement that conforms to ASTM C 150, 4000-psi compressive strength, and normal weight aggregate.
4. Anchor housekeeping pads to slab using #3 rebar bent in "L" or "Z" shape 12 inch on center on each side of slab.

1.33 MECHANICAL SUBMITTAL CHECKLIST:

<table>
<thead>
<tr>
<th>Spec Section</th>
<th>Item</th>
<th>Requirements</th>
<th>Shop Drawings</th>
<th>Product Data</th>
<th>Include In O &amp; M</th>
<th>Test³</th>
<th>Report³</th>
<th>Factory Rep Super-Vision At Site</th>
<th>Training Req’d At Site</th>
<th>Extra Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>230500</td>
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Notes:
1. For Starters and Variable Frequency Drives
2. Requires Review & Approval of calibrated balance valves from T & B Contractor
3. See Specific Specification Section for Test & Certification Requirements

END OF SECTION 23 05 00
SECTION 23 05 07
MOTOR, DRIVES, MOTOR CONTROLLERS AND ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

A. This section specifies the basic requirements for electrical components which are either separate components or are an integral part of all mechanical equipment. These components include, but are not limited to starters, variable frequency drives and disconnect switches.

B. Wiring of field-mounted switches and similar mechanical-electrical devices provided for mechanical systems, to equipment control panels.

C. Refer to electrical drawings and specifications for specific electrical requirements pertaining to mechanical equipment are scheduled on the Electrical Drawings. In case of conflict, Electrical Drawings shall take precedence. Do not purchase motors or electrical equipment until power characteristics available at building site location have been confirmed by Contractor. Provide equipment that meets all of the electrical requirements including but not limited to:

1. Voltage and number of phases
2. Circuit Ampacity,
3. Maximum Overcurrent protection
5. Wire size listed. Provide lugs with the ability to terminate the provided wire size at each piece of equipment.

As a minimum provide nameplate with the above information for each piece of equipment.

D. SCCR at incoming terminals and throughout the equipment shall be rated for the available fault current at the equipment as indicated and/or required. In addition to meeting NEC requirements, including 450.52 and 450.53, provide one of the following two options based on the equipment configuration:

1. Provide individual fused disconnects rated for the available short circuit current at the disconnect with current limiting fuses supplying mechanical equipment and packaged equipment (for example; a single piece of equipment or starter, a packaged piece of equipment such as a rooftop unit, etc.). See Division 26 requirements for disconnects, fuses, available short circuit values, etc. SCCR of the equipment can be rated for the let thru of the fuse WHEN the equipment does not have a main or other circuit breaker that provides additional levels of branch circuit/short circuit protection AND if acceptable to the authority having jurisdiction.

2. Provide fully rated devices with the appropriate interrupting rating above the available fault current levels for circuits feeding equipment that contain an overcurrent device such as a main or other circuit breakers that provide additional levels of branch circuit or short circuit protection (for example: circuit breakers provided for multiple motors, VFD’s, etc. The nameplate on this type of equipment shall indicate an SCCR above the available fault level at the equipment.

3. Equipment protection schemes shall be submitted with equipment cutsheets/shop drawings.

E. Refer to Table in Division 26 for Mechanical/Electrical coordination.

F. See other sections of Division 23 for vibration and seismic control requirements.
1.2 QUALITY ASSURANCE:

A. Manufacturers: Firms regularly engaged in manufacture of motors, motor starters and drives of types, ratings and characteristics required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Single Manufacturer: Provide all motors, starters and VFDs for the project by a single manufacturer except when part of factory packaged equipment. All variable frequency drives and starters for the project shall be by a single manufacturer, including packaged equipment, except chillers, etc.

C. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects utilizing motors, motor starters, capacitors and drives similar to that required for this project.

D. NEC Compliance: Comply with NEC as applicable to wiring methods, construction and installation of motors, motor starters, capacitors and drives.

E. NFPA Compliance: Comply with applicable requirements of NFPA 70E, "Standard for Electrical Safety Requirements for Employee Workplaces".

F. UL Compliance: Comply with applicable requirements of UL 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors", and UL 508, "Electrical Industrial Control Equipment" pertaining to installation of motor starters.

G. UL Compliance: Provide equipment and components which are UL-listed and labeled.

H. ETL Compliance: Provide equipment and components which are ETL-listed and labeled.

I. IEEE Compliance: Comply with applicable requirements of IEEE including Std 241, "Recommended Practice for Electric Power Systems in Commercial Buildings" pertaining to motor starters and Std 519.

J. NEMA Compliance: Comply with applicable requirements of NEMA including Standard ICS 2, "Industrial Control Devices, Controllers and Assemblies", and Pub No. 250, "Enclosures for Electrical Equipment (1000 Volts Maximum)", pertaining to motor controllers/starters and enclosures.

K. In addition comply with the following standards:

1. NEMA Standards MG 1: Motors and Generators.
2. NEMA Standard ICS 2: Industrial Control Devices, Controllers, and Assemblies.

L. Comply with National Electrical Code (NFPA 70).

M. Coordination with Electrical Work: Wherever possible, match elements of electrical provisions of mechanical work with similar elements of electrical work specified in Division 26 sections. Comply with applicable requirements of Division 26 sections for electrical work of this section which are not otherwise specified.

1.3 SUBMITTALS:

A. Product Data: Submit in accordance with Section 23 05 00 “Common Work Results for Mechanical”.

B. Shop Drawings: Submit dimensional drawings of VFD’s and starters showing accurately scaled equipment layouts. Drawings shall include, as a minimum: physical dimensions of each unit; general
arrangements with incoming and outgoing conduit locations, schematic; connection diagram sufficient to install system, and enclosure details.

C. Wiring Diagrams: Submit schematic power and control wiring diagrams, prepared for this project, of complete VFD and starter assemblies. General wiring diagrams with various non-applicable options shown are not acceptable. Clearly differentiate between factory and field wiring.

D. Listing, Motors of Mechanical Work: Concurrently, with submittal of mechanical products listing, submit separate listing showing rating, power characteristics, efficiencies, power factors, application and general location of every motor to be provided with mechanical work. Submit updated information promptly when and if initial data is revised.

1. Include in listing of motors, notations of whether motor starter is furnished or installed integrally with equipment containing motor or separately from equipment.

E. Electrical coordination listing. Provide the following information for each field wired electrical power connection. Information shall use nameplate data and nomenclature of actual installed nameplates. Information should list as a minimum:

1. Field connection details such as maximum/minimum wire size lugs can accommodate. Include number of lugs per phase.
2. Number and location of field connections.
3. Field interconnection wiring.
4. Nameplate Information, as a minimum include:
   a. Operating voltage and phase.
   b. Maximum fuse size (MFS) or maximum overcurrent protection size (MOP)(as applies).
   c. Minimum circuit ampacity (MCA).
   d. Full load amperes (FLA).
   e. Short Circuit Current Rating (SCCR).
5. Locked rotor current (LRA) and duration for high inertia equipment.
6. Manufacturers recommended overload setting (if applicable).

F. The contractor shall fully coordinate these items with all subcontractors prior to submittal.

G. Equipment provided shall match electrical equipment and protection/distribution sizes and be rated for available short circuit currents as shown on the drawings.

1.4 PRODUCT STORAGE:

A. All variable frequency drives, starters, etc. shall be protected from dirt, debris, and moisture at all times. Variable frequency drives shall be wrapped air and water tight with dust-tight and moisture proof material until factory start-up of variable frequency drives is initiated.

1. Exception: Drives may be opened only during wiring terminations by temperature control contractor and/or electrical contractors.

B. All motors not designed for exposure to water or moisture shall be protected at all times.
PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Subject to compliance with requirements, provide products by one of the following manufacturers for each type of product:

1. Motors
   a. Century/MagneTek
   b. Baldor
   c. Reliance
   d. Westinghouse
   e. Siemens
   f. General Electric
   g. Louis Allis
   h. Lincoln
   i. U.S. Motors
   j. Square D

2. Starters
   a. Cutler Hammer
   b. Allen-Bradley
   c. Sprecher & Schuh
   d. Square D
   e. Eaton
   f. Siemens
   g. GE
   h. Greenheck (single phase starters)

3. Variable Frequency Drives
   a. Robicon
   b. ABB
   c. Reliance
   d. Allen-Bradley
   e. Square D
   f. Toshiba
   g. Graham
   h. Eaton
   i. Cutler Hammer
   j. Siemens
   k. Yaskawa

2.2 MOTORS:

A. The following are basic requirements for simple or common motors. For special motors, more detailed and specific requirements are specified in the individual equipment specifications.

1. Torque characteristics shall be sufficient to satisfactorily accelerate the driven loads with a time limit acceptable to the motor manufacturer. Motors shall be capable of starting the driven equipment while operating at 90 percent rated terminal voltage.

2. Motor sizes shall be large enough so that the driven load will not require the motor to operate in the service factor range.
3. 2-speed motors shall have (1) single winding on poly-phase motors.
5. Temperature Rating: Rated for 40 degrees C environment with maximum 80 degrees C temperature rise for continuous duty at full load (Class B Insulation). Provide Class F insulation for variable frequency drive motors.
6. Starting capability: Frequency of starts as indicated by automatic control system, and not less than 5 evenly times spaced starts per hour for manually controlled motors.
7. Service Factor: 1.15 for poly-phase motors, 1.35 for single phase motors, and 1.0 for inverter duty motors.
8. Motor construction: NEMA Standard MG 1, general purpose, continuous duty, Design "B", except "C" where required for high starting torque. Design "E" shall not be used.
   a. Frames: NEMA Standard No. 48 or 54; Use driven equipment manufacturer's standards to suit specific application.
   b. Bearings:
      1) Ball bearings with inner and outer shaft seals.
      2) Re-greasable, except permanently sealed where motor is normally inaccessible for regular maintenance.
      3) Bearings shall be rated for minimum L-10 life of 40,000 hours.
      4) Designed to resist thrust loading where belt drives or other drives produce lateral or axial thrust in motor.
      5) For fractional horsepower, light duty motors, sleeve type bearings are permitted.
      6) All cooling tower fan motors shall be TEFC type. [2-speed] [and reversible with reversible starter at low speed.]
   c. Enclosure Type:
      1) Open drip-proof motors for indoor use where satisfactorily housed or remotely located during operation.
      2) Guarded drip-proof motors where exposed to contact by employees or building occupants.
      3) Weather protected Type I for housed outdoor use, TEPC II where not housed.
   d. Overload protection: Built-in thermal overload protection for all single phase motors and, where indicated, internal sensing device suitable for signaling and stopping motor at starter.
   e. Noise rating: "Quiet".
   f. Efficiency: All motors shall be NEMA premium efficiency motors, in accordance with Table 12-11 and Table 12-12 of NEMA MG 1-2011 and the US-DOE Premium Efficiency Motor Selection and Application Guide.
   g. Nameplate: indicate the full identification of manufacturer, ratings, characteristics, construction, special features and similar information.
9. Phases and Current Characteristics: Unless indicated otherwise, provide squirrel-cage induction polyphase motors for 3/4 hp and larger, and provide capacitor-start single-phase motors for 1/2 hp and smaller, except 1/6 hp and smaller may, at equipment manufacturer's option, be split-phase type. Tri-voltage motors are not acceptable. Coordinate current characteristics with power specified in Division 26 sections. Do not purchase motors until power characteristics available at building site have been confirmed by contractor.
10. The Contractor shall be responsible for all additional electrical and other costs involved to accommodate any motors which differ from the scheduled horsepower sizes or correct any
motor which does not meet the listed efficiency as called for in mechanical or electrical plans and specifications.

11. Motors shall be of the same manufacturer, except those that are an integral part of a factory assembled packaged unit. These motors shall likewise meet the conditions of the specification in this section except motors which are part of a motor/compressor assembly are exempted from this requirement.

12. All motors 75 HP and larger shall be factory test certified for power factor, efficiency, and shall have a three year warranty. Factory certification of motor tests shall be provided to the Owner.

13. All equipment specified to operate with variable frequency drives shall be provided with inverter-duty motors specifically designed for variable speed operation with high efficiency at part load conditions and constructed with Class F inverter grade insulation. Inverter duty motors shall meet requirements of NEMA MG-1 Part 31.

14. All motors which will be operated by a variable frequency drive shall be warranted against any damage or defects as a result of being used with a variable frequency drive.

2.3 STARTERS, ELECTRICAL DEVICES AND WIRING:

A. Motor Starter Characteristics:

1. Coordinate with the Electrical Contractor for motor control center starters provided by Division 26.

2. Enclosures: NEMA 1, general purpose enclosures with padlock ears, except in wet locations shall be NEMA 3R with conduit hubs, or units in hazardous locations which shall have NEC proper class and division.

3. Type and size of starter shall be as recommended by motor manufacturer and the driven equipment manufacturer for applicable protection and start-up condition.

4. Provide two-speed starters with a High-Low selector switch wired to allow manual speed selection with the H-O-A in HAND or remote speed selection in AUTO. Provide an automatic accelerating relay/timer to assure that the motor will always start at low speed and operate at an adjustable time before switching to high speed. Also, provide an integral automatic decelerating timing relay to prevent damage to the motor and load when switching from high to low speed. High and low speed contactors shall be mechanically and electrically interlocked. Complete instructions shall be provided for adjusting the timer in the field to match the deceleration characteristics of the driven equipment.

a. For cooling towers or other two-speed motors which are noted to have reversible operation, starters for those applications shall include the features described above for two-speed motors and include Reverse Selector Switch wired to allow manual direction In The Hand Position of the H-O-A. Starters with reverse direction shall have an integral built-in time delay to allow the motor to come to a full stop, prior to reversing for both the In the Hand and Automatic positions of the H-O-A switch.

B. Manual switches:

1. See Division 26 for electrical requirements, provide control devices as required for sequence of operation and/or equipment specifications.

C. Magnetic Starters:

1. Unless otherwise indicated, provide magnetic starters including contacts and coils for all 1-phase motors where interlock or automatic operation is indicated or required:

a. Provide equipment with Short Circuit Current Rating (SCCR) above available fault current.
b. Adjustable motor overload. Select range so that upper limit is no more than 150 percent of the connected motor full load amps.

c. Interlocks, auxiliary contacts, and similar devices as required for coordination with control requirements of Division-23 Controls sections.

d. H-O-A selector

e. Pilot lights for “power on” and “run” status.

f. Mount starter and all appurtenances in a NEMA enclosure suitable for the environment.

2. Unless otherwise indicated, provide NEMA style, sized and rated 75 degrees C magnetic starters including contacts and coils for all 3-phase motors. In addition to the requirements listed above for 1-phase motors provide the following features:

a. Built-in 120 volt control circuit transformer, fused from line side, where service exceeds 120 volts.

b. Maintained contact H-O-A push buttons or selector switch, speed selector switch (for two speed starters), and pilot lights shall be located on the cover of the enclosure, properly arranged for single speed or multi-speed operation as indicated. H-O-A shall be suitable to provide a monitor point to the Building Automation System where required.

c. Electronic motor overload protection including thermal modeling type thermal protection, Ground fault protection, individual monitoring of motor current in each phase, and a wide FLA adjustment with selectable trip.

d. Each starter shall be provided with a minimum of (4) four sets of auxiliary contacts, (2) two normally open & (2) two normally closed.

e. All 3-phase motors shall be protected against loss of phase wired into the starter utilizing a solid state 3 phase monitor that senses each phase and is capable of automatic restart of equipment when adverse condition clears.

f. All 3-phase motors shall be provided with Over and Under voltage protection. The ability for automatic re-start of equipment shall be provided. Settings shall be 110% for overvoltage and 80-90% for under voltage unless stated otherwise on the motor data sheets.

g. All 3-phase motors shall be protected against Voltage and current unbalance. Settings shall be 10-15% of FLA for current unbalance alarm with 5-10 second delay and 20-25% of FLA for current unbalance trip with 2-5 second delay unless otherwise stated on the motor data sheets.

h. HOA switch

3. Where reduced voltage starting is required, the starting method shall be part winding or closed transition auto-transformer/solid state electronic starting. Motors shall be constructed accordingly. Other methods of reduced voltage starting shall not be used unless reviewed by the Engineer prior to bid.

4. All starters used for life safety systems shall have an additional control relay to by-pass all external safeties and internal safeties except for overload protection. Coordinate with 23 09 93.

5. Ammeters, Voltmeters, and Frequency Meters: Where indicated. Panel type, 2 1/2 inch minimum size with 90 degree or 120 degree scale and plus or minus 2 percent accuracy. Current Sensors: Rated to suit application.

D. Motor connections:

1. PVC jacketed liquid-tight flexible metallic conduit with liquid tight connectors., except where plug-in electrical cords are specifically indicated.
2.4 DISCONNECT SWITCHES:

A. See Division 26 for electrical requirements, coordinate disconnect switch selection, installation, and wiring for equipment being provided.

2.5 DRIVES:

A. V-Belt Drives:

1. Capacity of V-Belt Drives at rated RPM shall be not less than 150 percent of motor nameplate horsepower rating.
2. V-Belt Drive combinations shall be limited to A, B, C and fractional horsepower belts. 3V, 5V and 8V belts and sheaves shall not be used.
3. Motors and Fan Wheel Pulleys: Adjustable pitch for use with motors through 15 HP; fixed pitch for use with motors larger than 15 HP. Select pulley so that pitch adjustment is at the middle of the adjustment range at fan design conditions.
4. All fixed pitch sheaves, including single groove fan sheaves, shall be of the bushed type. Fixed bore sheaves will not be acceptable for adjustable pitch sheaves.
5. Belts: Oil-resistant, non-sparking, and non-static.
6. Unit manufacturer shall provide OSHA approved belt guard with tachometer holes.

2.6 VARIABLE FREQUENCY DRIVES:

A. General:

1. Comply with NEMA (including NEMA ICS 7.1), and IEEE (including IEEE 519) Standards as applicable to wiring methods, construction and installation and operation of VFDs. Comply with applicable requirements of UL 908. “Power Conversion Equipment” and UL 508 C. Provide units which have been UL-listed and labeled by Underwriters Laboratory or ETL Testing. The entire unit shall carry this label, not just components.
2. Provide the following factory tests on VFD assembly as a complete package (not just individual components):
   a. High pot test per UL 508.
   b. Test assembled panel with a motor load.
   c. Test operation of all components and pilot lights.
3. The manufacturer shall verify compatibility of each VFD unit with the motor being supplied under Division 23. The vendor shall be responsible for reviewing Division 23 specifications sections, plans and schedules related to motors prior to bid and shall notify the Engineer at least ten (10) days prior to the bid of any discrepancies or incompatibilities between VFD units and motor characteristics.

B. Enclosure and support:

1. Provide NEMA enclosure suitable for the environment in which the VFD is to be installed. Provide floor stand where building walls are not suitable for mounting drive.
2. Where installed within an enclosure, the enclosure shall be provided with filtered, thermostatically controlled fan powered ventilation, and a thermostatically controlled heater. Fan shall be sized for “dirty filter” condition, at project altitude.
3. Drive and by-pass enclosure doors shall have provisions for locking with a padlock or integral lock, keyed to the building standards.
4. Switches and pilot lights shall be labeled with engraved plastic laminate tags riveted or similarly permanently fastened.

C. By-pass and Disconnects:

1. Provide manual by-pass circuitry where indicated or “required”.
2. Provide a fused disconnect with Type “J” fuses, with a through-the-door handle, pad lockable in the OFF position. The door interlock shall be defeatable with a tool to allow service access without de-energizing the system. The disconnect shall remove power from all components.
3. Provide a three position “VFD/OFF/BY-PASS” switch to control VFD line side, VFD load side, and by-pass contactors. Contactors shall be interlocked to completely isolate the VFD in the by-pass mode for service.
4. Provide control relays to operate by-pass contactor due to remote start/stop, safety interlock, or via the HAND-OFF-AUTO switch. See “Controls and Operation”.
5. Provide a three pole motor overload relay connected to shut down the motor in both the VFD and by-pass modes.
6. 120V control power transformer with fused secondary and primary. Primary power shall be derived ahead of the VFD input contactor.
7. Panel shall be arranged to allow power-off maintenance of the VFD while motor is operating on by-pass. By-pass or control circuitry in the same compartment as the VFD will not be allowed.

D. Input Power:

1. The drive shall be capable of accepting facility power as specified on the drawings. Variations of up to plus or minus 10 percent of line voltage and plus or minus 2Hz of line frequency shall be permitted without the drive shutting down on a fault.
2. Power line interruptions of up to 0.5 seconds shall be permitted without the drive shutting down on a fault.
3. The drive input circuitry shall not generate line notches or large voltage transients on the incoming line.
4. The drive efficiency at rated load and frequency shall be 95 percent or better.
5. The drive shall present a displacement power factor of 0.95 or better to the AC line at any speed or load.
6. Manufacturer shall guarantee that harmonic voltage and current distortion, on the line side (input terminals) of the VFD does not exceed 5 percent total voltage Harmonic distortion, and 15 percent total current Harmonic distortion.
   a. Manufacturer shall correct harmonic voltage and current distortion with an AC line reactor, an isolation transformer, or a tuned filter to stay within the above limit.
   b. Manufacturer shall review electrical drawings to determine optimum characteristics of the reactor/filter system.
   c. The installed drive shall be tested to verify the above distortion limits. The manufacturer shall replace the reactor/filter system if the installed drive does not meet the THD criteria. See Part 3.

E. Output Power:

1. The variable frequency AC drive shall convert 3 phase, 60 Hz input power to an adjustable AC frequency and voltage for controlling the speed of any standard NEMA B Design, AC squirrel cage motors driving variable torque loads. The drive shall be rated for continuous duty at the NEC standard full load current of its associated motor.
2. Transistors (IGBT) to produce a sine weighted PWM three phase output for the load.
3. The drive shall have sufficient capacity to provide stepless speed control of the motor throughout the operating range as specified herein.
4. The drive output will be adjustable from 0 to 60 HZ.
5. The drive shall have the capability to adjust the frequency above 4 kHz. The drive shall not operate with a frequency above 12 kHz.
6. The IGBTs shall have a minimum rating of 1200 VDC on 480 V units and 600 VDC on 230 V units.
7. The drive shall be suitable for operating at the altitude of the project location with no degradation or loss of performance.

F. Control and Operation Features:

1. Adjustable acceleration and deceleration, with automatic acceleration rate limiting to avoid overload and automatic deceleration rate limiting to avoid excessive regeneration voltage.
2. Speed/frequency settings to limit the maximum and minimum motor speed, to avoid up to 3 system critical resonance points and to provide a preset speed for operation in the event of loss of the remote speed signal.
3. Capability to set drive to a pre-determined speed upon a contact closure input from the BAS.
4. Capability of restarting into a rotating motor.
5. The following operator control and monitoring functions shall be accessible without opening the door of the enclosure.

a. HAND/OFF/AUTO (or Local/Off/Remote) selector switch.
   1) With the “H-O-A” switch in the “HAND” or “LOCAL” position, the motor shall start in either VFD or by-pass mode as determined by VFD/OFF/BYPASS switch, and if in the “VFD” mode, the speed shall be controlled by the manual speed adjustment on the drive door.
   2) With the “H-O-A” switch in “AUTOMATIC” or “REMOTE”, the motor shall start from the remote start/stop input in either VFD or by-pass mode as determined by the VFD/OFF/BYPASS switch and, if in the “VFD” mode, its speed shall be controlled by the BAS input speed signal.
   3) With the “H-O-A” switch in the “OFF” position, the run circuit will be open and the VSC will not operate.
   4) This must be a physical switch, not a keypad input function.

b. Manual (local) speed adjustment.
c. Frequency (speed) indication.
d. Output amperage indication.
e. Pilot lights for:
   1) Power On (green)
   2) VFD Fault (red)
   3) External Fault (red)
   4) Motor on VFD (green)
   5) Motor on By-pass (red)
   6) Motor Overload (red)

6. The following control interfaces shall be provided:

a. Remote start/stop (run enable input)
   1) Provide a control relay and a terminal block in the by-pass compartment to allow remote start/stop in either the VFD or by-pass mode.

b. Remote speed input signal
1) 4-20 mA, 0-5 VDC, 0-10 VDC, or as required by control system. Coordinate with Section 23 09 33.

c. Safeties interlock input
   1) Provide a control relay and terminal block in the by-pass compartment to allow hardwired safety shutdown in either the VFD or by-pass mode.

d. Fault indication output contacts. Indicate fault for the following:
   1) Drive protection features
   2) Safety interlock
   3) Drive hardware fault
   4) Input power fault
   5) Others as provided by manufacturer

e. Speed indication output (isolated)

f. Amperage indication output.

g. Run forward input.

h. Run backward input.

i. Drive running (status) output.

j. Drive on by-pass output.

k. Drive on manual output.

l. Pre-set speed input.

m. RS 485 communications to DDC system.

n. Complete open protocol communications with DDC system.

7. Provide a key pad and scrolling LCD display for operator interface with programming capabilities, fault diagnostics, fault reset, and security lockout code. Information shall be presented in plain English, not requiring codes.

a. Key pad shall not be accessible without opening enclosure panel door.

8. In addition to the interlock and switches specified above, each variable frequency drive shall be provided with (4) four additional spare sets of auxiliary contacts, (2) two normally open and (2) two normally closed.

G. Drive protection and safety features:

1. Provide equipment with Short Circuit Current Rating (SCCR) above available fault current.

2. Electronic motor overload protection including thermal modeling type thermal protection, Ground fault protection, individual monitoring of motor current in each phase, and a wide FLA adjustment and selectable trip.

3. Over-voltage/under-voltage protection.

   a. The VFD shall be arranged to provide the option for automatic restart after a trip condition resulting from over-voltage or under-voltage.

   b. For safety, the drive shall shut down and require manual reset and restart if the automatic reset/restart function is not successful within a maximum of five attempts.

   c. Settings shall be 110% for overvoltage and 80-90% for under voltage unless stated otherwise on the motor data sheets.

4. Drive shall be capable of withstanding random application of an output short circuit without damage to drive components or fuses.

5. Input phase loss.
a. The VFD shall be arranged to provide the option for automatic restart after a trip condition resulting from loss of phase.

b. For safety, the drive shall shut down and require manual reset and restart if the automatic reset/restart function is not successful within a maximum of five attempts.

6. Voltage and current unbalance. Settings shall be 10-15% of FLA for current unbalance alarm with 5-10 second delay and 20-25% of FLA for current unbalance trip with 2-5 second delay unless otherwise stated on the motor data sheets.

7. Torque/current limit control which will slow the motor without tripping when the motor is subjected to an overload, or slow the acceleration ramp when accelerating a high inertia load.

8. High/over temperature protection.

9. VFD shall include a “Bus Charged” warning indicator, and shall be provided with automatic circuitry to discharge the bus within 120 seconds after main power is disconnected.

2.7 EQUIPMENT FABRICATION:

A. General: Fabricate mechanical equipment for secure mounting of motors and other electrical items included in work. Provide either permanent alignment of motors with equipment, or adjustable mountings as applicable for belt drives, special couplings and similar indirect coupling of equipment. Provide safe, secure, durable, and removable guards for motor drives, arranged for lubrication and similar running-maintenance without removal of guards.

PART 3 - EXECUTION

3.1 TEST AND TEST DATA:

A. A factory load test shall be performed on each motor of 1000 watt input or greater to assure compliance with the energy-efficiency section of this specification.

B. Typical test data on every motor to be used on this project shall be made available upon request.

3.2 INSTALLATION:

A. Install motors on motor mounting systems in accordance with motor manufacturer’s instructions, securely anchored to resist torque, drive thrusts, and other external forces inherent in mechanical work. Secure sheaves and other drive units to motor shafts with keys and Allen set screws, except motors of 1/3 hp and less may be secured with Allen set screws on flat surface of shaft. Unless otherwise indicated, set motor shafts parallel with machine shafts.

B. Deliver starters and wiring devices which have not been factory-installed on equipment unit to electrical installer for installation.

C. Install power and control connections for motors to comply with NEC and applicable provisions of Division 26 sections. Install grounding except where non-grounded isolation of motor is indicated.

D. Provide 4 inch high concrete housekeeping pad for floor mounted variable frequency drive.

E. Where a separate disconnect switch is provided in the motor feeders between a VFD and the motor, provide end switch/auxiliary contacts at the disconnect and interconnect to the VFD to open the remote interlock shutdown (safety) circuit (De-energizes power to the VFD).
3.3 VFD START-UP SERVICES:

A. Provide field start-up service by an authorized factory trained service representative. The factory representative shall be trained in the maintenance and troubleshooting of the equipment as specified herein. Start-up services shall include system check-out, start-up and system run.

B. Start-up adjustments shall include optimizing frequency, optimizing volts/Hz ratio, identifying and avoiding resonant speeds, setting accel/decel ramps, and setting overload and circuit breaker trip points.

3.4 VFD HARMONIC DISTORTION TESTING:

A. After installation is complete, measure the harmonic voltage and current distortion of each VFD with the drive assembly in by-pass mode, with the VFD running at 50 percent operating speed and with the VFD running at highest operating speed. Take measurements on each phase (L-L) on the line side (input terminals) of the VFD.

B. If measurements exceed the limits as specified in Part 2, install corrective reactors or filters at no additional cost to the owner and retake measurements after corrective equipment is installed.

C. Include all measurements (before and after) in the harmonic distortion report. Provide the Engineer with a copy of the harmonic distortion report.

D. The Harmonic Distortion Test and Report shall be conducted by an approved independent testing agency.

3.5 VFD NOISE TEST:

A. Measure the dBa sound level of the motor with the drive in by-pass mode, and with the drive operating at 25 percent, 75 percent, and 100 percent speed output.

B. If the measurements exceed the limits specified in part 2, correct as required at no cost to the Owner, and retake measurements.

C. Report all tests to the Engineer.

3.6 VFD INDUCED SHAFT VOLTAGE TEST:

A. After installation is complete, and system is operating under normal conditions, measure and report any voltage potential between the motor shaft and the motor frame, this test may occur anytime between substantial completion and the end of the overall project warranty period. Report findings to the Engineer. Costs for any corrective measures required shall not be included in the bid.

3.7 INSTALLATION COORDINATION:

A. Furnish equipment requiring electrical connections to operate properly and to deliver full capacity at electrical service available.

B. Verify windings of multi-speed or reduced voltage starters are compatible with the connected motor prior to installation.

C. All control wiring to be in accordance with manufacturer's recommendations; all wiring shall be color coded to facilitate checking.
D. It is the intent of this specification that one "General" Contractor enters an agreement with the Owner. The use and coordination of subcontractors is at the option of the General Contractor. All mechanical equipment, motors and controls shall be furnished, set in place, and wired. The schedule contained in Division 1 / 26 is provided as a guide only. The exact furnishing and installation of the equipment is left to the Contractors involved. Contractor should note that the intent of the schedule is to have the Division 23 and 26 Contractors responsible for coordinating all control wiring as outlined, whether or not specifically called for by the mechanical or electrical drawings and specifications. Comply with the applicable requirements of Division 26 for all electrical work which is not otherwise specified. No extras will be allowed for Contractor's failure to provide for these required items. The Contractor shall refer to the Division 26 and Division 23 specifications and plans for all power and control wiring and shall advise the Architect/Engineer of any discrepancies prior to bidding.

END OF SECTION 23 05 07
SECTION 23 05 10

BASIC PIPING MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUBMITTALS:

A. Refer to Division 1 and Section 23 05 00 “Common Work Results for Mechanical” for administrative and procedural requirements for submittals.

B. Product Data: Submit industry standards and manufacturer's technical product data, installation instructions, and dimensioned drawings for each type of pipe and pipe fitting. Submit piping schedule showing pipe or tube weight, fitting type, and joint type for each piping system.

C. Welding Certifications: Submit reports as required for piping work.

D. Brazing Certifications: Submit reports as required for piping work.

1.2 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacturer of pipes and pipe fittings of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Welder's Qualifications: All welders shall be qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.

C. Welding procedures and testing shall comply with the latest revisions of the applicable sections for B31, of the ANSI/ASME standard codes for pressure piping, noted as follows: B31.1 - Pressure Piping Code / B31.2 - Fuel Gas Piping Code / B31.5 - Refrigeration Piping / B31.9 - Building Service Piping Code.

D. Before any welding is performed, the contractor shall submit to the Architect/Engineer, or his authorized, a copy of the Manufacturer's Record of Welder or Welding Operator Qualification Tests and his Welding Procedure Specification together with the Procedure Qualification Record as required by ASME Boiler and Pressure Vessel Code.

E. Each manufacturer or contractor shall be responsible for the quality of welding done by his organization and shall repair or replace any work not in accordance with these specifications.

F. Soldering and Brazing procedures shall conform to ANSI Standard Safety Code for Mechanical Refrigeration.

G. Installers of Mechanical Grooved Couplings shall be trained and certified by the coupling manufacturer.

1. Certification shall consist of training of field personnel. Crews installing Mechanical Grooved Couplings shall be supervised on the job site by a person trained to the specific grooved coupling manufacturer’s standards.

2. Training certificates shall be submitted thru the formal submittal process for all field personal who will be working with grooved mechanical couplings.
1.3 30 YEAR SPECIAL WARRANTY – MECHANICAL GROOVED COUPLINGS

A. The Contractor shall fully support and administer the special warranty.

B. The Manufacturer of Grooved Mechanical Coupling products shall warrant to the Owner that the couplings have been installed in accordance with the manufacturer’s instructions and the certified training program and shall perform in accordance with the applicable published specifications.

C. The Warranty shall cover any and all installation errors including pipe preparation and installation.

1. Permissible exclusions are for defective pipe or corrosion.

D. The Warranty program shall include inspection services by the Grooved Mechanical Coupling manufacturer, the extent of which is sufficient in the view of the manufacturer to be able to assure compliance with the manufacturer’s standards.

E. The warranty shall be assignable to future owners for the full 30 year period.

F. The warranty period shall extend from the standard project warranty to cover a period of 30 years from Substantial Completions and shall:

1. Pay replacement costs for parts and labor to repair or replace any coupling which fails to meet this warranty.
2. Pay reasonable costs for cutting and patching building construction to repair or replace damaged piping products.
3. Pay reasonable costs to repair property damage to the building.

PART 2 - PRODUCTS

2.1 GENERAL:

A. Piping Materials: Provide pipe and tube of type, pressure and temperature ratings, capacities, joint type, grade, size and weight (wall thickness or Class) indicated for each service. Where type, grade or class is not indicated, provide proper selection as determined by Installer for installation requirements, and comply with governing regulations and industry standards.

B. Pipe/Tube Fittings: Provide factory-fabricated fittings of type, materials, grade, class and pressure rating indicated for each service and pipe size. Provide sizes and types matching pipe, tube, valve or equipment connection in each case. Where not otherwise indicated, comply with governing regulations and industry standards for selections, and with pipe manufacturer's recommendations where applicable.

2.2 STEEL PIPES AND PIPE FITTINGS:

A. Black Steel Pipe: ASTM A 53, Grade B, type E, electric resistance welded.

B. Galvanized Steel Pipe: ASTM A 53, Grade B.

C. Seamless Steel Pipe: ASTM A 53, Grade B, type S or A106 high temperature.

D. Stainless Steel Pipe: ASTM A 312; Grade TP 304 (high temperature and corrosive service, 1/8 inch thru 30 inches).

E. Stainless Steel Sanitary Tubing: ASTM A 270; Finish No. 80, (dairy and food industry, 1 inch thru 4 inches).
F. Steel Water Pipe: AWWA C200 for pipe 6 inches and larger.

G. Coal Tar Protective Coatings and Linings for Steel Water Pipe: AWWA C203 for enamel and tape, hot applied.

H. Chlorinated Rubber-Alkyd Paint System for Steel Water Pipe: AWWA C204 (exterior above-ground steel water pipe).


J. Cast-Iron Flanged Fittings: ANSI/ASME B16.1, including bolting (Class 125 and 250).


L. Malleable-Iron Threaded Fittings: ANSI/ASME B16.3; plain or galvanized as indicated (Class 125 and 300).

M. Malleable-Iron Threaded Unions: ANSI B16.39, Class 150, 250 or 300; selected by Installer for proper piping fabrication and service requirements, including style, end connections, and metal-to-metal seats (iron, bronze or brass); plain or galvanized as indicated (Class 150, 250 and 300).


O. Steel Flanges/Fittings: ANSI/ASME B16.5, ASTM A234 (Fire Protection) including bolting and gasketing of the following material group, end connection and facing, except as otherwise indicated.
   Material Group: Group 1.1.
   End Connections: Buttwelding.
   Facings: Raised-face.

P. Steel Pipe Flanges for Waterworks Service: AWWA C207 (water service piping only).

Q. Corrosion-Resistant Cast Flanges/Fittings: MSS SP-51, including bolting and gasketing (threaded where pressure is not critical).

R. Forged-Steel Socket-Welding and Threaded Fittings: ANSI B16.11, except MSS SP-79 for threaded reducer inserts; rated to match schedule of connected pipe (up to 4 inch pipe size).

S. Wrought-Steel Buttwelding Fittings: ANSI B16.9, except ANSI B16.28 for short-radius elbows and returns; rated to match connected pipe.

T. Stainless-Steel Buttwelding Fittings: MSS SP-43.


V. Forged Branch-Connection Fittings: Except as otherwise indicated, provide type as determined by Installer to comply with installation requirements.

W. Pipe Nipples: Fabricated from same pipe as used for connected pipe; except do not use less than Schedule 80 pipe where length remaining unthreaded is less than 1-1/2 inches, and where pipe size is less than 1-1/2 inches, and do not thread nipples full length (no close-nipples).
2.3 COPPER TUBE AND FITTINGS:
   A. Copper Tube: ASTM B 88; Type K or L as indicated for each service; hard-drawn temper, except as otherwise indicated.
   B. DWV Copper Tube: ASTM B 306.
   C. ACR Copper Tube: ASTM B 280.
   D. Cast-Copper Solder-Joint Fittings: ANSI B16.18.
   E. Wrought-Copper Solder-Joint Fittings: ANSI B16.22.
   F. Cast-Copper Solder-Joint Drainage Fittings: ANSI B16.23 (drainage and vent with DWV or tube).
   G. Wrought-Copper Solder-Joint Drainage Fittings: ANSI B16.29.
   I. Bronze Pipe Flanges/Fittings: ANSI B16.24 (Class 150 and 300).
   J. Copper-Tube Unions: Provide standard products recommended by manufacturer for use in service indicated.

2.4 BRASS PIPE AND FITTINGS:
   A. Red Brass Pipe: ASTM B 43 (boiler feed pipe, 1/8 inch thru 12 inches, regular or extra strong weight).
   B. Cast-Bronze Threaded Fittings: ANSI B16.15, Class 125 or 250.
   C. Cast-Bronze Threadless Fittings: ASTM B 61 or B 62, brazed joints.

2.5 CAST-IRON PRESSURE PIPES AND PIPE FITTINGS:
   A. Ductile-Iron Pipe: Class 52, ANSI A21.51; AWWA C151; 350 psi pressure rating.

2.6 COPPER PRESS FITTINGS:
   A. Copper and copper alloy press fittings shall conform to material requirements of ASME B16.18 or ASME B16.22 and performance criteria of ASME B16.51 and IAPMO PS117. Sealing elements for press fittings shall be EPDM. Sealing elements shall be factory installed. Press end shall have a design feature that assures leakage of liquids and/or gases from inside the system past the sealing element of an unpressed connection. The function of this feature is to provide the installer quick and
easy identification of connections which have not been pressed prior to putting the system into operation.

1. Viega Pro Press.
2. NIBCO Press System
3. Mueller Streamline PRS

2.7 GROOVED PIPING PRODUCTS FOR CARBON STEEL PIPING:

A. General: All mechanical grooved pipe couplings and fittings shall be rated by the manufacturer for applications of at least 250 °F (110 °C), and 300 psi.

B. Mechanical Couplings, 2 inch (DN50) through 12 inch (DN300): Manufactured in two segments of cast ductile iron, conforming to ASTM A-536, Grade 65-45-12. Gaskets shall be pressure-responsive synthetic rubber, grade to suit the intended service, conforming to ASTM D-2000. Gaskets used for potable water applications shall be further UL classified in accordance with ANSI/NSF-61 for potable water service. Mechanical Coupling bolts shall be zinc plated (ASTM B-633) heat treated carbon steel track head conforming to ASTM A-449 and ASTM A-183, minimum tensile strength 110,000 psi (758450 kPa). Grooved couplings shall meet the requirements of ASTM F-1476.

1. Rigid Type: Coupling housings with offsetting, angle-pattern bolt pads shall be used to provide system rigidity and support and hanging in accordance with ANSI B31.1, B31.9, and NFPA 13. Angled mating pads shall grip the pipe rigidly and force the pipe ends to their maximum separation. Full engagement shall be indicated by metal to metal contact at both pads.

   a. 2” (DN50) through 8” (DN200): Victaulic Style 107H (Quick-Vic™). Installation ready rigid coupling for direct stab installation without field disassembly. Gasket shall be Grade “EHP” EPDM compound with red color code designed for operating temperatures from -30 deg F (-34 deg C) to +250 deg F (+120 deg C).
   b. 10” (DN250) through 12” (DN300): Victaulic Style 07 (Zero-Flex®). Standard rigid coupling. Gasket shall be Grade “E” EPDM compound with green color code designed for operating temperatures from -30 deg F (-34 deg C) to +230 deg F (+110 deg C).

2. Flexible Type

   a. 2” (DN50) through 8” (DN200): Victaulic Style 177 (Quick-Vic™). Installation ready flexible coupling for direct stab installation without field disassembly. Gasket shall be Grade “EHP” EPDM compound with red color code designed for operating temperatures from -30 deg F (-34 deg C) to +250 deg F (+120 deg C).
   b. 10” (DN250) through 12” (DN300): Victaulic Style 75 or 77 standard flexible couplings. Gasket shall be Grade “E” EPDM compound with green color code designed for operating temperatures from -30 deg F (-34 deg C) to +230 deg F (+110 deg C).

3. Reference shall always be made to the manufacturer’s latest published Selection Guide for Gaskets for proper gasket selection for the intended service.

C. Grooved End Fittings:

1. Standard fittings shall be cast of ductile iron conforming to ASTM A-536, Grade 65-45-12, forged steel conforming to ASTM A-234, Grade WPB 0.375” wall (9.53 mm wall), or fabricated from Std. Wt. Carbon Steel pipe conforming to ASTM A-53, Type F, E or S, Grade B. Fittings provided with an alkyd enamel finish or hot dip galvanized to ASTM A-153. Zinc electroplated fittings and couplings conform to ASTM B633.
2. Branch Outlets:
a. Bolted Branch Outlet: For branch outlets on 2"(DN50) through 8"(DN200) main piping. The branch outlet hole is cut oversize to receive a “holefinder” locating collar which secures the outlet in position permanently. Bolted branch outlets shall be manufactured from ductile iron conforming to ASTM A-536, Grade 65-45-12, with synthetic rubber gasket, and heat treated carbon steel zinc plated bolts and nuts conforming to physical properties of ASTM A-183. A pressure responsive gasket seals on the pipe O.D. Victaulic Style 920 / 920N.

b. Strapless Branch Outlets are prohibited.

D. Pipe/Grooves: Carbon Steel, A-53B/A-106B - Roll or cut grooved-ends as appropriate to pipe material, wall thickness, pressures, size and method of joining. Pipe ends to be grooved in accordance with current listed standards conforming to ANSI/AWWA C-606.

E. All other pipe products shall conform to the requirements of the Division 23 sections. Acceptance of grooved pipe systems does not imply acceptance of the coupling manufacture’s valves, flow measuring stations, strainers, or other specialties.

F. Manufacturer:
   1. Victaulic Co. of America – no substitutions NO EXCEPTIONS will be considered.

2.8 COUPLINGS FOR COPPER GROOVED TUBE

A. Mechanical Couplings: 2"-8" (DN50-DN200) for copper tubing consisting of ductile iron cast housings, complete with a synthetic rubber gasket of a pressure-responsive design, with plated nuts and bolts to secure unit together. Couplings shall be manufactured to connect copper tubing sized tube and fittings. Flaring of tube and fitting ends to IPS dimensions is not allowed.

1. Coupling Housings: Ductile iron conforming to ASTM A-536, Grade 65-45-12, coated with copper colored alkyd enamel. Housings cast with offsetting, angle-pattern bolt pads to provide rigidity.

2. Coupling Gaskets: Gasket shall be Grade “EHP” EPDM compound with red color code designed for operating temperatures from -30 deg F to +250 deg F.

a. Reference shall always be made to the manufacturer’s latest published Selection Guide for Gaskets for proper gasket selection for the intended service.

3. Victaulic Style 607 (Quick-Vic™). Installation ready rigid coupling for direct stab installation without field disassembly.

B. Branch outlet for Copper Tubing: 2-1/2"-4" (DN65-DN100) Branch outlet shall consist of a cast bronze (C83600 85-5-5-5) upper housing with female NPT threaded outlet and locating collar, ductile iron (ASTM A536) lower housing coated with copper-colored enamel and a pressure responsive gasket which seals on the pipe O.D. Grade “E” EPDM, temperature range -30 °F to +230 °F (-34°C to +110°C). UL Classified in accordance with ANSI/NSF 61 heat-treated plated carbon steel track-head bolts and nuts, meeting the physical and chemical requirements of ASTM A-449 and physical requirements of ASTM A-183.

1. Victaulic Style 622.

C. Grooved-End Copper Fittings: Fittings shall be manufactured to copper tubing sizes, with grooves designed to accept grooved end couplings of the same manufacturer. Fittings shall be wrought copper, conforming to ASTM B-75 alloy C12200 or ASTM B-152 alloy C11000 and ANSI B16.22, or bronze sand casting ANSI B16.18 and UNS-C89836. Victaulic Copper Connection Fittings.
D. Grooved Copper Tube: ASTM B-88 (Type K, L, M, or DWV) Roll grooved only in accordance to manufacturer's current listed standards and copper tube dimensions.

E. Manufacturer:

1. Victaulic Co. of America – no substitutions.

2.9 MISCELLANEOUS PIPING MATERIALS/PRODUCTS:

A. Welding Materials: Except as otherwise indicated, provide welding materials as determined by Installer to comply with installation requirements.


B. Soldering Materials: All soldering materials shall be lead free.

1. 95-5 Tin-Antimony: ASTM B 32, Grade 95TA. Melting Range 450-470 degrees F.
3. Flux: All flux shall be lead free, water soluble, and compatible with the solder and the materials being joined. ASTM B813-93.

C. Brazing Materials: Except as otherwise indicated, provide brazing materials to comply with installation requirements.

1. Comply with AWSA 5.8, Section II, ASME Boiler and Pressure Vessel Code for brazing filler metal materials.

   a. Copper phosphorus -Bcup-5, 15 percent solver content, melting range 1190 to 1480 degrees F.
   b. Silver - BAg-36, 45 percent silver, cadmium-free. Melting range 1195 to 1265 degrees F.

D. Gaskets for Flanged Joints: ANSI B16.21; full-faced for cast-iron flanges; raised-face for steel flanges, unless otherwise indicated.

E. Piping Connectors for Dissimilar Non-Pressure Pipe: Elastomeric annular ring insert, or elastomeric flexible coupling secured at each end with stainless steel clamps, sized for exact fit to pipe ends and subject to approval by plumbing code.

1. Manufacturer: Subject to compliance with requirements, provide piping connectors of the following:

   a. Husky Technologies (Husky SD 4000):

F. Pipe Thread Sealant Material: Except as otherwise indicated, provide all pipe threads with the sealant material as recommended by the manufacturer for the service.

1. Manufacturer: Subject to compliance with requirements, provide piping thread sealant material of the following:

   a. The Rectorseal Corporation
PART 3 - EXECUTION

3.1 EXAMINATION:

A. Verify all dimensions by field measurements. Verify that all water distribution piping may be installed in accordance with pertinent codes and regulations, and original design, and the referenced standards.

B. Examine rough-in requirements for plumbing fixtures and other equipment having water connections to verify actual locations of piping connections prior to installation.

C. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PIPING INSTALLATION:

A. General: Install pipes and pipe fittings in accordance with recognized industry practices which will achieve permanently-leakproof piping systems, capable of performing each indicated service without piping failure. Install each run with minimum joints and couplings, but with adequate and accessible unions for disassembly and maintenance/replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align piping accurately at connections, within 1/16 inch misalignment tolerance.

1. Comply with ANSI B31 Code for Pressure Piping.
2. Electrical Equipment Spaces: Do not run piping through transformer vaults and other electrical or electronic equipment spaces and enclosures. Only piping serving this type of equipment space shall be allowed.
3. Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of piping systems. Locations and arrangements of piping take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated.
4. Use fittings for all changes in direction and all branch connections.
5. Install piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.
6. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.
7. Install piping tight to slabs, beams, joists, columns, walls, and other permanent elements of the building. Provide space to permit insulation applications, with 1 inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.
8. Locate groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
9. Install drains in pressure pipe systems at all low points in mains, risers, and branch lines consisting of a tee fitting, ¾ inch ball valve, and short ¾ inch threaded end nipple and cap with chain.
10. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.
11. Fire and Smoke Wall Penetrations: Where pipes pass through fire and smoke rated walls, partitions, ceilings, and floors, maintain the fire and smoke rated integrity. Refer to Division 23, Sections 23 05 18 and 23 05 09 for materials.
12. Exterior Wall Penetrations: Seal pipe penetrations through exterior walls using sleeves and mechanical sleeve seals (See Section 23 05 18). Pipe sleeves smaller than 6 inch shall be steel; pipe sleeves 6 inches and larger shall be sheet metal.
13. Anchor piping to ensure proper direction of expansion and contraction.
14. Coordinate foundation and all other structural penetrations with structural engineer.
B. Hydronic Piping:
   1. Make reductions in hydronic pipe sizes using eccentric reducer fitting installed with the level side up.
   2. Install hydronic piping branch connections to mains using Tee fittings in main with take-off out the bottom of the main, except for up-feed risers which shall have take-off out the top of the main line. Install all hydronic piping level with manual air vent at all high points in direction of flow.
   3. Install hydronic piping level except for gravity flow systems such as condenser water and condensate drain piping.

3.3 PIPING SYSTEM JOINTS:

   A. General: Provide joints of type indicated in each piping system.

   B. Thread pipe in accordance with ANSI B2.1; cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint compound, or pipe joint tape (Teflon) where recommended by pipe/fitting manufacturer, on male threads at each joint and tighten joint to leave not more than 3 threads exposed.

   C. Braze copper tube-and-fitting joints in accordance with ASME B31.

   D. Solder copper tube-and-fitting joints with silver solder or 95-5 tin-antimony. Cut tube ends squarely, ream to full inside diameter, and clean outside of tube ends and inside of fittings. Apply solder flux to joint areas of both tubes and fittings. Insert tube full depth into fitting, and solder in manner which will draw solder full depth and circumference of joint. Wipe excess solder from joint before it hardens.

   E. Weld pipe joints in accordance with ASME Code for Pressure Piping, B31. Provide weld-o-let fittings for two pipe sizes less than main pipe size.

   F. Weld pipe joints in accordance with recognized industry practice and as follows:
      1. Weld pipe joints only when ambient temperature is above 0 degrees F (-18 degrees C) where possible.
      2. Bevel pipe ends at a 37.5 degrees angle where possible, smooth rough cuts, and clean to remove slag, metal particles and dirt.
      3. Use pipe clamps or tack-weld joints with 1 inch long welds; 4 welds for pipe sizes to 10 inches, 8 welds for pipe sizes 12 inch to 20 inch.
      4. Build up welds with stringer-bead pass, followed by hot pass, followed by cover or filler pass. Eliminate valleys at center and edges of each weld. Weld by procedures which will ensure elimination of unsound or unfused metal, cracks, oxidation, blow-holes and non-metallic inclusions.
      5. Do not weld-out piping system imperfections by tack-welding procedures; refabricate to comply with requirements.

   G. Weld pipe joints of steel water pipe in accordance with AWWA C206.

   H. Flanged Joints: Match flanges within piping system, and at connections with valves and equipment. Clean flange faces and install gaskets. Tighten bolts to provide uniform compression of gaskets.
3.4 GROOVED MECHANICAL COUPLING APPLICATION:

A. At contractor’s option, grooved mechanical couplings may be used in lieu of soldered, threaded, or flanged joints on hydronic and domestic water systems operating between 40°F and 180°F as follows:

1. Dedicated Mechanical Rooms: Rigid couplings only, except that where specifically identified on the Contract Documents or specifically engineered by the coupling manufacturer and reviewed by the engineer, flexible couplings may be used for vibration isolation or expansion compensation.
2. Outside of Mechanical Rooms: Rigid couplings only, as substitution for flanges, and to connect sections of pre-fabricated piping.
   a. Grooved mechanical joints shall not account for more that 25% of all pipe joints outside of the mechanical room.
3. Where specifically shown on the Drawings.
4. Shafts, chases, above inaccessible ceilings, and within partitions: No grooved joints allowed.
5. Grooved mechanical joints shall not be located above the following types of rooms:
   a. Enter room types as needed
6. Maximum 12” pipe connections.

B. All changes in direction shall be made with radius type elbows.

1. Use long radius (R=1.5D) fittings wherever possible.
2. Angles less than 22-1/2° may be made with pre-manufactured mitered fittings.
3. Use of the angular deflection capabilities of grooved pipe couplings for intentional changes of direction shall not be allowed.

C. All changes in pipe size shall be made with reducing fittings, not bushings or reducing couplings.

D. Pipe shall be installed and adequately laterally supported to maintain all lines straight, true and plumb. Piping with rigid couplings may be supported as per welded/soldered/screwed piping. Where flexible connections are used, provide a minimum of one hanger per pipe section. No pipe section shall be left unsupported between any two couplings.

E. Where flanges are required, provide a standard welded slip-on or weld neck with a spool piece to a grooved end joint. "Flange adapters" are not allowed.

F. Grooved pipe systems shall not be considered to be electrically conductive.

1. Provide wire jumpers across all couplings where the piping system is required to be electrically conductive.

G. Installation:

1. Pipe ends shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove for proper gasket sealing.
2. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified.
3. Coupling installation shall be complete when visual metal-to-metal contact is reached.
4. Comply with the latest copy of the coupling manufacturer’s field assembly and installation instructions.
H. Training and inspection:

1. An IACET accredited representative of the manufacturer shall provide fabrication facility and on-site training for contractor’s fabrication and field personnel in the use of grooving tools, pipe preparation, application of groove, product installation, and installation inspection.

2. An IACET accredited representative of the manufacturer shall periodically visit the job site and inspect 10% of the installation. If any improperly installed products are located in the first 10%, an additional 10% of the installation must be inspected. If any improperly installed products are located in the additional 10% of the installation, 100% of the installation must be inspected. Contractor shall correct any improperly installed products.

3.5 PIPING APPLICATION:

A. Heating Water, Chilled Water and Water-side Economizer Piping:

1. 2 Inches and Smaller:
   a. Schedule 40, black steel with 125 lb. cast iron or 150 lb. malleable iron threaded fittings or Type L or K copper, hard drawn copper wrought copper or bronze fittings, silver – tin alloy solder joints.

2. 2-1/2 Inches and Larger:
   a. Schedule 40, seamless or ERW (std. weight 12 inches and over) black steel with flanged or welded joints.
   c. Flanges: 150 lb. 300 lb. forged steel slip-on or welding neck type.
   d. Bolting: Regular square head machine bolts with heavy hexagonal nuts.
   e. Gaskets: Thickness, material and type suitable for fluid to be handled, and design temperature and pressures.

B. Equipment Drains:

1. Type "M" or "DWV" copper.

3.6 PIPING TESTS:

A. General: Provide temporary equipment for testing, including pump and gauges. Test piping system before insulation is installed wherever feasible, and remove control devices before testing. Test each section of each piping system independently but do not use piping system valves to isolate sections where test pressure exceeds valve pressure rating. Fill each section with water and pressurize for indicated pressure and time.

B. Test all piping systems as specified. Correct leaks by remaking joints. Remove equipment not able to withstand test procedure during test.

C. Work to be installed shall remain uncovered until the required tests have been completed.

D. Piping which is to be concealed shall be tested before being permanently enclosed.

E. As soon as work has been completed, conduct preliminary tests to ascertain compliance with specified requirements. Make repairs or replacements as required.

F. Give a minimum of twenty-four hours notice to Engineer of dates when acceptance test will be conducted. Conduct tests as specified for each system in presence of representative of owner,
agency having jurisdiction or his representative. Submit three (3) copies of successful tests to the Engineer for his review. Report shall state system tested and date of successful test.

G. Contractor shall obtain certificates of approval, acceptance and compliance with regulations of agencies having jurisdiction. Work shall not be considered complete until such certificates have been delivered by the Engineer to the Owner.

H. All costs involved in these tests shall be borne by Contractor.

I. System Tests

1. Hydrostatic Test: The test shall be accomplished by hand pumping the system to the specified water pressure, and maintaining that pressure until the entire system has been inspected for leaks, but in no case for a time period of less than four hours.
   a. Heating water: 100 psig or 150 percent of operating pressure, whichever is greater.
   b. Chilled water: 100 psig or 150 percent of operating pressure, whichever is greater.
   c. Water-side economizer water: 100 psig or 150 percent of operating pressure, whichever is greater.

2. Compressed Air or Nitrogen Test: Compressed air tests may be substituted for hydrostatic tests only when ambient conditions or existing building conditions prohibit safe use of hydrostatic testing and must be reviewed by the Engineer prior to any testing. For tests of this type, the piping system shall be subjected to the gas pressure indicated for that specific system. The piping capped or plugged and water-pumped with oil free air, or a nitrogen bottle shall be introduced into the entire system to the pressure specified. The system shall maintain that pressure for the duration of a soapy water test of each joint.

3. Repair piping systems sections which fail required piping test, by disassembly and re-installation, using new materials to extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods.

4. Drain test water from piping systems after testing and repair work has been completed.

3.7 ADJUSTING AND CLEANING:

A. General: Clean exterior surfaces of installed piping systems of superfluous materials, and prepare for application of specified coatings (if any). Flush out piping systems with clean water before proceeding with required tests. Inspect each run of each system for completion of joints, supports and accessory items.

1. Inspect pressure piping in accordance with procedures of ASME B31.

B. Clean and flush hydronic piping systems. Remove, clean, and replace strainer screens. After cleaning and flushing hydronic piping system, but before balancing, remove disposable fine mesh strainers in pump suction diffusers.

C. Chemical Treatment: Provide hydronic systems with a water analysis prepared by the chemical treatment supplier to determine the type and level of chemicals required for prevention of scale and corrosion. Perform initial treatment after completion of system testing.

3.8 CLOSE-OUT:

A. Fill system and perform initial chemical treatment.

B. Check expansion tanks to determine that they are not air bound and that the system is completely full of water.
C. Before operating the system perform these steps:

1. Open valves to full open position. Close coil bypass valves.
2. Remove and clean strainers.
3. Check pump for proper rotation and proper wiring.
4. Set automatic fill valves for required system pressure.
5. Check air vents at high points of systems and determine if all are installed and operating freely (automatic type) or to bleed air completely (manual type).
6. Set temperature controls so all coils are calling for full flow.
7. Check operation of automatic bypass valve.
8. Check and set operating temperature of boilers, chillers, and cooling towers to design requirements.
9. Lubricate motors and bearings.

END OF SECTION 23 05 10
PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

A. Extent of piping specialties work required by this section is indicated on drawings and schedules and by requirements of this section.

B. Piping specialties furnished as part of factory-fabricated equipment, are specified as part of equipment assembly in other Division-23 sections.

1.2 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of piping specialties of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:

1. FCI Compliance: Test and rate "Y" type strainers in accordance with FCI 73-1 "Pressure Rating Standard for "Y" Type Strainers". Test and rate other type strainers in accordance with FCI 78-1 "Pressure Rating Standard for Pipeline Strainers Other than "Y" Type".

2. ASME B 31.9 "Building Services Piping" for materials, products, and installation.

3. Safety valves and pressure vessels shall bear the appropriate ASME label.

4. Fabricate and stamp air separators and compression tanks to comply with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

5. ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualification" for qualifications for welding processes and operators.

1.3 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data, including installation instructions, and dimensioned drawings for each type of manufactured piping specialty. Include pressure drop curve or chart for each type and size of pipeline strainer. Submit schedule showing manufacturer's figure number, size, location, and features for each required piping specialty.

B. Shop Drawings: Submit for fabricated specialties, indicating details of fabrication, materials, and method of support.

C. Maintenance Data: Submit maintenance data and spare parts lists for each type of manufactured piping specialty. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of Division 23.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:

1. Air Vents:

   a. Bell & Gossett
2. Air Eliminator and Dirt Separator
   a. Spirotherm, Inc.
   b. Taco

3. Diaphragm-Type Expansion Tanks:
   a. Amtrol, Inc.
   b. Armstrong Pumps, Inc.
   c. Bell and Gossett
   d. Taco, Inc.
   e. The John Wood Co.
   f. Wessiles
   g. Niles Steel Tank

4. Pump Suction Diffusers:
   a. Amtrol, Inc.
   b. Armstrong Pumps, Inc.
   c. Bell & Gossett
   d. Taco, Inc.
   e. Victaulic Company of America

5. Automatic Flow Control Valves:
   a. Apollo
   b. Flow Design

6. Pressure Regulating Valves:
   a. Wilkins Regulator/Div Zurn Industries Inc.
   b. Watts Regulator Co.

7. Pipe Escutcheons:
   b. Producers Specialty & Mfg. Corp.

8. Low Pressure Strainers:
   a. Armstrong International
   b. Hoffman Specialty
   c. Metraflex Co.
   d. R-P&C Valve.
   e. Spirax Sarco.
   f. Victaulic Co. of America.
   g. Watts Regulator Co.
   h. Keckley

9. High Pressure Y-Type Strainers:
   a. Armstrong International
   b. Hoffman Specialty
   c. Metraflex Co.
d. Spirax Sarco.
e. Trane Co.
f. Watts Regulator Co.

10. Dielectric Waterways

a. Victaulic Co.
b. Perfection Corp.
c. Flow Design Inc.
d. Precision Plumbing Products
e. Rockford-Eclipse Div.

2.2 HYDRONIC PIPING SPECIALTIES:

A. General: Provide factory-fabricated piping specialties recommended by manufacturer for use in service indicated. Provide piping specialties of types and pressure ratings indicated for each service, or if not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide sizes as indicated, and connections, which properly mate with pipe, tube, and equipment connections. Where more than one type is indicated, selection is Installer's option.

B. Pressure Reducing Valves: Diaphragm operated, bronze or brass body valve, with low inlet pressure check valve, stainless steel inlet strainer removable without system shut-down, and stainless steel valve seat and stem. Select valve size, capacity, and operating pressure to suit system. Valve shall be factory-set at operating pressure and have the capability for field adjustment.

C. Coin Operated Manual Air Vent: Bronze body and nonferrous internal parts; 150 psig working pressure, 212 degrees F operating temperature; manually coin operated and having discharge outlet connection and 1/8 inch NPT male connection.


E. Small Capacity Automatic Air Vent: 100 psi working pressure, 240 degrees working temperature, stamped brass body and non-metallic float, with threaded outlet connector for "safe waste" discharge pipe.

1. Amtrol 700-30 or approved equivalent.

F. High Capacity Automatic Air Vent: 150 psig working pressure, 250 degrees working temperature, cast iron body, bronze pilot mechanism. Snap acting operation, preventing opening under negative pressure conditions. Capable of 18 scfm elimination at 30 psig.

1. Amtrol 747 or approved equivalent.

G. Air Eliminator and Dirt Separator: Furnish and install as shown on the drawings combination coalescing type air eliminator and dirt separators. Pipe size is not a factor and all units shall be selected per the manufacturer's recommendations. All combination units shall be fabricated steel, rated for 150 psig working pressure with entering velocities not to exceed 4 feet per second at specified GPM. Units specifically designed for high velocity systems may have an entering velocity of up to 10 feet per second. Units shall include an internal bundle filling the entire vessel to suppress turbulence and provide high efficiency. The bundle shall consist of a copper core tube with continuous wound copper medium permanently affixed to the internal element. Each eliminator shall have a separate venting chamber to prevent system contaminants from harming the float and venting valve operation. At the top of the venting chamber shall be an integral full port float actuated brass venting mechanism. Units shall include a valved side tap to flush floating dirt or liquids and for quick bleeding of large amounts of air during system fill or refill. Air separators shall
be capable of removing 100% of the free air, 100% of the entrained air and up to 99.6% of the dissolved air in the system fluid. Dirt separation shall be at least 80% of all particles 30 micron and larger within 100 passes.

1. Spirovent by Spirotherm, Inc., or approved equal.

H. Diaphragm-Type Expansion Tanks: Size and number as indicated; construct of welded carbon steel for 125 psig working pressure, 240 degrees F maximum operating temperature. Separate air charge from system water to maintain design expansion capacity, by means of a flexible heavy duty diaphragm securely sealed into tank. Diaphragm shall be permanently sealed for tank sizes up to 45 gallon acceptance volume. For acceptance volumes greater than 45 gallons, tank shall have replaceable diaphragm/bladder. Diaphragm/bladder shall be suitable for glycol service and system water treatment chemicals. Provide taps for pressure gauge and air charging fitting, and drain fitting. Support vertical tanks with steel legs or base; support horizontal tanks with steel saddles. Tank, with taps and supports, shall be constructed, tested, and labeled in accordance with ASME Pressure Vessel Code, Section VIII, Division 1.

I. Pump Suction Diffusers: Cast-iron body, with threaded connections for 2 inch and smaller, flanged connections for 2-1/2 inch and larger; 175 psig working pressure, 300 degrees F maximum operating temperature; and complete with the following features:

1. Inlet vanes with length 1-1/2 times pump suction diameter or greater.
2. Cylinder strainer with 3/16 inch diameter openings with total free area equal to or greater than 5 times cross-sectional area of pump suction, designed to withstand pressure differential equal to pump shutoff head.
3. Disposable fine mesh strainer to fit over cylinder strainer.
4. Permanent magnet, located in flow stream, removable for cleaning.
5. Adjustable foot support, designed to carry weight of suction piping.

2.3 PIPE ESCUTCHEONS:

A. General: Provide pipe escutcheons as specified herein with inside diameter closely fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls, or ceilings; and pipe sleeve extension, if any. Furnish pipe escutcheons with nickel or chrome finish for occupied areas, prime paint finish for unoccupied areas.

B. Pipe Escutcheons for Moist Areas: For waterproof floors, and areas where water and condensation can be expected to accumulate, provide cast brass or sheet brass escutcheons, solid or split hinged.

C. Pipe Escutcheons for Dry Areas: Provide sheet steel escutcheons, solid or split hinged.

2.4 LOW PRESSURE PIPELINE STRainers:

A. General: Provide strainers full line size of connecting piping, with ends matching piping system materials. Select strainers for 125 psi working pressure, with Type 304 stainless steel screen. Two inches and smaller steam and liquid strainers shall have 20 mesh screens. Provide 3/64 inch perforations for 2-1/2 inch and 3 inch steam and liquid strainers. Provide 1/8 inch mesh perforations for 4 inches and larger liquid strainers. Provide 1/16 inch mesh perforations for 4 inches and larger steam strainers.

B. Threaded Ends, 2 inch and Smaller: Bronze or Cast-iron body, screwed screen retainer with centered blowdown fitted with pipe plug.
C. Threaded Ends, 2-1/2 inches and Larger: Cast-iron body, bolted screen retainer with off-center blowdown fitted with pipe plug.

D. Flanged Ends, 2-1/2 inches and Larger: Cast-iron body, bolted screen retainer with off-center blowdown fitted with pipe plug.

E. Butt Welded Ends, 2-1/2 inches and Larger: Schedule 40 cast carbon steel body, bolted screen retainer with off-center blowdown fitted with pipe plug.

F. Grooved Ends, 2-1/2 inches and Larger: Tee pattern, ductile-iron or malleable-iron body and access end cap, access coupling with EDPM gasket.

2.5 HIGH PRESSURE PIPELINE STRAINERS:

A. General: Provide strainers full line size of connecting piping, with ends matching piping system materials. Select strainers for 250 psi working pressure, with Type 304 stainless steel screens. Two inches and smaller steam and liquid strainers shall have 20 mesh screens. Provide 3/64 inch perforations for 2-1/2 inch and 3 inch steam and liquid strainers. Provide 1/8 inch mesh perforations for 4 inch and larger liquid strainers. Provide 1/16 inch mesh perforations for 4 inch and larger steam strainers.

B. Threaded Ends, 2 inches and Smaller: Cast-iron body, screwed screen retainer with centered blowdown fitted with pipe plug.

C. Threaded Ends, 2-1/2 inches and Larger: Cast-iron body, bolted screen retainer with off-center blowdown fitted with pipe plug.

D. Flanged Ends, 2-1/2 inches and Larger: Cast-iron body, bolted steel retainer with off-center blowdown fitted with pipe plug.

E. Butt Welded Ends, 2-1/2 inches and Larger: Schedule 80 cast carbon steel body, bolted screen retainer with off-center blowdown fitted with pipe plug.

2.6 DIELECTRIC WATERWAY:

A. General: Zinc electroplated nipple with non-metallic lining for use in service indicated, which effectively isolate ferrous from non-ferrous piping (electrical conductance), prevent galvanic action, and stop corrosion. Union style not acceptable.

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPING SPECIALTIES:

A. Pipe Escutcheons: Install pipe escutcheons on each pipe penetration thru floors, walls, partitions, and ceilings where penetration is exposed to view; and on exterior of building. Secure escutcheon to pipe or insulation so escutcheon covers penetration hole, and is flush with adjoining surface.

B. Strainers: Install strainers full size of pipeline, in accordance with manufacturer’s installation instructions. Install pipe nipple and shut off full port ball valve with ¾ inch hose end and cap in strainer blow down connection. Where indicated, provide drain line from shutoff valve to plumbing drain, full size of blow down connection.

1. Provide strainers in supply line ahead of the following equipment, and elsewhere as indicated.
   
a. Pumps
b. Pressure reducing valves  
c. Control valves  

C. Dielectric Waterway: Install at each piping joint between ferrous and non-ferrous piping. Comply with manufacturer's installation instructions.  

1. Not required in closed hydronic systems treated with corrosion inhibitors, where there is a bronze valve body between the two materials.  

3.2 HYDRONIC SPECIALTIES INSTALLATION:  

A. Manual Air Vent: Provide manual air vents at all high points and drops in the direction of flow, of all mains and risers of the hydronic systems, at heat transfer coils, radiation and elsewhere shown and as required for system air venting.  

1. Provide enlarged air collection standpipe where large air quantities can accumulate.  
2. Use a 1/2 inch ball valve with a soft copper tubing discharge pipe directed to a convenient collection point except as noted below.  
3. Use a coin operated air vent inside terminal unit and baseboard radiation enclosures.  

B. Provide automatic air vents where shown on drawings. Provide high capacity automatic air vents at all air separators, provide an isolation valve to allow removal of all automatic air vents, provide minimum 1/4 inch soft copper tubing to a convenient drain location, and to avoid water damage.  

C. Pump Suction Diffuser: Install pump suction diffusers on hydronic systems pump suction inlet, adjust foot support to carry weight of suction piping. Install nipple and ball valve in blowdown connection. Arrange installation to allow strainer removal and replacement.  

D. Bladder-and-Diaphragm-Type Expansion Tanks: Install bladder-and-diaphragm type compression tanks in hydronic systems on floor stand as indicated. Provide Schraeder valve on air charge fitting. Vent and purge air from the water side, and charge tank with proper air charge to suit system design requirements.  

1. Provide support from the floor or structure adequate to carry twice the weight of the tank, piping connections, fittings, and weight of water assuming a full tank of water. Do not overload building components and structural members.  

END OF SECTION 23 05 18
SECTION 23 05 19

METERS AND GAUGES FOR MECHANICAL PIPING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

A. Extent of meters and gauges required by this section is indicated on drawings and/or specified in other Division-23 sections.

B. Meters and gauges furnished as part of factory-fabricated equipment, are specified as part of equipment assembly in other Division-23 sections.

1.2 QUALITY ASSURANCE:

A. Manufacturer’s Qualifications: Firms regularly engaged in manufacturer of meters and gauges, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:

1. UL Compliance: Comply with applicable UL standards pertaining to meters and gauges.

2. ANSI and ISA Compliance: Comply with applicable portions of ANSI and Instrument Society of America (ISA) standards pertaining to construction and installation of meters and gauges.

C. Certification: Provide meters and gauges whose accuracies, under specified operating conditions, are certified by manufacturer.

1.3 SUBMITTALS:

A. Product Data: Submit manufacturer’s technical product data, including installation instructions for each type of meter and gauge. Include scale range, ratings, and calibrated performance curves, certified where indicated. Submit meter and gauge schedule showing manufacturer’s figure number, scale range, location, and accessories for each meter and gauge.

B. All flow measuring devices to be provided shall be reviewed and approved by the test & balance contractor and the temperature control contractor for proper scale, rangeability and function prior to submitting shop drawings. The test & balance contractor and temperature control contractor shall provide a typed letter stating this review has been completed and included with shop drawing submittals.

C. Maintenance Data: Submit maintenance data and spare parts lists for each type of meter and gauge. Include this data and product data in Maintenance Manual; in accordance with requirements of Division 23.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:

1. Glass Thermometers:
   a. Ernst Gauge Co.
b. Marshalltown Instruments, Inc.
c. Trerice (H.O.) Co.
d. Weiss Instruments, Inc.
e. Miljoco Corp.

2. Photo Voltaic Digital Thermometers:
   a. Versa Gauge
   b. Weiss Instruments
   c. Miljoco Corp.

3. Temperature Gauge Connector Plugs:
   a. Fairfax Company
   b. Peterson Equipment Co.
c. Universal Lancaster
d. Sisco
e. MG Piping Products Co.
f. Miljoco Corp.

4. Pressure Gauges:
   b. Marsh Instrument Co.; Unit of General Signal.
c. Marshalltown Instruments, Inc.
d. Trerice (H.O.) Co.
e. Weiss Instruments, Inc.
f. MG Piping Products Co.
g. Versa Gauge
h. Miljoco Corp.

5. Pressure Gauge Connector Plugs:
   a. Fairfax Company
   b. Peterson Equipment Co.
c. Universal Lancaster
d. Sisco
e. MG Piping Products Co.
f. Miljoco Corp.

6. Venturi Tube Flow Measuring Elements:
   a. Gerand
   b. Hyspan
   c. Preso
d. Flow Design, Inc.

7. Calibrated Balancing Valves (Valve and Venturi Type):
   a. IMI Flow Design

8. Automatic Balancing Valves
   a. IMI Flow Design
2.2 GLASS THERMOMETERS:

A. General: Provide glass thermometers of materials, capacities, and ranges indicated, designed and constructed for use in service indicated.

B. Case: Die cast aluminum finished in baked epoxy enamel, glass front, spring secured, 9 inches long.

C. Adjustable Joint: Die cast aluminum, finished to match case, 180 degrees adjustment in vertical plane, 360 degrees adjustment in horizontal plane, with locking device.

D. Tube and Capillary: Non-Mercury Liquid filled, magnifying lens, 1 percent scale range accuracy, shock mounted.

E. Scale: Satin faced, non-reflective aluminum, permanently etched markings.

F. Stem: Copper-plated steel, or brass, for separable socket, length to suit installation. Sampling tube type with duct flange for air duct installations.

G. Range: Conform to the following:

1. Hot Water: 30 degrees - 240 degrees F with 2 degrees F scale divisions (-1 degree - 116 degrees C with 2 degrees C scale divisions).
2. Chilled Water: 0 - 100 degrees F with 2 degrees F scale divisions (-18 degrees - 37.8 degrees C with 1 degrees C scale divisions).
3. Steam and Condensate: 50–400 degrees F with 2 degrees scale divisions (10-205 degrees C with 1 degrees scale divisions).
4. Duct work: 0-160 degrees F with 2 degrees scale divisions.

2.3 PHOTO VOLTAIC DIGITAL THERMOMETERS:

A. Case: High image ABS, with photovoltaic power cell and digital readout.

B. Range: Selectable between -40-300 degrees F/ -40-150 degrees F, displayed to 0.1 degrees.

C. Accuracy: 1 percent of reading or 1 degrees F, whichever is greater. Recalibratable via internal potentiometer. Not affected by ambient temperature.

D. Ambient light required: 10 lux.

E. Display update: 10 seconds.

F. Stem: Compatibly with standard thermowell for piping applications, or sampling tube with flange for air duct applications.

2.4 THERMOMETER WELLS:

A. General: Provide thermometer wells constructed of brass or stainless steel, pressure rated to match piping system design pressure. Provide 2 inch extension for insulated piping. Provide cap nut with chain fastened permanently to thermometer well.

2.5 TEMPERATURE GAUGE CONNECTOR PLUGS:

A. General: Provide temperature gauge connector plugs pressure rated for 500 psi and 200 degrees F (93 degrees C). Construct of brass and finish in nickel-plate, equip with ½ inch NPS fitting, with self-sealing valve core type neoprene gasketed orifice suitable for inserting 1/8 inch O.D. probe
assembly from dial type insertion thermometer. Equip orifice with gasketed screw cap and chain. Provide extension, length equal to insulation thickness, for insulated piping.

2.6 PRESSURE GAUGES:

A. General: Provide pressure gauges of materials, capacities, and ranges indicated, designed and constructed for use in service indicated.

B. Type: General use, 1 percent accuracy, ANSI B40.1 grade A, phospher bronze bourdon type, bottom connection.

C. Case: Drawn steel or brass, glass lens or acrylic, minimum 4 inch diameter.

D. Connector: Brass with 1/4 inch male NPT. Provide protective syphon when used for steam service.

E. Scale: White coated aluminum, with permanently etched markings.

F. Range: Conform to the following:
   1. Vacuum: 30 inches Hg - 15 psi.
   2. Water: 0 - 100 psi.
   3. Steam: 0 - 200 psi.

2.7 PRESSURE GAUGE COCKS:

A. General: Provide pressure gauge cocks between pressure gauges and gauge tees on piping systems. Gauge cock shall be ¼ inch female NPT on each end ball valve as specified in Section 23 05 23 - Valves.

B. Syphon: ¼ inch straight coil constructed of brass tubing with ¼ inch male NPT on each end.

C. Snubber: ¼ inch brass bushing with corrosion resistant porous metal disc, through which pressure fluid is filtered. Select disc material for fluid served and pressure rating.

2.8 VENTURI TUBE FLOW MEASURING ELEMENTS:

A. Primary flow measuring elements shall consist of venturi tubes. Arrange piping in accordance with manufacturer's published literature. In horizontal pipes, place connections slightly above horizontal centerline of pipe.

B. Provide each primary element with integral tab, or metal tag on stainless steel wire, extending outside pipe covering on which is stamped or clearly printed in plainly visible position the following information:
   1. Manufacturer's name and address.
   2. Serial number of meter to which element is to be connected.
   3. Name, number, or location of equipment served.
   4. Specified rate of flow.
   5. Multiplier (including unity, where applicable) to be applied to meter reading.

C. Provide taps with Schraeder or Hanson type fittings. Provide tap extensions to accommodate insulation.
D. Manufacturer shall certify venturi tubes for actual piping configuration. Any necessary piping changes required for certification shall be provided without cost to Owner. Insert type tubes may be furnished, provided they meet specification requirements in other respects.

E. Provide venturi with throat diameter such that specified rate of flow will register scale reading of between 20 percent and 80 percent of full scale value.

F. Venturi sizes and beta ratios shall be selected so that design flow rates shall read between 20 percent and the full scale range on a linear meter (e.g. between 10 inches and 50 inches on a 0-50 inches meter), with permanent pressure loss of not more than 25 percent of indicated flow rate differential pressure.

G. Provide venturi tubes of solid brass or bronze. Tubes larger than 2 inches shall have flanges or butt weld connections and may be cast iron or steel. Steel tubes may be fabricated or cast with cadmium or zinc-plating. Line throats of cast iron tubes with bronze and plate cast iron portion with cadmium.

H. Tubes shall be calibrated and tested by independent testing laboratory and performance data furnished with shop drawings.

I. Connections for attachment to portable flow meter hoses shall be readily accessible.

2.9 CALIBRATED BALANCE VALVES:

A. General: Provide as indicated, calibrated balance valves equipped with readout valves to facilitate connecting of differential pressure meter to balance valves. Equip each readout port with a quick connect valve designed to minimize system fluid loss during monitoring process. Provide balance valves with preformed insulation suitable for use on heating and cooling systems, and to protect balance valves during shipment. Calibrated balance valves packages may combine additional features shown on the drawings such as strainers, P/T ports, drain valves, etc as long as those features are equivalent to the specification of the individual component.

B. Body – Dezincification resistant brass.

C. Design, valve and venturi type:

1. Ball or butterfly type throttling valve with stainless steel ball.
2. Bubble-tight shut-off.
3. Fixed venturi, upstream of valve.
4. Schraeder type taps on venturi, upstream and downstream.
5. Memory stop device to allow valve to be returned to balanced position after being closed.
   (Note: this does not take the place of isolation valves shown on drawings)
6. Provide metal tag with flow curve for each valve.

2.10 AUTOMATIC BALANCE VALVES

A. General:

1. Provide as indicated, automatic balance valves equipped with readout valves to facilitate connecting of differential pressure meter to balance valves. Equip each readout port with a quick connect valve designed to minimize system fluid loss during monitoring process. Provide balance valves with preformed insulation suitable for use on heating and cooling systems, and to protect balance valves during shipment. Valve packages may combine additional features shown on the drawings such as strainers, P/T ports, drain valves, etc as long as those features are equivalent to the specification of the individual component.
B. Design:

1. Changeable GPM flow cartridges with +/- 10% accuracy
2. Inlet and outlet P/T ports
3. Differential operating pressure range: 2-80PSI
4. Label valves with model no. and flow rate

2.11 FLOW METER READ-OUT KITS:

A. Provide flow meter read-out kits with bellows type differential pressure element and minimum 5 inch diameter indicating dial.

B. Design pressure elements for full scale pressure differential of 50 inches or 100 inches water gauge. Design shall incorporate rupture-proof metal beryllium or stainless steel bellows and torque tube drive requiring no lubrication. Design forged bodies for not less than 150 percent of maximum surge pressure, fully protected against surges, with full provision for venting and draining. Provide integral, adjustable pulsation dampers.

C. Dials of portable meters shall have square root scales not less than 12 inches in developed length. Dials shall read from 0 to 10 gpm to which multiplier is to be applied, as required; also provide with uniform scale reading from 0 inches to 10 inches w.g., to which multiplier of 10 to be applied (100 inches at full scale), or from 0 inches to 5 inches w.g., to which multiplier of 10 is to be applied (50 inches at full scale).

D. Engineer and manufacture in accordance with ASME recommendations for flowmeters. Provide portable meters with overall accuracy of + 5 percent.

E. Provide flow meter with factory-fabricated carrying case with integral carrying handle. Case shall be fitted to hold meter and following accessories.

1. Two 10 feet lengths of connecting hose with suitable female connectors for connecting to venturi tube pressure tap nipples. Design hose for operating pressure of minimum of 150 percent of maximum system operating pressure.
2. Completely assembled 3-value manifold with 2 block valves and vent and drain valves shall be piped and mounted on base, which shall be designed for use lying flat on stationary base.
3. Bound set of descriptive bulletins, installation and operating instructions, parts list, and set of curves showing flow verses pressure differential for each orifice or venturi tube with which meter is to be used.
4. Metal instruction plate, secured inside cover, illustrating use of meter. Deliver meter with case to Owner.

PART 3 - EXECUTION

3.1 INSPECTION:

A. Examine areas and conditions under which meters and gauges are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF THERMOMETERS:

A. General: Install thermometers in vertical upright position, and tilted so as to be easily read by observer standing on floor.

B. Thermometer Wells: Install in piping tee where indicated, in vertical upright position. Fill well with oil or graphite, secure cap.
C. Temperature Gauge Connector Plugs: Install in piping tee where indicated, located on pipe at most readable position. Secure cap. Provide portable temperature gauge for each plug connection.

3.3 INSTALLATION OF PRESSURE GAUGES:

A. General: Install pressure gauges in piping tee with pressure gauge cock, located on pipe at most readable position.

B. Locations: Install in the following locations, and elsewhere as indicated:

1. At suction and discharge of each pump.

C. Pressure Gauge Cocks: Install in piping tee with snubber. Install syphon for steam pressure gauges.

D. Pressure Gauge Connector Plugs: Install in piping tee where indicated, located on pipe at most readable position. Secure cap. Provide portable pressure gauge for each plug connection.

3.4 INSTALLATION OF FLOW MEASURING METERS:

A. General: Install flow measuring meters on piping systems located in accessible locations at most readable position.

B. Locations: Install in the following locations, and elsewhere as indicated:

1. At discharge of each pump.
2. At health sciences BTU meter location in tunnel.

C. Wafer-Type Flow Meters: Install between 2 Class 125 pipe flanges, ANSI B16.1 (cast-iron) or ANSI B16.24 (cast-bronze). Provide minimum straight lengths of pipe upstream and downstream from meter in accordance with manufacturer's installation instructions.

D. Calibrated Balance Valves and Automatic Balance Valves: Install on piping with readout valves in vertical upright position. Maintain minimum length of straight unrestricted piping equivalent to 3 pipe diameters upstream of valve.

3.5 ADJUSTING AND CLEANING:

A. Adjusting: Adjust faces of meters and gauges to proper angle for best visibility.

B. Cleaning: Clean windows of meters and gauges and factory-finished surfaces. Replace cracked or broken windows, repair any scratched or marred surfaces with manufacturer's touch-up paint.

END OF SECTION 23 05 19
SECTION 23 05 23

GENERAL DUTY VALVES FOR MECHANICAL PIPING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

A. This Section includes general duty valves common to most mechanical piping systems.

B. Valves tags and charts are specified in Division 23 Section "Mechanical Identification."

1.2 SUBMITTALS:

A. Product Data: including body material, valve design, pressure and temperature classification, end connection details, seating materials, trim material and arrangement, dimensions and required clearances, and installation instructions.

1.3 QUALITY ASSURANCE:

A. Single Source Responsibility: Comply with the requirements specified in Division-23 Section "Basic Mechanical Requirements," under "Product Options."

B. MSS Standard Practices: Comply with the following standards for valves:
   1. MSS SP-45: Bypass and Drain Connection Standard
   2. MSS SP-67: Butterfly Valves
   3. MSS SP-71: Cast Iron Swing Check Valves, Flanged and Threaded Ends
   4. MSS SP-72: Gray Valves with Flanged or Butt-Welding Ends for General Service
   5. MSS SP-80: Bronze Gate, Globe Angle and Check Valves
   6. MSS SP-85: Cast Iron Globe and Angle Valves, Flanged and Threaded Ends
   7. MSS SP-92: MSS Valve User Guide

C. Solenoid valves shall be UL listed, FM and CSA approved.

1.4 DELIVERY, STORAGE, AND HANDLING:

A. Preparation for Transport: Prepare valves for shipping as follows:
   1. Ensure valves are dry and internally protected against rusting and galvanic corrosion.
   2. Protect valve ends against mechanical damage to threads, flange faces and weld end preps.
   3. Set valves in best position for handling. Globe and gate valves shall be closed to prevent rattling; ball and plug valves shall be open to minimize exposure of functional surfaces; butterfly valves shall be shipped closed or slightly open; and swing check valves shall be blocked in either closed or open position.

B. Storage: Use the following precautions during storage:
   1. Valves shall be stored and protected against all dirt, debris and foreign material at all times.
   2. Do not remove valve end protectors unless necessary for inspection; then reinstall for storage.
   3. Protect valves against weather. Where practical store valves indoors. Maintain valve temperature higher than the ambient dew point temperature. If outdoor storage is necessary, support valves off the ground or pavement and protect in watertight enclosures.
C. Handling: Valves whose size requires handling by crane or lift shall be slung or rigged to avoid damage to exposed valve parts. Handwheels and stems, in particular, shall not be used as lifting or rigging points.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Manufacturer: Subject to compliance with requirements, provide products by the manufacturers listed.

   1. Ball Valves:
      a. Nibco
      b. Watts

   2. Globe Valves:
      a. Anvil
      b. Hammond
      c. Nibco
      d. Milwaukee
      e. Kitz

   3. Butterfly Valves:
      a. Nibco
      b. Watts

   4. Swing Check Valves
      a. Metraflex
      b. Nibco
      c. Watts

   5. Non-Slam Check Valves:
      a. Metraflex
      b. Nibco
      c. Watts

2.2 VALVE FEATURES:

A. General: Comply with MSS-92

B. Valve Design: Valves shall have rising stem, or rising stem outside screw and yoke design; except, non-rising stem valves may be used where headroom prevents full operation of rising stem valves.

C. Sizes: Unless otherwise indicated, provide valves of same size as upstream pipe size. (Control valves shall be sized for required flow.)

D. Operators: Provide the following special operator features:

   1. Handwheels, fastened to valve stem for valves other than quarter turn.
2. Lever handle on quarter turn valves 6 inch and smaller, except plug valves. Provide a wrench for every plug valve.

3. Chainwheel operators for valves 2-1/2 inch and larger that are installed 96 inches or higher above finished floor elevation. Provide chains to an elevation of 6'-0" above finished floor elevation.

4. Worm gear operators of an enclosed weather-proof design shall be provided on all quarter turn valves 8 inches and larger.

E. Extended Stems: Where insulation is indicated or specified, provide extended stems to allow full operation of the valve without interference by the insulation.

F. Bypass and Drain Connections: Comply with MSS SP-45.

G. End Connections: As specified in the individual valves specifications.
      a. Caution: Where soldered end connections are used, use solder having a melting point below 840 degrees F for gate, globe, and check valves and below 421 degrees F for ball valves.

2.3 BALL VALVES FOR HYDRONIC SYSTEMS:

A. Ball Valves: 150 WSP, 600 WOG, rated for 150 PSI at 350 degrees F, two piece end entry body style, bronze body conforming to ASTM B584, full port chrome plated brass ball, 15% glass reinforced PTFE seats, PTFE packing, adjustable packing nut blow-out proof stem, vinyl covered steel handle. Provide solder ends or threaded ends to match piping system. Stem length to allow handle to clear insulation. Valves shall have a Cv value of a full port ball valve. Comply with NSF-61.

B. Ball Valves for all silver soldered or brazed lines: ANSI B16.34, 150 WSP, 600 WOG, rated for 150 PSI at 350 degrees F. Three piece body style for brazed lines, bronze body conforming to ASTM B584, full port, chrome plated brass ball and stem of ASTM A276 type 316, 15% glass reinforced RTFE seats, RTFE packing and blow out proof stem, vinyl coated steel handle. Stem length to allow handle to clear insulation. Provide solder ends. Valves shall have a Cv value of a full port ball valve.

2.4 BALL VALVE OPTIONS/ACCESSORIES:

A. Provide the following as required or as specifically indicated:
   1. Tee handle for tight fit applications (within enclosures, etc.).
   2. Drain cap (drain valves).
   3. Stem extension where the stem otherwise would not clear the insulation thickness.
   4. Mounting pads (actuated valves).

2.5 GLOBE VALVES:

A. Hydronic Systems (2-1/2 inches and smaller): MSS SP-80 Class 150, body, bonnet and bonnet ring, cast bronze ASTM B-62, Teflon disc, copper-silicon bronze stem, non-asbestos teflon impregnated stem packing, union bonnet and malleable iron handle.
   1. Stockham Fig. B-22/B-24
2.6 BUTTERFLY VALVES:

A. Hydronic Service Butterfly Valves - 2-1/2 inches to 12 inches: MSS SP-67, cast iron body conforming to ASTM A126 class B, aluminum bronze ASTM B148 disc, single piece or two piece 416 stainless steel stem, EPDM seat, upper and lower bronze bearing, non-metallic bushing and stem seal, ANSI class 125 flange, rated for 200 psi pressure differential, 200 psi drop-tight shut off dead end service, with downstream flange removed. Provide extended neck for 2 inches thick insulation. All valves shall be factory tested to 110% of pressure rating. All butterfly valves shall be full lugged body, drilled and tapered.

2.7 CHECK VALVES:

A. Swing Check Valves - 2-1/2 Inch and Smaller: MSS SP-80; Class 125/150 WSP 200/300, cast bronze body and cap conforming to ASTM B 62, ASTM B61 for 200/300 bronze, horizontal swing design, Y-pattern, with a bronze disc, stainless steel pin and having threaded or solder ends. Class 150 valves meeting the above specifications may be used where pressure requires or Class 125 are not available.

B. Swing Check Valves - 2-1/2 to 3 Inch: MSS SP-71; Class 125 /250 (Class 175 FM approved for fire protection piping systems), cast iron body and bolted cap conforming to ASTM A 126, Class B; horizontal swing, with a bronze disc or cast iron disc with bronze disc ring, and flanged ends. Valve shall be capable of being refitted while the valve remains in the line. For sewage ejector and sump pump discharge swing check valves 2-1/2 inches and larger, provide outside lever with weight or spring to assist disc to close rapidly.

C. Non-Slam Check Valves - 2 Inch and smaller: Bronze body, 200 psi @ 250 degrees F., threaded ends, resilient seats, center guided spring loaded disk.

D. Non-Slam Check Valves - 2-1/2 Inch and Larger: Class 125/ 250 cast iron or stainless steel body, replaceable lapped bronze seat and balanced twin bronze flappers or bronze center guided disc and stainless steel trim. Valve shall be designed to open and close at approximately one foot differential pressure. Twin flappers or center guided disc shall be loaded with a stainless steel spring to assure even non-slam checking action. Seals shall be EPDM.

2.8 DRAIN VALVES:

A. For Hydronic Systems: Provide ball valve with threaded hose end and cap with chain.

2.9 MOTORIZED VALVE ACTUATORS:

A. Electric Valve Actuators

1. The valve actuator shall consist of a 120 volt, single phase, permanent split capacitor, reversible type electric motor which drives a compound epicyclic gear. A manual override handwheel shall be integral to the unit. The electric actuator shall have visual mechanical position indication, readable from a distance of 25 feet, showing output shaft and valve position. Unit shall be capable of mounting directly to butterfly valve without brackets and adapters.

2. The actuator shall have an integral terminal strip, for wiring to power supplies. Cable entry shall be by means of two (2) 1 inch NPT threaded connections. Cable entries shall have UL recommended gland stops within the NPT hole to prevent glands from being screwed in too far and damaging cable.

3. The actuator shall be constructed to withstand high shock and vibrations without operations failure. The actuator cover shall have captive bolts to eliminate loss of bolts when removing the cover from the base. One copy of the wiring diagram shall be provided with the actuator.
4. Actuators with 600 in/lbs or more output torque shall be two adjustable factory calibrated mechanical torque limit switches of the single pole, double-throw type. Motor rotor shaft shall run in ball bearings at each end of the motor.

5. The actuator housing shall be manufactured to NEMA IV Standards and UL recognized.

6. The environmental temperature range of the actuator shall be -20 to 140°F (-30 to 60°C).

7. For two position service, the actuator shall be rated at a 20 percent duty cycle (i.e. 12 minutes extended duty in every hour, or alternatively; one complete cycle every two minutes). For frequent cycling and modulating service, the actuator shall be rated for continuous duty, capable of operating 100 percent of the time at an ambient temperature of 104 degrees F (40°C).

8. The actuator shall have a permanently lubricated, self-locking gear train. Motor brakes shall not be required to maintain desired valve position. Levers or latches shall not be required to engage or disengage the manual override. Mechanical travel stops, adjustable to 15 degrees in each direction of 90 degrees rotation, shall be standard, as well as two adjustable travel limit switches with electrically isolated contacts. Additional adjustable switches shall be provided where required to meet the sequence of operation.

9. The motor shall have Class B insulation capable of withstanding locked rotor for 25 seconds without overheating. Wiring shall also be Class B insulation. An auto-reset thermal cut-out protector shall be embedded in the motor windings. The motor shall be UL recognized and CSA approved. Disassembly of gears shall not be required to remove the motor.

10. Materials
   a. The electric actuator shall have a pressure die-cast, hard anodized aluminum base and cover. The compound gear shall be made of die-cast, hard anodized aluminum or steel. An alloy steel worm gear shall be provided for manual override and torque limiting. Bearings for gears shall be of the ball and needle type; bronze bearings shall be used on the shafting parts.

11. Electric Valve Actuator Accessories
   a. Provide thermostatically controlled heaters for all exterior valves.
   b. Provide potentiometer or 4-20 MA-transmitter for providing continuous feedback of actuator position where required to meet the sequence of operations.
   c. Provide an electronic servo amplifier and speed control module capable of accepting a 0-5K ohm, 4-20mA DC or other input signal for all modulating control valves.
   d. For the valves listed below, provide an electric power fail-safe unit in a NEMA I/IV enclosure to drive the actuator closed upon failure of the main power supply. The unit shall be capable of operating the actuator up to 20 cycles without the main power supply being available.

1) Provide fail-safe unit for the following valves.
   a) Boiler Warm-up By-pass Valve

PART 3 - EXECUTION

3.1 EXAMINATION:
   A. Install valves in accordance with manufacturer’s instructions.
   B. Examine valve interior through the end ports, for cleanliness, freedom from foreign matter and corrosion. Remove special packing materials, such as blocks used which prevents disc movement during shipping and handling.
C. Actuate valve through an open-close and close-open cycle. Examine functionally significant features, such as guides and seats made accessible by such actuation. Following examination, return the valve closure member to the position in which it was shipped.

D. Examine threads on both the valve and the mating pipe for form (out-of-round or local indentation) and cleanliness.

E. Examine mating flange faces for conditions which might cause leakage. Check bolting for proper size, length, and material. Check gasket material for proper size and material, and for freedom from defects and damage.

F. Prior to valve installation, examine the piping for cleanliness, freedom from foreign materials, and proper alignment.

3.2 VALVE SELECTION:

A. Selection of Valve Ends (Pipe Connections): Except as otherwise indicated, select valves with the following ends or types of pipe/tube connections:

1. Copper Tube Size 2 Inch and Smaller: Solder ends, except in heating hot water and low pressure steam service which shall have threaded ends.
2. Steel Pipe Sizes 2 Inch and Smaller: Threaded.
4. At all piping hot taps provide a ball valve with the hot tap and a ball valve or butterfly valve for shut-off service. Hot taps shall be provided only where approved by the Engineer.

3.3 VALVE INSTALLATIONS:

<table>
<thead>
<tr>
<th>SERVICE</th>
<th>VALVE TYPE</th>
</tr>
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<tbody>
<tr>
<td>HVAC Hydronic Piping; 3&quot; and smaller</td>
<td>Ball Valve</td>
</tr>
<tr>
<td>HVAC Hydronic Piping; 3&quot; and larger</td>
<td>Butterfly Valve</td>
</tr>
<tr>
<td>HVAC Hydronic Balancing valve; 2&quot; and smaller</td>
<td>Automatic Flow Control Valve See Section 230519</td>
</tr>
<tr>
<td>HVAC Hydronic Balancing Valve; 2-1/2&quot; and larger</td>
<td>Calibrated Balancing Valve See Section 230519</td>
</tr>
<tr>
<td>HVAC Hydronic Check Valves; 2&quot; and smaller</td>
<td>Swing Check</td>
</tr>
<tr>
<td>HVAC Hydronic Check Valves; 2-1/2&quot; and larger</td>
<td>Swing Check</td>
</tr>
<tr>
<td>HVAC Hydronic Pump Discharge Check Valve; 3&quot; and larger</td>
<td>Non-Slam Spring Loaded</td>
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</tbody>
</table>

A. Locate valves for easy access and provide separate support where necessary.

B. Install valves and unions for each fixture and item of equipment in a manner to allow equipment removal without system shut-down. Unions are not required on flanged devices.

C. Globe valves shall be installed with the stem in the upright position. In overhead horizontal piping, ball valves shall be installed with the handle in the side or bottom of the piping. Butterfly valves shall be installed with the stem within 45 degrees of the horizontal position. The handle of quarter turn
valves shall open in the direction of flow. Quarter turn valves with hand wheels or chain wheels shall be located so that the position indicator is visible from the floor without the use of a ladder or climbing on equipment or piping.

D. Installation of Check Valves: Install for proper direction of flow as follows:
   1. Swing Check Valves: Install in horizontal position with hinge pin level.
   2. Wafer Check Valves: Install between 2 flanges in horizontal or vertical upward flow position.

3.4 SOLDER CONNECTIONS:

A. Cut tube square and to exact lengths.
B. Clean end of tube to depth of valve socket, using steel wool, sand cloth, or a steel wire brush to a bright finish. Clean valve socket in same manner.
C. Apply proper soldering flux in an even coat to inside of valve socket and outside of tube.
D. Open gate and globe valves to fully open position.
E. Remove the cap and disc holder of swing check valves with composition discs.
F. Insert tube into valve socket making sure the end rests against the shoulder inside valve. Rotate tube or valve slightly to insure even distribution of the flux.
G. Apply heat evenly to outside of valve around joint until solder will melt upon contact. Feed solder until it completely fills the joint around tube. Avoid hot spots or overheating the valve. Once the solder starts cooling, remove excess amounts around the joint with a cloth or brush.

3.5 BRAZED CONNECTIONS:

A. Protect valves from temperatures which exceed the valve material temperature limitations as recommended by the valve manufacturer.
B. Disassemble 3 piece ball valves prior to brazing.

3.6 THREADED CONNECTIONS:

A. Note the internal length of threads in valve ends, and proximity of valve internal seat or wall, to determine how far pipe should be threaded into valve.
B. Align threads at point of assembly.
C. Apply appropriate tape or thread compound to the external pipe threads (except where dry seal threading is specified).
D. Assemble joint wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.

3.7 FLANGED CONNECTIONS:

A. Align flanges surfaces parallel.
B. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using a torque wrench.

3.8 BUTTERFLY VALVE MOTORIZED ACTUATORS:

A. Coordinate with the control system installer to set up all end switches, pilot valves, and control panels.

B. Provide min 80 psig main air piping to pneumatic actuators.

C. Provide electric valve actuator power in accordance with Division 26.

D. Set travel stops as recommended by the valve manufacturer or as indicated.
   1. Valves shall stop just short of seating to allow a minimal amount of bleed.
   2. Valves shall be set to shut off but not fully seat.

E. Locate pilot positioners and valve position indicators so that they will be visible from the floor or roof surface, without the need of a ladder or climbing over equipment and piping.

3.9 FIELD QUALITY CONTROL:

A. Testing: After piping systems have been tested and put into service, but before final adjusting and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks; replace valve if leak persists.

3.10 ADJUSTING AND CLEANING:

A. Cleaning: Clean mill scale, grease, and protective coatings from exterior of valves and prepare to receive finish painting or insulation.

END OF SECTION 23 05 23
HANGERS AND SUPPORTS FOR MECHANICAL PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of supports and anchors, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:
   1. Regulatory Requirements: Comply with applicable plumbing codes pertaining to product materials and installation of supports and anchors.
   2. MSS Standard Compliance:
      a. Provide pipe hangers and supports of which materials, design, and manufacture comply with MSS SP-69.

1.2 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data, including installation instructions for each type of support and anchor. Submit pipe hanger and support schedule showing Manufacturer's figure number, size, location, and features for each required pipe hanger and support.

B. Shop Drawings: Submit manufacturer's assembly-type shop drawings for each type of support and anchor, indicating dimensions, weights, required clearances, and methods of assembly of components.

C. Product certificates signed by the manufacturer of hangers and supports certifying that their products meet the specified requirements.

D. Maintenance Data: Submit maintenance data and parts list for each type of support and anchor. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of Division 23.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:

1. Pipe Hangers and Supports:
   a. B-Line Systems Inc.
   b. ANVIL International
   c. PHD Manufacturing, Inc.
   d. Unistrut Metal Framing Systems
   e. Hubbard Enterprises (Supports for domestic water piping)
   f. Specialty Products Co. (Supports for domestic water piping)
   g. Erico
   h. Grinnell
2. Saddles, Shield and Thermal Shield Inserts:
   a. ANVIL International
   b. Pipe Shields, Inc.
   c. B-Line
   d. Snapp Itz
   e. Erico
   f. Value Engineered Products, Inc.
   g. Grinnell

3. Concrete Inserts and Anchors:
   a. Unistrut Metal Framing Systems
   b. Power-Strut
   c. ITW Ramset/Red Head
   d. Hilti
   e. B-Line
   f. Erico
   g. Grinnell

2.2 PIPE HANGERS & SUPPORTS:

A. Hangers and support components shall be factory fabricated of materials, design, and manufacturer complying with MSS SP-69.

   1. Components shall have galvanized coatings where installed for piping and equipment that will not have field-applied finish.
   2. Pipe attachments shall have nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing.

B. Adjustable Clevis Hanger: MSS Type.

   1. Steel Pipe, size 3/8” thru 30”, Type 1.
   2. Non-insulated Copper Pipe, size 1/2” thru 4”, Type 1. (PVC Coated)
   3. Cast Iron Pipe, size 4” thru 24”, Type 1.

C. Adjustable Swivel Ring for Non-insulated Pipe: MSS Type .

   1. Steel Pipe, size 1/2” thru 8”, Type 7.
   2. Copper Pipe, size 1/2” thru 4”, Type 7 (PVC Coated)

D. Pipe Clamps: MSS Type .

   1. Steel Pipe, size 3/4” thru 24”, Type 8.
   2. Copper Pipe, size 1/2” thru 4”, Type 8 (PVC Coated).

E. U Bolts: MSS Type .

   1. Steel Pipe, size 1/2” thru 30” Type 24
   2. Copper Pipe, size 1/2” thru 8”, Type 24 (PVC Coated).

F. Straps: MSS Type 26.

G. Pipe Stanchion Saddle: MSS Type 37.
H. Yoke & Roller Hanger: MSS Type 43

I. Hanger Rods: Continuous threaded steel, sizes as specified.

J. Hangers:
   1. Hot Pipes:
      a. 1/2" through 1-1/2": Adjustable wrought steel ring.
      b. 2" through 5": Adjustable wrought steel clevis.
      c. 6" and Over: Adjustable steel yoke and cast iron roll.

   2. Cold Pipes:
      a. 1/2" through 1-1/2": Adjustable wrought steel ring.
      b. 2" and Over: Adjustable wrought steel clevis.

   3. Multiple or Trapeze: Structural steel channel (with web vertical and engineered for the specific applications), with welded spacers and hanger rods. Provide cast iron roll and base plate for hot pipe sizes six inches and over. Provide hanger rods one size larger than for largest pipe in trapeze. If the deflection at center of trapeze exceeds 1/360 of the distance between the end hangers, install an additional hanger at mid-span or use a larger channel.

K. Wall Supports for Horizontal Steel Pipe:
   1. ½ inch through 4 inches: Offset or straight j-hook.
   2. 4 inches and Over: Welded steel bracket Type 31, 32 or 33 and wrought steel clamp. Provide adjustable steel yoke and cast iron roll Type 44 for hot pipe 200 degrees F and over and for sizes six inches and over.

L. Supports for Vertical Pipe: Steel riser clamp. Type 8.

M. Upper Attachments:
   1. For attaching hanger rods to structural steel I-beams:
      a. Provide adjustable beam clamp, MSS-Type 21. Attach to bottom flange of beam.

   2. For attaching hanger rods to bar joists:
      a. When bottom chord is constructed of structural steel angles, provide square washer. Place hanger rod between backs of the two angles and support with the washer and dual locking nuts on top of the angles. Spot weld washer to angles.
      b. When bottom chord is constructed of round bars, provide Elcen No. 137 bar joint washer or equal.

2.3 CONCRETE INSERTS AND ANCHORS:

A. Inserts: Case shall be of galvanized carbon steel with square threaded concrete insert nut for hanger rod connection; top lugs for reinforcing rods, nail holes for attaching to forms. This type of upper attachment is to be used for all areas having poured in place concrete construction.

   1. Size inserts to suit threaded hanger rods.
B. Provide fasteners attached to concrete ceilings that are vibration and shock resistant. Provide hangers for piping attached to concrete construction with one of the following types.

1. Concrete insert per MSS SP 69, Type 18.
2. Powder driven fasteners subject to approval of Architect and Structural Engineer. Each fastener shall be capable of holding a test load of 1000 pounds whereas the actual load shall not exceed 50 pounds.
3. Self-drilling expansion shields. The load applied shall not exceed one-fourth the proof test load required.
4. Machine bolt expansion anchor. The load applied shall not exceed one-fourth the proof test load required.

C. Anchors: Carbon steel, zinc plated and coated with a clear chromate finish. Installation shall be in holes drilled with carbide-tipped drill bits or by use of self-drilling anchors.

1. Provide anchors suitable for the location of installation and designed to withstand all forces and movements acting in the anchor. Manufacture pipe anchors in accordance with MSS SP 69. Provide a safety factor of four for the anchor installation.

2.4 SADDLES AND THERMAL SHIELD INSERTS:

A. Protection Saddle: MSS Type 39; fill interior voids with segments of insulation matching adjoining insulation.

B. Protection Shields: MSS Type 40; 180 degrees arc, galvanized steel, minimum 12 inches long, to prevent crushing of insulation.

C. Thermal Shield Inserts: Provide 100-psi minimum compressive strength, waterproof, asbestos free calcium silicate, encased with a sheet metal enclosure. Insert and shield shall cover the entire circumference or the bottom half circumference of the pipe as required by Part 3 of this Specification, and shall be of length recommended by the manufacturer for pipe size and thickness of insulation. For cold piping, calcium silicate shall extend beyond the sheet metal shield to allow overlap of the vapor barrier. Where piping 4 inches and larger is supported on trapeze or pipe rollers, provide double thickness shields. For piping 12 inches and over, provide 600 psi calcium silicate structural insert.

2.5 MISCELLANEOUS MATERIALS:

A. Steel Plates, Shapes, and Bars: ASTM A 36.

B. Heavy-Duty Steel Trapezes: Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS standards.

C. Pipe Alignment Guides: Provide factory-fabricated guides, of cast semi-steel or heavy fabricated steel, consisting of bolted two-section outer cylinder and base with two-section guiding spider bolted tight to pipe. Size guide and spiders to clear pipe and insulation (if any), and cylinder. Provide guides of length recommended by manufacturer to allow indicated travel.

PART 3 - EXECUTION

3.1 INSPECTION:

A. Examine areas and conditions under which supports and anchors are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.
3.2 PREPARATION:

A. Proceed with installation of hangers, supports and anchors only after required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including (but not limited to) proper placement of inserts, anchors and other building structural attachments. Review Structural Drawings to obtain structural support limitations.

B. Prior to installation of hangers, supports, anchors and associated work, Installer shall meet at project site with Contractor, installer of each component of associated work, inspection and testing agency representatives (if any), installers of other work requiring coordination with work of this section and Architect/Engineer for purpose of reviewing material selections and procedures to be followed in performing the work in compliance with requirements specified. Provide Shop Drawing showing method and support locations from structure.

3.3 INSTALLATION OF BUILDING ATTACHMENTS:

A. Install building attachments within concrete or on structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert to forms. Where concrete with compressive strength less than 2500 psi is indicated, install reinforcing bars through openings at top of inserts.

B. Existing Construction:

1. In existing concrete construction, drill into concrete slab and insert and tighten expansion anchor bolt. Connect anchor bolt to hanger rod. Care must be taken in existing concrete construction not to sever reinforcement rods or tension wires.

3.4 INSTALLATION OF HANGERS AND SUPPORTS:

A. Install hangers, supports, clamps and attachments to support piping properly from building structure; comply with MSS SP-69. Arrange for grouping of parallel runs of horizontal piping to be supported together on field fabricated, heavy-duty trapeze hangers where possible. Install supports with maximum spacings complying with MSS SP-69. Where piping of various sizes is supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.

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

C. Support fire-water piping independently from other piping systems.

D. Prevent electrolysis and abrasion in support of copper tubing by use of hangers and supports which are plastic coated, or with EPDM isolation strips. Duct tape or copper coated hangers are not acceptable.

E. Install hangers and supports to allow controlled movement of piping systems, to permit freedom of movement between pipe anchors, to facilitate action of expansion joints, expansion loops, expansion bends and similar units and within 1'-0" of each horizontal elbow.

F. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
G. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ANSI B31.9 Building Services Piping Code is not exceeded.

H. Insulated Piping: Comply with the following installation requirements.
   1. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ANSI B31.
   2. Saddles: Install Protection saddles where supported by pipe rollers. Fill interior voids with segments of insulation that match adjoining pipe insulation.
   3. Shields: Install galvanized steel protection shields, on all insulated piping 2 inches and less, except where required to be clamped. Where necessary to prevent dislocation, strap shield to pipe with wire ties or "Zip Strips".
   4. Thermal Inserts: Provide thermal shield inserts at all supports for all insulated piping over 2 inches and for all piping required to be clamped. Provide 180 percent inserts at clevis and roller hangers. Provide 360 percent inserts for all trapeze and clamped supports.

I. Install horizontal hydronic piping with the following minimum rod sizes and maximum spacing:

<table>
<thead>
<tr>
<th>SIZE (NPS)</th>
<th>MAX. SPAN IN FEET</th>
<th>MIN. ROD SIZE-INCHES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Steel</td>
<td>Copper</td>
</tr>
<tr>
<td>1</td>
<td>7</td>
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</tr>
<tr>
<td>1-1/2</td>
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<tr>
<td>30</td>
<td>33</td>
<td>-</td>
</tr>
</tbody>
</table>

J. Place a hanger within one foot of each horizontal elbow.

K. Use hangers which are vertically adjustable 1-1/2 inch minimum after piping is erected.
L. Support vertical steel and copper piping at every story height but at not more than 15 foot intervals for steel and 10 feet for copper.

M. Where several pipes can be installed in parallel and at same elevation, provide trapeze hangers.

N. Where practical, support riser piping independently of connected horizontal piping.

O. Each pipe drop to equipment shall be adequately supported. All supporting lugs or guides shall be securely anchored to the building structure.

P. Install anchors and fasteners in accordance with manufacturer's recommendations and the following:

1. In the event a self-drilling expansion shield or machine bolt expansion shield is considered to have been installed improperly, the Contractor shall make an acceptable replacement or demonstrate the stability of the anchor by performing an on-site test under which the anchor will be subjected to a load equal to twice the actual load.

2. Powder-driven fasteners may be used only where they will be concealed after the construction is complete. Where an occasional fastener appears to be improperly installed, additional fastener(s) shall be driven nearby (not closer than 6 inches) in undisturbed concrete. Where it is considered that many fasteners are improperly installed, the Contractor shall test load any 50 successively driven fasteners. If 10 percent or more of these fasteners fail, the Contractor shall utilize other fastening means as approved and at no additional cost to the Owner.

3. Hangers for piping and ducts shall be attached to cellular steel floor decks with steel plates and bolted rod conforming to the steel deck manufacturer's requirements. Where the individual hanger load exceeds the capacity of a single floor deck attachment, steel angles, beams or channels shall be provided to span the number of floor deck attachments required.

4. Welding may be used for securing hangers to steel structural members. Welded attachments shall be designed so that the fiber stress at any point of the weld or attachment will not exceed the fiber stress in the hanger rod.

3.5 INSTALLATION OF ANCHORS:

A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ANSI B31.9, and to prevent transfer of loading and stresses to connected equipment.

B. Fabricate and install anchor by welding steel shapes, plates and bars to piping and to structure. Comply with ANSI B31.9 and with AWS Standards D1.1.

C. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions, to control movement to compensators.

D. Anchor Spacings: Where not otherwise indicated, install anchors at ends of principal pipe-runs, at intermediate points in pipe-runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping. Provide shop drawing for review by Engineer.

3.6 EQUIPMENT SUPPORTS:

A. Fabricate structural steel stands to suspend equipment from structure above or support equipment above floor.
B. Concrete bases for the mechanical equipment indoors or outdoors will be provided by the General Contractor only if shown on the architectural or structural drawings. Otherwise, all bases shall be provided by this Contractor.

C. Housekeeping bases shall be 4 inches thick minimum, extended 4 inches beyond machinery bedplates.

D. This Contractor shall be responsible for the proper size and location of all bases and shall furnish all required anchor bolts and sleeves. If bases are provided by the General Contractor, furnish him with templates showing the bolt locations.

E. Equipment shall be secured to the bases with anchor bolts of ample size. Bolts shall have bottom plates and pipe sleeves and shall be securely imbedded in the concrete. This Contractor shall provide lead washers at all equipment anchor bolts.

F. Construct equipment supports above floor of structural steel members or steel pipe and fittings. Brace and fasten with flanges bolted to structure.

G. Provide rigid anchors for pipes immediately after vibration connections to equipment. See also Section 23 05 48 “Vibration and Seismic Controls for Mechanical Piping”.

3.7 METAL FABRICATION:

A. Cut, drill, and fit miscellaneous metal fabrications for pipe anchors and equipment supports. Install and align fabricated anchors in indicated locations.

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 for procedures of manual shielded metal-arc welding, appearance and quality of welds made, methods used in correcting welding work, and 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 contours at welded surfaces match adjacent contours.

3.8 ADJUSTING:

A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe. Cut off the bottom of threaded rods so they are no more than one rod diameter below the bottom nut.

B. Touch-Up Painting: Immediately after erection of anchors and supports, clean field welds and abraded areas of shop paint and paint exposed areas with same material as used for shop painting to comply with SSPC-PA-1 requirements for touch-up of field-painted surfaces.

1. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.

C. For galvanized surfaces clean welds bolted connections and abraded areas and apply galvanizing repair paint to comply with ASTM A 780.

END OF SECTION 23 05 29
SECTION 23 05 40

VIBRATION CONTROL FOR MECHANICAL PIPING & EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

A. Extent of vibration control work required by this section is indicated on drawings and schedules, and/or specified in other Division-23 sections.

B. Types of vibration control products specified in this section include the following:
   1. Fiberglass Pads and Shapes
   2. Neoprene Pads
   3. Neoprene Mountings
   4. Flexible Pipe Connectors

C. Vibration control products furnished as integral part of factory-fabricated equipment are specified as part of equipment assembly in other Division 23 sections.

D. Refer to other Division 23 sections for equipment foundations; hangers; sealants; gaskets; requirements of electrical connections to equipment isolated on vibration control products; requirements of duct connections to air handling equipment isolated on vibration control products.

1.2 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of vibration control products, of type, size, and capacity required, whose products have been in satisfactory use in similar service for not less than 5 years.
   1. Except as otherwise indicated, obtain vibration control products from single manufacturer.
   2. Engage manufacturer to provide technical supervision of installation of support isolation units produced, and of associated inertia bases (if any).

1.3 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of vibration control product. Submit schedule showing size, type, deflection, and location for each product furnished.
   1. Include data for each type and size of unit, showing isolation efficiency, stiffness, natural frequency and transmissibility at lowest operating speed of equipment.
   2. For spring units, show wire size, spring diameter, free height, solid-compression height, operating height, fatigue characteristics, ratio of horizontal to vertical stiffness and bases of spring-rated selection for range of loading weights.
   3. Include performance certifications from manufacturers.

B. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weights, required clearances, and method of assembly of components. Detail bases, and show location of equipment anchoring points, coordinated with equipment manufacturer's shop drawings.
   1. Shop drawings showing structural design and details of inertia bases, steel beam bases and other custom-fabricated work not covered by manufacturer's submitted data.
a. Furnish templates, anchor bolts and sleeve for equipment bases, foundations and other support systems for coordination of vibration isolation units with other work.

2. Submit shop drawings indicating scope of vibration isolation work and locations of units and flexible connections. Include support isolation points for piping and ductwork including risers, air housings and inertia bases.

a. Include schedule of units, showing size or manufacturer's part number, and weight supported and resulting deflection of each unit.

C. Maintenance Data: Submit maintenance data for each type of vibration control product. Include this data, product data and shop drawings in maintenance manual; in accordance with requirements of Divisions 23.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:

1. Vibration Control Products:

   a. Amber/Booth Company, Inc.
   b. Kinetics Noise Control
   c. Mason Industries, Inc.
   d. Peabody Noise Control, Inc.

2.2 VIBRATION CONTROL MATERIALS AND SUPPORT UNITS:

A. Fiberglass Pads and Shapes: Glass fiber of not more than 0.18 mil diameter, produced by multiple-flame attenuation process, molded with manufacturer's standard fillers and binders through 10 compression cycles at 3 times rated load bearing capacity, to achieve natural frequency of not more than 12 Hertz, in thicknesses and shapes required for use in vibration isolation units.

B. Neoprene Pads: Oil-resistant neoprene sheets of manufacturer's standard hardness and cross-ribbed or waffled pattern.

   1. Mason Industries Type W.

C. Neoprene Mountings: Provide neoprene mountings consisting of neoprene element bonded between 2 steel plates that are neoprene-covered to prevent corrosion. Provide minimum rated deflection of 0.35 inches. Provide threaded hole in upper plate and 2 holes in base plate for securing to equipment and to substrate.

   1. Mason Industries Type ND.
   2. Mason Industries Type SLR.

D. Flexible Pipe Connectors:

   1. For non-ferrous piping, provide bronze hose covered with bronze wire braid with copper tube ends or bronze flanged ends, braze-welded to hose.
   2. Mason Industries Type BBF.

a. For ferrous piping, provide stainless steel hose covered with stainless steel wire braid with NPT steel nipples or 150 psi ANSI flanges, welded to hose.
1) Mason Industries Type BSS.

PART 3 - EXECUTION

3.1 INSPECTION:

A. Examine areas and conditions under which vibration control units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Owner or his representative.

3.2 PERFORMANCE OF ISOLATORS:

A. General: Comply with minimum static deflections recommended by ASHRAE, for selection and application of vibration isolation materials and units as indicated.

B. Manufacturer's Recommendations: Except as otherwise indicated, comply with manufacturer's recommendations for selection and application of vibration isolation materials and units to achieve minimum static deflection and displacement requirements.

3.3 APPLICATIONS:

A. General: Except as otherwise indicated, select vibration control products in accordance with ASHRAE Applications Handbook 2015, Table 47, Chapter 48 – Noise and Vibration Control.

B. Piping: For piping connected to equipment mounted on vibration control products, install isolation hangers Type N, as indicated, and for first 3 points of support for pipe sizes 4 inches and less, for first 4 points of support for pipe sizes 6 inches through 8 inches, and for first 6 points of support for pipe sizes 10 inches and over.

3.4 INSTALLATION:

A. General: Except as otherwise indicated, comply with manufacturer's instructions for installation and load application to vibration isolation materials and units. Adjust to ensure that units do not exceed rated operating deflections or bottom out under loading, and are not short-circuited by other contacts or bearing points. Remove space blocks and similar devices (if any) intended for temporary protection against overloading during installation.

B. Install units between substrate and equipment as required for secure operation and to prevent displacement by normal forces.

C. Adjust leveling devices as required to distribute loading uniformly onto isolators. Shim units as required where substrate is not level.

D. Flexible Pipe Connectors: Install on equipment side of shutoff valves, horizontally and parallel to equipment shafts wherever possible.

3.5 EXAMINATION OF RELATED WORK:

A. Installer of vibration isolation work shall observe installation of other work related to vibration isolation work, including work connected to vibration isolation work; and, after completion of other related work (but before equipment startup), shall furnish written report to Engineer listing observed inadequacies for proper operation and performance of vibration isolation work. Report shall cover, but not necessarily be limited to the following:

1. Equipment installations (performed as work of other sections) on vibration isolators.
2. Piping connections including flexible connections.
3. Passage of piping and ductwork which is to be isolated through walls and floors.

B. Do not start-up equipment until inadequacies have been corrected in manner acceptable to vibration isolation installer.

3.6 ADJUSTING AND CLEANING:

A. Clean each vibration control unit, and verify that each is working freely, and that there is no dirt or debris in immediate vicinity of unit that could possibly short-circuit unit isolation.

3.7 DEFLECTION MEASUREMENTS:

A. Upon completion of vibration isolation work, prepare report showing measured equipment deflections theoretical floor deflection and isolation efficiency for each major item of equipment.

PART 4 - SCHEDULES

4.1 EQUIPMENT VIBRATION ISOLATION TABLE:

A. The following Base and Isolator Types are for these tables only. Refer to Part 2 and Part 3 for additional information.

Base Type Legend:
A = No base, isolators attached directly to equipment
B = Structural steel rails or base
C = Concrete inertia base
D = Curb-mounted base

Isolator Type Legend:
1 = Pad, rubber or glass fiber
2 = Rubber floor isolator or hanger
3 = Spring floor isolator or hanger
4 = Restrained spring isolator
5 = Thrust restraint

<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>Slab On Grade</th>
<th>Up To 20-FT Floor Span</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Base Type</td>
<td>Isol Type</td>
</tr>
<tr>
<td>Pumps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inline, Vertical, 5 thru 25 HP</td>
<td>N/A</td>
<td>1</td>
</tr>
<tr>
<td>Cooling Towers and Fluid Coolers</td>
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</tr>
<tr>
<td>501 rpm and faster</td>
<td>A</td>
<td>1</td>
</tr>
</tbody>
</table>

END OF SECTION 23 05 40
SECTION 23 05 53
IDENTIFICATION FOR MECHANICAL SYSTEMS

PART 1 - GENERAL

1.1 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacturer of identification devices of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:
1. ANSI Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

1.2 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data and installation instructions for each identification material and device required.

B. Schedules: Submit valve schedule for each piping system, typewritten and reproduced on 8-1/2 x 11" bond paper. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), size of valve, and variations for identification (if any). Only tag valves which are intended for emergency shut-off and similar special uses, such as valve to isolate individual system risers, individual floor branches or building system shut off valves. In addition to mounted copies, furnish extra copies for Maintenance Manuals as specified in Division 23.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:

B. Mechanical Identification:
1. Allen Systems, Inc.
4. Industrial Safety Supply Co., Inc.
5. Seton Name Plate Corp.
6. PVC Specialties
7. Marking Systems, Inc. (MSI)

2.2 MECHANICAL IDENTIFICATION MATERIALS:

A. General: Provide manufacturer's standard products of categories and types required for each application as referenced in other Division-23 sections. Where more than single type is specified for application, selection is Installer's option, but provide single selection for each product category.
2.3 PAINTED IDENTIFICATION MATERIALS:

A. Stencils: Standard fiberboard stencils, prepared for required applications with letter sizes generally complying with recommendations of ANSI A13.1 for piping or to match existing size in existing building, but not less than 1-1/4" high letters for ductwork and not less than 3/4" high letters for access door signs and similar operational instructions.

B. Stencil Paint: Standard exterior type stenciling enamel; black, except as otherwise indicated; either brushing grade or pressurized spray-can form and grade.

C. Identification Paint: Standard identification enamel of colors indicated or, if not otherwise indicated comply with ANSI A13.1 for colors or to match existing building standard identification.

2.4 PLASTIC PIPE MARKERS:

A. Snap-On Type: Provide manufacturer's standard pre-printed, semi-rigid snap-on, color-coded pipe markers, complying with ANSI A13.1.

B. Insulation: Furnish 1 inch thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125 degrees F. (52 degrees C.) or greater. Cut length to extend 2 inches beyond each end of plastic pipe marker.

C. Small Pipes: For external diameters less than 6 inches (including insulation if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:
   1. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.
   2. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 3/4 inch wide; full circle at both ends of pipe marker, tape lapped 1-1/2 inches.

D. Large Pipes: For external diameters of 6 inches and larger (including insulation if any), provide either full-band or strip-type pipe markers, but not narrower than 3 times letter height (and of required length), fastened by one of the following methods:
   1. Steel spring or non-metallic fasteners.
   2. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 1-1/2 inches wide; full circle at both ends of pipe marker, tape lapped 3 inches.
   3. Strapped-to-pipe (or insulation) application of semi-rigid type, with manufacturer's standard stainless steel bands.

E. Lettering: Comply with piping system nomenclature as specified, scheduled, shown, or to match existing building lettering nomenclature system and abbreviate only as necessary for each application length.

F. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastic.

2.5 PLASTIC TAPE:

A. General: Provide manufacturer's standard color-coded pressure-sensitive (self-adhesive) vinyl tape, not less than 3 mils thick.

B. Width: Provide 1-1/2 inches wide tape markers on pipes with outside diameters (including insulation, if any) of less than 6 inches, 2-1/2 inches wide tape for larger pipes.
C. Color: Comply with ANSI A13.1, except where another color selection is indicated.

2.6 VALVE TAGS:
A. Brass Valve Tags: Provide 19-gage polished brass valve tags with stamp-engraved piping system abbreviation in 1/4-inch high letters and sequenced valve numbers 1/2-inch high, and with 5/32-inch hole for fastener.
   1. Provide 1-1/2-inch diameter tags, except as otherwise indicated.
   2. Fill tag engraving with black enamel.
B. Valve Tag Fasteners: Provide manufacturer's standard solid brass chain (wire link or beaded type), and solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.

2.7 VALVE SCHEDULE FRAMES:
A. General: For each page of valve schedule, provide glazed display frame, with screws for removable mounting on masonry walls. Provide frames of finished hardwood or extruded aluminum, with non-glare type sheet glass.

2.8 ENGRAVED PLASTIC-LAMINATE SIGNS:
A. General: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in the sizes and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black with white core (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
B. Thickness: 1/16-inch, except as otherwise indicated.
C. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.

2.9 PLASTICIZED TAGS:
A. General: Manufacturer's standard pre-printed or partially pre-printed accident-prevention tags, of plasticized card stock with matt finish suitable for writing, approximately 3-1/4-inch x 5-5/8-inch, with brass grommets and wire fasteners, and with appropriate pre-printed wording including large-size primary wording (as examples; DANGER, CAUTION, DO NOT OPERATE).

2.10 LETTERING AND GRAPHICS:
A. General: Coordinate names, abbreviations and other designations used in mechanical identification work, with corresponding designations shown, specified, scheduled and approved by the Owner/Engineer. Provide numbers, lettering and wording as indicated and approved by the Owner/Engineer for proper identification and operation/maintenance of mechanical systems and equipment.
B. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as designated on the drawings or schedule as well as service.
PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS:

A. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

3.2 PIPING SYSTEM IDENTIFICATION:

A. General: Install pipe markers of the following type on each system indicated to receive identification, and include arrows to show normal direction of flow. Existing building identification shall match the existing method which exists in the building.

B. Plastic pipe markers, with application system as indicated under "Materials" in this section. Install on pipe insulation segment where required for hot non-insulated pipes.

C. Locate pipe markers and color bands as follows wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations.

D. Near each valve and control device.

E. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.

F. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.

G. At access doors, manholes and similar access points which permit view of concealed piping.

H. Near major equipment items and other points of origination and termination.

I. Spaced intermittently at maximum spacing of 25 feet along each piping run, except reduce spacing to 15' in congested areas of piping and equipment.

J. On piping above removable acoustical ceilings.

3.3 VALVE IDENTIFICATION:

A. General: Provide valve tag on valves in each piping system. List each tagged valve in valve schedule for each piping system.

1. Building services main shut-off valves.
2. Each individual system main shut-off valves.
3. Each individual system by-pass shut-off valves.
4. Each individual system major branch shut-off valves.

B. Mount valve schedule frames and schedules in mechanical equipment rooms where directed by Owner.

C. Where more than one major mechanical equipment room is shown for project, install mounted valve schedule in each major mechanical equipment room, and repeat only main valves which are to be operated in conjunction with operations of more than single mechanical equipment room.
3.4 MECHANICAL EQUIPMENT IDENTIFICATION:

A. General: Install minimum 2 inch x 4 inch engraved plastic laminate equipment marker on each individual items of mechanical equipment. Provide marker for the following general categories of equipment.

1. Main building systems control and operating valves, including safety devices and hazardous units such as gas outlets.
2. Room thermostats, except gun tag labels are acceptable for room thermostats.
3. Fuel-burning units including boilers, furnaces, heaters, stills and absorption chillers.
4. Pumps, compressors, chillers, condensers and similar motor-driven units.
5. Heat exchangers, cooling towers, heat recovery units and similar equipment.
6. Fans and blowers.
7. Air terminal units.
8. Tanks and pressure vessels.
9. Water treatment systems and similar equipment.

B. Lettering Size: Minimum 1/4 inch high lettering for name of unit.

C. Text of Signs: In addition to the identified unit, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

D. Hand-Lettered Equipment Identification Option: If proposed to and accepted by the Owner in writing, the Contractor shall have the option of providing hand-lettered equipment identification above accessible ceilings for the following equipment:

1. Air Terminal Units: Identification shall be provided on left and right sides and on the bottom of the unit. Letters shall be clear and concise, minimum 1” high, in color contrasting with that of the unit.

3.5 ADJUSTING AND CLEANING:

A. Adjusting: Relocate any mechanical identification device which has become visually blocked by work of this division or other divisions.

B. Cleaning: Clean face of identification devices, and glass frames of valve charts.

END OF SECTION 23 05 53
PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

A. This section covers testing and balancing of environmental systems described herein and specified under Division 23. The testing and balancing of all environmental systems shall be the responsibility of one Testing, Balancing and Adjusting firm.

1. Test, adjust and balance the following mechanical systems and the mechanical equipment associated with these systems:

   b. Hydronic Systems and Equipment
      1) Heating/Chilled water systems
      2) Water-side Economizer water systems
      3) Heat Exchangers
      4) Hydronic Pumps
      5) Heating Water Boilers
      6) Water Treatment systems
      7) Glycol systems
   c. Electrical Components
      1) Electric resistance heating
      2) Manual and magnetic starters
      3) Variable frequency drives
   d. Control Systems and Equipment
      1) General

1.2 QUALIFICATIONS OF CONTRACTOR:

A. The Mechanical Contractor shall procure the services of an independent testing and balancing agency specializing in the testing, adjusting and balancing of environmental systems to perform the above mentioned work. An independent contractor is defined as an organization that is not engaged in engineering design or is not a division of a mechanical contractor entity, which installs mechanical systems.

B. The actual fieldwork shall be performed by qualified technicians who are currently certified by the Testing, Adjusting and Balancing Bureau (TABB), the National Environmental Balancing Bureau (NEBB), or the Associated Air Balance Council (AABC) certification agencies.

C. The Testing & Balancing Contractor shall have a minimum of three years experience in testing and balancing mechanical systems.
1.3 APPROVAL OF CONTRACTOR:

A. The following firms are preferred contractors to complete the work. Any Testing and Balancing firm desiring to offer their services for this work and who are not listed below, shall submit their qualifications to the Engineer, not less than [seven (7)] working days before the bid date. Approval or disapproval will be given on each request and this action will be given in writing prior to bidding the work.

1. Griffith Engineering
2. Complete Mechanical Balancing
3. JPG Engineering
4. Lawrence H. Finn & Assoc.
5. TAB Services, Inc.

B. Firms who are not listed, or who have not received prior approval shall not be approved to complete work on this project.

1.4 CODES AND STANDARDS:


1.5 PRELIMINARY SUBMITTALS:

A. Within ten (10) days of award of the contract the Mechanical Contractor shall submit the name of the Test and Balance Contractor who will be performing the work. The submittal shall include a complete list of all technicians who will be performing the field work and include a photocopy of their current certification by either NEBB, AABC, or TABB certification agencies. Only those technicians included in the submittal shall perform the work. Any personnel or staff used to perform the work without prior approval of the Engineer, who are not included in the submittal, shall be grounds for rejecting the test and balance report and the project in whole.

B. Meet all requirements of Section 23 05 00 “Common Work Results for Mechanical” as applicable.

C. Submit a list of all instrumentation to be used on an individual project and include calibration dates. Submit calibration curves. If more than one instrument of a similar type is used, a comparison of individual readings should be made. The variation between instrument readings should not exceed plus or minus 5%.

1.6 FINAL REPORTS:

A. Refer to Division 1 for supplemental requirements.

B. The Testing and Balancing Contractor shall submit electronic copy of the final testing and balancing report at least fifteen (15) calendar days prior to substantial completion, unless noted otherwise in Division 1. Report contents shall be per Part 3 of this Section.

C. Meet all requirements of Section 23 05 00 “Common Work Results for Mechanical” as applicable.

D. If more than two reports are made by the contractor, the Owner reserves the right to charge the contractor for subsequent reviews by their consultants. Such extra fees shall be deducted from payments by the Owner to the contractor.
1.7 SEQUENCING AND SCHEDULING:

A. Notify Contractor/Engineer/Architect in writing of conditions detrimental to the proper completion of the test and balance work. Provide the Contractor/Architect/Engineer with a copy of the notification.

B. Prepare a project schedule. Schedule shall indicate critical path of the balancing process and shall incorporate both requirements of other contractors necessary to meet test and balance commitments and process flow of test and balance work. Coordinate with general and mechanical contractors and insert critical steps into project master schedule.

PART 2 - PRODUCTS

2.1 BELTS, SHEAVES, IMPPELLERS:

A. Refer to specific equipment sections and Section 23 05 00 “Common Work Results for Mechanical” for additional requirements.

B. The Testing & Balancing Contractor shall coordinate with the Mechanical Contractor to supply correctly sized drive belts and sheaves. Impellers shall be trimmed or replaced by the mechanical contractor and shall be correctly re-sized and coordinated by the Test and Balancing Contractor per the hydronic systems and equipment portion of this section.

PART 3 - EXECUTION

3.1 PRELIMINARY PROCEDURES:

A. Testing and balancing shall not begin until the system has been completed and is in full working order and the following project conditions have been determined suitable for start of work.

1. Preliminary Testing & Balancing Contractor requirements shall be ascertained prior to the commencement of work through a review of the project plans and specifications. In addition, visual observations at the site during construction shall be made to determine the location of required balancing devices, that they are being installed properly, and in an accessible location for the need. Report in writing any deficiencies to the Contractor/Engineer/Architect immediately.

2. Before any air balance work is done, the system shall be checked for duct leakage (obtain pressure test results), assure filters are installed, verify filters are changed if they are dirty, check for correct fan rotation, equipment vibration, and check automatic dampers for proper operation. All volume control dampers and outlets shall be wide open at this time.

3. Before any Hydronic, domestic water or applicable system balancing work is done, the systems shall be checked for plugged strainers, proper pump rotation, proper control valve installation and operation, air locks, proper system static pressure to assure a full system, proper flow meter and check valve installation. All throttling devices and control valves shall be open at this time.

4. Verify systems do not exhibit excessive sound and/or vibration levels. Report in writing any deficiencies to the Contractor/Engineer/Architect immediately.

3.2 GENERAL SYSTEM AND EQUIPMENT PROCEDURES:

A. Balance all water flows within +10% to -5% of design flow quantities. Notify Contractor/Engineer/Architect in writing of conditions detrimental to the proper completion of the test and balance work. Provide the Contractor/Architect/Engineer with a copy of the notification.
B. Mark equipment settings with paint, balancing cocks, circuit setters, valve indicators, pump speed control settings and similar controls and devices, to show final settings at completion of test-adjust-balance work.

C. Patch holes in insulation which have been cut for test purposes, in a manner recommend by the original installer.

D. Measure, adjust and report equipment running motor amps and power factor, KW, rated motor amperage, listed motor power factor, voltage, and all nameplate data. Perform these measurements for all equipment operational modes.

E. Check keyway and setscrew tightness. Report any loose screws and notify Mechanical Contractor prior to equipment balancing.

F. Record and include in report all equipment nameplate data.

G. Verify that all equipment safety and operating controls are in place, tested, adjusted and set prior to balancing.

H. Verify that manufacturer start-up has occurred per specification prior to balancing.

3.3 HYDRONIC SYSTEMS AND EQUIPMENT:

A. Heating water systems:

1. Hydronic Systems with Meters: The system shall be balanced proportionally using the flow meters. On completion of the balance, the following information shall be recorded in the report: Flow meter size and brand, required flow rate and pressure drop, valve settings on meters with a readable scale, flow rate in both full coil flow and full bypass modes. Contractor shall verify the meters are installed per the manufacturer's recommendations and shall notify the Mechanical Contractor of any deficiencies before utilizing meter.

2. Hydronic Systems without Meters (thermal or terminal rated pressure drop balance): The system shall be balanced proportionally to the terminal ratings. On completion of the balance the following information shall be recorded in the report: Design entering and leaving water temperature/pressure, final balanced entering and leaving water temperature/pressure drop.

3. For 3-way valve terminals/heat exchangers, set bypass flow to equal coil flow.

B. Hydronic Pumps:

1. Adjust and balance pumps to provide design system flow rate, and design flow to most remote system location. Trim or replace impellers as necessary to achieve this. Do not induce false head to achieve balance results, without the prior approval of the Engineer. See Part 2 - “Products” of this section.

   a. Prior to trimming of impellers, notify the Architect/Contractor/Engineer in writing of performance of pumps with and without false head induced.

2. Report impeller size, flow rate, inlet and outlet water pressure and pump shut-off head. Provide pump curve and operating point in final report. Include compensations for temperature and percentage glycol.

3.4 ELECTRICAL COMPONENTS ASSOCIATED WITH MECHANICAL SYSTEMS:

A. Manual and Magnetic Starters:
1. Check all new and existing thermal overloads. Identify improperly protected equipment in report. Furnish and exchange thermals as required for proper motor protection.


3. Two-speed Starters: In addition to the above, set time delay between changes of speeds for proper operation.
   a. Verify windings of motor and starter is compatible prior to starting any equipment.

B. Variable frequency drives.
   1. Coordinate balance process with equipment manufacturer start-up representative.
   2. Record nameplate data.
   3. Record motor overload setting.
   4. Record full load amps.

3.5 CONTROL SYSTEMS AND EQUIPMENT:

A. General:
   1. Operate all temperature control systems with the temperature control contractor's representative for proper sequence of operation. Be responsible for calibration of flow measurement devices used as input to the temperature control system. All air system flow measurement stations including VAV terminals shall be calibrated against a Pitot tube traverse or air diffuser capture hood. Balancing Contractor shall assure accuracy of all flow measurement devices or shall report their failure to be accurate.
   2. Work with the Controls Contractor to set minimum outside air damper positions.
   3. Work with the Controls Contractor to optimize VAV duct static pressure, VFD pump hydronic system pressure differential and building pressure.

3.6 SOUND AND VIBRATION:

A. Sound Inspection and Testing:
   1. Prior to sound testing, all equipment that can potentially impact sound testing shall be put into operation. Examples include fan coil units, humidifiers, air handling units, and equipment in adjacent mechanical spaces. VFD systems shall be placed at 80% of full speed.
   2. Prior to sound testing the mechanical test and balance of all systems shall be completed.
   3. Report audible tonal characteristics such as whine, whistle, hum or rumble. Also report time varying sound levels or beats induced from aerodynamic instability, perform this for all rooms.

B. Vibration Inspection and Testing:
   1. Prior to vibration testing, all equipment shall be put into operation. On variable speed equipment, testing shall occur at low, medium and high speeds.
   2. Prior to vibration testing, the mechanical test and balance of all systems shall be completed.
   3. Report excessive vibrations from any equipment. Inspect upstream and downstream duct and piping systems and report excessive vibrations.

3.7 REPORT OF WORK:

A. The Testing and Balancing Contractor shall submit six (6) bound copies of the final testing and balancing report at least fifteen (15) calendar days prior to the Mechanical Contractor's request for final inspection.
B. A complete reduced set of mechanical contract drawings (showing each system) shall be included in the report with all equipment, flow measuring devices, terminals (outlets, inlets, coils, fan coil units, schedules, etc.) clearly marked and all equipment designated. The test and balance contractor can obtain drawing files from Cator, Ruma, & Associates for development of these drawings.

C. Data shall be reported per Part 3 of this Section on standard NEBB forms. Generate custom forms that contain the information in this Section when a standard NEBB form does not exist for a piece of equipment. All NEBB forms shall be fully filled out for this report. When additional information is required by this Section, it shall be provided.

D. The report shall include a list of all equipment used in the testing and balancing work.

E. Report systems for excessive sound and vibration per the sound and vibration inspection and testing portions of this specification.

F. Substantial completion of this project will not take place until a satisfactory report is received. The Testing & Balancing Contractor shall respond and correct all deficiencies within seven (7) days of receiving the Engineer’s written review of the balancing report. Failure to comply will result in holding retainage of the final payment until all items have been corrected to the satisfaction of the Engineer.

G. The report shall be signed by the supervising registered professional engineer and affixed with their registration stamp, signed and dated in accordance with state law.

3.8 GUARANTEE OF WORK:

A. The Testing & Balancing Contractor shall guarantee the accuracy of the tests and balance for a period of 90 days from date of final acceptance of the test and balance report. During this period, the Testing & Balancing Contractor shall make personnel available at no cost to the Owner to correct deficiencies that may become apparent in the system balance.

END OF SECTION 23 05 93
SECTION 23 07 00

INSULATION FOR MECHANICAL SYSTEMS

PART 1 - GENERAL

1.1 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of mechanical insulation products and systems, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.

B. Installer's Qualifications: Firm with at least 5 years successful installation experience on projects with mechanical insulations similar to that required for this project.

C. Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 (NFPA 255) method. In addition, the products, when tested, shall not drip flame particles, and flame shall not be progressive. Provide Underwriters Laboratories Inc. label or listing, or satisfactory certified test report from an approved testing laboratory to prove that fire hazard ratings for materials proposed for use do not exceed those specified.

D. Definitions

1. ASJ: All Surface Jacket.
2. FSK: Foil Scrim Kraft.
3. MRT: Mean Temperature Rating.
4. NRTL: Nationally Recognized Testing Laboratory
5. PCF: Pounds per Cubic Foot.
6. PSF: Pounds per Square Foot.

E. Codes and Standards:

1. ASHRAE 90.1, latest edition.

1.2 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, k-value, thickness, density, and furnished accessories for each mechanical system requiring insulation. Submit detail product information and installation information for all jacketing systems specified in this section.

1.3 DELIVERY, STORAGE, AND HANDLING:

A. Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with manufacturer's stamp or label, affixed showing fire hazard indexes of products.

B. Protect insulation against dirt, water, and chemical and mechanical damage. Do not install damaged or wet insulation; remove from project site.
PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Manufacturer: Subject to compliance with requirements, provide product by one of the following:

1. Mechanical Insulation:
   a. Johns Manville Corp.
   b. Owens-Corning Fiberglas Corp.
   c. Knauf Fiber Glass
   d. Manson
   e. CertainTeed
   f. Einsulation
   g. Armacell
   h. Pittsburgh Corning Corp.
   i. Aeroflex.
   j. PABCO, Inc.
   k. Rubatex Corp.
   l. Thermal Structures

2. Jacketing & Covering Products:
   a. Childers
   b. Ceel-Co
   c. Zeston
   d. Alpha Associates, Inc.
   e. Venture Tape
   f. Polyguard

2.2 PIPING INSULATION MATERIALS:

A. Fiberglass Piping Insulation: ASTM C 547, Class 1 unless otherwise indicated. Jacket with tensile strength of 35 lbs/in, mullen burst 70 psi, Beach Units puncture 50 oz. in/in, permeability 0.02 perm factory applied vapor barrier jacket and adhesive self-sealing lap joint. “K” factor shall be maximum 0.23 at 75°F MRT, 0.24 at 100°F MRT, 0.29 at 200°F MRT and 0.36 at 300°F MRT.

B. Cellular Glass Piping Insulation: ASTM C 552, Type II, Class 2. Permeability of 0.00 perm. Preformed pipe insulation with factory-applied all-service jacket with self-sealing lap. “K” factor shall be maximum 0.28 at 50°F MRT, 0.29 at 75°F MRT, 0.31 at 100°F MRT, 0.38 at 200°F MRT and 0.45 at 300°F MRT.

C. Flexible Elastomeric, Closed Cell Piping Insulation: ASTM C 534, Type I. Water vapor permeability of 0.10 perm inches or less. Insulation shall be pre-installed on piping, or un-slit to be slipped over piping as a single piece. “K” factor shall be maximum 0.245 at 50°F MRT, 0.25 at 75°F MRT and 0.26 at 90°F MRT.

D. Jackets for Piping Insulation: ASTM C 921, Type I for piping with temperatures below ambient, Type II for piping with temperatures above ambient. Type I may be used for all piping at Installers option.

1. Fitting Covers: UV resistant PVC, pre-molded fitting covers, flame spread 25, smoke developed 50. PVC tape for cold systems, serrated tacks or PVC tape for hot systems.

insulation cladding and jacketing applications. Superior resistance to weathering, mold, UV, and extreme environmental conditions.

a. Product thickness (flat): 17.5 mils  
b. Product Thickness (embossed): 24.0 mils  
c. Peel Adhesion: 100 oz/in  
d. Tensile Strength: 187 lb/in  
e. Puncture: 68 lbs  
f. Water Vapor Transmission Rate (ASTM E96): 0.0  
g. Service Temperature: -94 to 248 °F  
h. VentureTape 1579GCW-E (VentureClad Plus) or equivalent.

3. Aluminum Jacketing: Manufactured from T3003 (or T/5005) H14 to H19 aluminum alloy with 3/16" corrugations and shall have a factory attached 1 mil thick polyethylene moisture barrier continuously laminated across the full width of the jacketing. Jacketing shall be 0.016" thick minimum. Provide matching factory fabricated covers for 90-degree and 45-degree elbows, tee fittings, flange fittings valve bodies, blind ends, reducers and other fittings necessary to make the covering system complete, waterproof and weatherproof. All jacketing shall be color coated baked on polyester finish, color selected by Architect.

4. PVC Jacketing: UV resistant PVC, 30 mil thick, flame spread 25, smoke developed 50, factory cut and curled to fit outside diameter of insulated pipe. Solvent weld adhesive for sealing joints and seams.

5. Rubber/Tedlar Jacketing: ASTM-D-1424-63, ASTM-D-774, and ASTM-E-84, manufactured from a combination of heavy fiberglass fabric coated with Hypalon Rubber, fully cured and laminated to a Tedlar facing. Jacketing will also be required to be vapor barrier and shall be laminated to a corrosion resistant aluminized Mylar. Jacketing shall be .010" thick minimum, UL Class I rated, acid and alkali resistant, and be both washable and paintable. Provide factory fabricated aluminum fitting covers with mil-polyethylene vapor barrier for all elbows, tees, flanges, valves, and other fittings. Alpha Associates Style TGH-1000 or equal.

6. Cloth Jacketing Material: Not less than 8 oz. per square yard with adhesives, cement and sealer as recommended by insulation manufacturer for the intended application. PVC premolded fitting covers shall not be provided.

E. Staples, Bands, Wires, and Cement: As recommended by insulation manufacturer for applications indicated.

F. Adhesives, Sealers, and Protective Finishes: As recommended by insulation manufacturer for applications indicated and additional finishes as specified.

2.3 EQUIPMENT INSULATION MATERIALS:

A. Flexible Fiberglass Equipment Insulation: ASTM C 553, Type I, "K" factor shall be maximum 0.45 at 250 °F mean temperature. 850 °F temperature limit.

B. Flexible Closed Cell Elastomeric Insulation: ASTM C534, Type I, "K" valve shall be a maximum of 0.27 at 75 °F mean temp, 220 °F temperature limit, water vapor permeability of 0.10 perm inches or less.

C. Jacketing Material for Equipment Insulation: Provide pre-sized glass cloth jacketing material, not less than 7.8 ounces per square yard, or metal jacket at Installer's option, except as otherwise indicated.
D. Equipment Insulation Compounds: Provide adhesives, cements, sealers, mastics and protective finishes as recommended by insulation manufacturer for applications indicated.

E. Equipment Insulation Accessories: Provide staples, bands, wire, wire netting, tape, corner angles, anchors and stud pins as recommended by insulation manufacturer for applications indicated.

PART 3 - EXECUTION

3.1 MINIMUM INSULATION REQUIREMENTS

A. All mechanical systems shall be insulated in accordance with the locally adopted energy codes or the requirements of this specification section, whichever is more stringent.

3.2 GENERAL:

A. Examine areas and conditions under which mechanical insulation is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

B. Insulation shall be installed to allow maintenance and replacement of system components without compromising the insulation integrity or vapor barrier on cold systems.

C. Workmanship shall be first class and of the highest quality, poor installation or bad appearance as determined by the engineer shall be due cause to reject the entire project in whole and retainage will be withheld until corrective action is completed to the engineer's satisfaction.

3.3 HVAC PIPING SYSTEM INSULATION:

A. Insulation Omitted: Omit insulation on steam condensate piping between steam trap and union; and on hot piping unions, flexible connections, and expansion joints. Insulation may be omitted inside of cabinet unit heaters, convectors and fan coils for hot piping. Cold piping insulation inside fan coil unit cabinet may be omitted provided piping is located over drain pan. Hot and cold piping routed inside air handler units shall be insulated. Omit insulation on strainers in heating water strainers operating below 200°F.

B. Heat Traced Piping:

1. Application Requirements: Insulate the following piping systems:

   a. Piping exposed to freezing which is specified with heat tracing cable.

2. Insulate each piping system specified above with the following types and thicknesses of insulation:

   a. 1 inch thicker than the insulation required than required by other portion of this specification.

C. Cold Piping for Condensation Control:

1. Application Requirements: Insulate the following cold plumbing piping systems:

   a. Potable and non-potable cold water piping
   b. Soft water piping

2. Insulate each piping system specified above with the following types and thicknesses of insulation:
a. Above Ground, Inside Building, Fiberglass; 1/2 inch thick.

D. Cold Piping for Thermal Control (40-60°F)
1. Application Requirements: Insulate the following plumbing piping systems:
   a. Soft water piping
   b. Chilled water supply and return piping
   c. Water-side economizer supply and return piping
2. Insulate each piping system specified above with the following types and thicknesses of insulation:
   a. Above Ground, Inside Building, Fiberglass:
      1) 1/2 inch thick insulation on pipe sizes 1-1/4 inch and smaller.
      2) 1 inch thick insulation on pipe sizes 1-1/2 inch and larger.
   b. Above Ground, Outside Building, Cellular Glass:
      1) 1 inch thick insulation on pipe sizes 1-1/4 inch and smaller.
      2) 1.5 inch thick insulation on pipe sizes 1-1/2 inch and larger.

E. Heating System Piping (105 to 200°F):
1. Application Requirements: Insulate the following piping systems:
   a. Hot water supply and return piping.
2. Insulate each piping system specified above with the following type and thicknesses of insulation:
   a. Above Ground, Inside Building, Fiberglass:
      1) 1.5 inch thick insulation on pipe sizes 1-1/4 inch and smaller.
      2) 2 inch thick insulation on pipe sizes 1-1/2 inch and larger.
   b. Above Ground, Exterior, Cellular Glass:
      1) 2 inch thick insulation on pipe sizes 1-1/4 inch and smaller.
      2) 2.5 inch thick insulation on pipe sizes 1-1/2 inch and larger.

F. Piping Installed in Vaults, Pits, Manholes, Trenches and Other Locations Where Moisture Problems May Exist:
1. Heating System Piping (105 to 200°F):
   a. Flexible Elastomeric, 1.5 inch thick insulation on pipe sizes smaller than 1.5 inch.
   b. Flexible Elastomeric, 2 thick insulation on pipe sizes 1.5 inch and larger.

3.4 EQUIPMENT INSULATION:

A. Hot Equipment:
1. Application Requirements: Insulate the following equipment:
   a. Hot water pumps.

2. Insulate each item of equipment specified above with the following types and thicknesses of insulation:
   1) Temperature Range 105 to 200°F, Rigid or Semi-Rigid Fiberglass insulation: 2 inch thick.

3.5 INSTALLATION OF PIPING INSULATION:

   A. General: Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.

   B. Install insulation on pipe systems subsequent to installation of heat tracing, testing, and acceptance of tests.

   C. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps abutting each other.

   D. Clean and dry pipe surfaces prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.

   E. Maintain integrity of vapor-barrier jackets on cold pipe insulation, and protect to prevent puncture or other damage.
      1. Do not use staples or tacks on vapor barrier jackets.
      2. Seal vapor barrier penetrations with vapor barrier finish recommended by the manufacturer.
      3. Seal fitting covers with PVC tape.
      4. Cover all unions, check valves, and other in-line devices. Mark outer covering with indelible marker to identify item covered.

   F. Neatly bevel and seal insulation at all exposed edges.

   G. Cover valves, fittings and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut or job fabricated units (at Installer's option) except where specific form or type is indicated.

   H. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.

   I. See equipment insulation for removable insulation on accessible piping components.

   J. See Section 23 05 29 for insulation inserts and shields. Butt pipe insulation against pipe hanger insulation inserts. For all piping apply wet coat of vapor barrier lap cement on butt joints and seal all joints and seams with 3 inch wide vapor barrier tape or band.

   K. Flexible Elastomeric Piping Insulation:
      1. Install unslit, by slipping over piping prior to joining, or install pre-insulated soft copper tubing.
      2. Seal butt ends with adhesive.
L. Cellular Glass Insulation:
   1. Apply in a single layer. Secure to pipe with ½ inch wide aluminum bands.
   2. For indoor applications, apply all-purpose Kraft paper/aluminum foil/vinyl coating jacket. Seal all lap and butt joints with self-seal vapor barrier tape.
   3. For outdoor applications, apply aluminum rubber/Tedlar jacketing as described below.

M. Piping Exposed to Weather: Protect outdoor insulation from weather by installing aluminum or self-adhesive laminate jacketing.
   1. Aluminum jacketing shall be secured by 1/2 inch wide stainless steel bands located on 24 inch centers. All joints and seams shall be caulked with clear silicone. Locate all longitudinal seams at the bottom of piping to minimize joint exposure to weather. Contractor may propose prefabricated sealing and fastening systems, submit samples and product data for approval.
   2. Install self-adhesive laminate jacketing in accordance with the manufacturer's instructions. Provide minimum.

3.6 INSTALLATION OF EQUIPMENT INSULATION:
   A. General: Install equipment thermal insulation products in accordance with manufacturer's written instructions, and in compliance with recognized industry practices to ensure that insulation serves intended purpose. Complete finishes as specified.

   B. Install insulation materials with smooth and even surfaces and on clean and dry surfaces. Redo poorly fitted joints. Do not use mastic or joint sealer as filler for gaping joints and excessive voids resulting from poor workmanship.

   C. Maintain integrity of vapor-barrier on equipment insulation and protect it to prevent puncture and other damage.

   D. Do not apply insulation to equipment while hot.

   E. Apply insulation using staggered joint method and double layer construction. Apply each layer of insulation separately.

   F. Insulation board shall be cut and mitered to fit the contour of the vessel and shall be applied with edges tightly butted, joints staggered where two or more layers are necessary (due to available thickness of insulation) and secured with 1/2 inch x 0.015 inch galvanized steel bands on 12 inch centers or with weld pins or stick clips with washers on 18 inch centers.

   G. Coat insulated surfaces with layer of insulating cement, cover the insulation, 1 inch galvanized wire mesh shall be tightly stretched in place with edges tied together and finished between two coats of insulating cement troweled to a hard finish (not less than 1/4 inch thick).

   H. Do not insulate hot equipment ASME stamp and manufacturer's nameplate. Provide neatly beveled edge at interruptions of insulation.

   I. Hot equipment requiring access: Provide removable section of insulation, fabricated from rigid fiberglass insulation board, adhered to an aluminum jacket, and fastened to the equipment with stainless steel bands. At Contractor’s option, provide pre-fabricated, canvas jacketed, lace-up insulation blankets.
3.7 EXISTING INSULATION REPAIR:
   A. Repair damaged sections of existing mechanical insulation, both previously damaged or damaged during this construction period. Use insulation, install new jacket lapping and sealed over existing.

3.8 PROTECTION AND REPLACEMENT:
   A. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.
   B. Protection: Insulation Installer shall advise Contractor of required protection for insulation work during remainder of construction period, to avoid damage and deterioration.

END OF SECTION 23 07 00
SECTION 23 09 00
INSTRUMENTATION AND CONTROL FOR MECHANICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

A. General: The Control System Contractor shall provide a complete modified control system using new control devices to replace existing devices to operate as specified. The contractor shall inspect the existing conditions prior to submitting a proposal. The existing temperature control system control devices, dampers, operators, wiring, conduit, air piping, valves, etc. not being modified and which are no longer utilized, shall be removed, and not abandoned in place.

1. All temperature control devices to be removed shall be returned to the Owner in good condition.

B. The Control Contractor will be responsible for all installation, programming, commissioning, testing and performance verification.

C. The Controls Contractor will be responsible for providing all devices required for a complete operating control system.

D. It shall be a digital, distributed microprocessor-based system with a pneumatic and electronic interface, where required. The Control System for this project will be referred to as a Building Automation System (BAS).

E. Total quantity and type of control points shall consist of specifications, drawings and as required to complete the sequence of operation as specified. Additional points shall be provided as required to meet all sequence of operation functions, safeties and data base. The drawings and Specifications are not intended to show all details necessary to make the system complete and operable.

F. The Control Contractor shall be responsible for all phases of software design, all equipment, installation and warranty for the BAS. The Control Contractor shall be responsible for supplying and installing all necessary control devices for completing the BAS.

G. The system shall include all control device, valves, interlocks, field devices, hardware, software, automatic dampers, piping, fittings, wire, conduit, etc., as specified and required and connected so as to perform all functions and operate according to the specified sequences.

H. This installation shall not be used as a test site for any new products unless explicitly approved by the Owner or Architect/Engineer in writing. Unless approved otherwise, all products (including firmware revisions) used in this installation shall have been used in at least twelve (12) projects prior to this installation. The previous sites may be located anywhere in the U.S.A. This requirement is not intended to restrict the Contractor to the use of any outdated equipment. Therefore, all products used in this installation shall also be currently under manufacture and have available, for at least ten years after completion of the contract, a complete line of spare parts. If the above requirements are mutually exclusive, the Contractor shall include a specific statement to this effect in the Bid.

I. Refer to other Division 23 sections for installation of instrument wells, valve bodies and dampers in mechanical systems.

J. Provide electrical work as required, complying with requirements of Division 26 sections including, but not limited to raceways, wires, cables, electrical identification, supporting devices and electrical connections for equipment. Work includes, but is not limited to, the following:
1. Interlock and control wiring between field-installed controls, indicating devices and unit control panels.
2. The Contractor shall be responsible for all additional electrical and other costs involved to accommodate the temperature control system panel, motors and electrical devices requiring power which differs from the power requirements shown on the electrical drawings.
3. Refer to Division 26 for mechanical/electrical coordination.

K. Control Contractor shall furnish & identify location requirements for all necessary control devices which may be installed by others including the following, but not limited to:

1. Automatic control valves.
2. Flow switches.
3. Required wells for insertion thermostats and/or temperature sensing wells.
4. Pressure Sensors.

1.2 QUALITY ASSURANCE:

A. Contractors Qualifications: Firms regularly engaged in installation and commissioning and servicing of digital control equipment, of types and sizes required, whose firm has been in business in similar service for not less than 5 years.

B. Only those manufacturers specified are allowed to bid temperature controls. All bidders shall make available, upon the Owner's request, open book unit pricing of all materials and labor.

C. The system shall be installed by competent mechanics, regularly employed by the Temperature Control Contractor.

D. All bidders must have installed and completed at least two (2) direct digital temperature control jobs of similar design, size and scope using the same equipment as specified.

E. All bidders must have a local office in the area of the project site.

F. All bidders must have capabilities of doing component level repairs on all systems, including electronic systems.

G. No Field Devices shall be multiplexed to a single I/O point unless specified. Each control or sensing point shall be terminated at a unique location on the BAS panel, Slave or Dedicated Controller and be associated with a unique software point on the BAS.

H. Codes and Standards:

1. All equipment and the installation shall comply with the requirements of all applicable local and national codes including but not limited to the currently enforced edition of the International Building, International Fire, International Mechanical and all applicable codes of the National Fire Protection Association including the National Electrical Code.

2. Electrical Standards: Provide electrical products, which have been tested, listed and labeled by UL and comply with NEMA standards.

3. NEMA Compliance: Comply with NEMA standards pertaining to components and devices for electric control systems.

4. NFPA Compliance: Comply with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" where applicable to controls and control sequences.

I. All bidders must have a minimum of one person dedicated to software generation. This person shall be located in an office local to the project site.
J. The equipment and software proposed by the supplier shall be currently in manufacture. No custom products shall be allowed unless required by the Specification. All products shall be supported by the manufacturer for a minimum of 5 years including spare parts, board repairs and software revisions.

K. The Temperature Control Contractor shall cooperate with other contractors performing work on this project necessary to achieve a complete and neat installation. To that end, each contractor shall consult the drawings and specifications for all trades to determine the nature and extent of others work.

L. It will be the responsibility of the Contractor to work in cooperation with the Owner and with all other contractors and employees rendering such assistance and so arrange his work such that the entire project will be delivered complete in the best possible condition and in the shortest time.

1.3 PROPRIETARY INFORMATION:

A. Project Documentation: All custom software, programs, code, databases, graphic files and drawings (whether hard copy or CADD based files) prepared for this system shall be the exclusive property of the Owner and shall not be reproduced or distributed without prior written permission from the Owner.

B. The use or reference to the Owner or any of its subsidiaries or any of the facility automation projects shall not be used by the Manufacturer or Contractor in any promotional media, including advertisements, sale brochures, annual reports and client references or endorsements, without prior written permission from the Owner. The Owner reserves the right to restrict or refuse access to any or all of its facilities.

1.4 SUBMITTALS:

A. Submit in accordance with Division 1 and 23 submittal requirements.

B. In addition to the requirements set forth in paragraph A above, the following shall be included in the shop drawing submittals including, but not limited to:

1. Product Data: Submit manufacturer's technical product data sheets for each control device furnished, each data sheet shall be labeled indicating its control drawing descriptor and include the following:
   a. indicating dimensions;
   b. capacities;
   c. performance characteristics;
   d. electrical characteristics;
   e. finishes of materials;
   f. commissioning, installation instructions and start-up instructions.

2. Valve and well and tap schedule showing size, configuration, capacity and location of all equipment.

3. Control system drawings containing pertinent data to provide a functional operating system and a sequence of operation.

4. Detailed wiring diagrams.

5. A floor plan of each area with a detailed new conduit/wiring layout shall be included. The plan shall indicate all conduit locations within ±2' of actual installed location. All walls, doors and temperature control devices shall be accurately shown.

6. Schematic flow diagram of system showing fans, pumps, coils, dampers, valves, and all control devices. Identify all control points with labeling.
7. Label each control device with setpoint or adjustable range of control. Provide a bill of materials with manufacturer's part number.
8. Indicate all required point to point electrical wiring. Clearly differentiate between portions of wiring that are existing and portions to be field-installed.
9. Provide details of faces of control panels, including controls, instruments, and labeling.
10. Include verbal description of sequence of operation and reference each device described by schematic symbol used.
11. Provide a detailed listing of all software program code written for each system.
12. Provide a point list with database input information to include a point name, address, base and span, action and other required information.
13. Provide a detailed test plan and procedure for each HVAC system and for each type of terminal unit control including valves. The test plans shall fully define reporting methods, procedure, equipment utilized, milestones for the tests, identifying the simulation programs, and personnel. The test procedures shall be developed from the test plans and shall consist of instructions for test execution and evaluation. A test report form shall be developed for each point and sequence of operation. Commissioning procedures shall be provided for each HVAC system and for each type of terminal unit control system. The procedure shall include setpoint, prop. band, integral, derivative, mode constraints input, output settings, tuning procedures., etc.

C. Submit manufacturer's installation instructions.

D. Submittal data and shop drawings shall be prepared and submitted in the following formats:
   1. All drawings prepared for the project shall be developed using the AutoCAD program, most current version, (or a CADD package capable of producing AutoCAD "DXF" compatible format files).
   2. All submittals data shall be the same size for any group of information and shall be in a three screw and post binder. (NO EXCEPTIONS). All the information shall be indexed and tabbed with reference to the specific section of these specifications.
   3. The format for different groups of submittal information are as follows:
      a. Control drawings, building plans (including complete floor plans), schematics and system configurations shall be CAD prepared drawing, bound and indexed. Drawings that cannot represent the total information on an individual ANSI size B (11" x 17") drawing, i.e. a building plan, shall be noted with appropriate match lines, cross references and key plans.
      b. Technical data, sequence of operations, material list, point lists, program listings, I/O schedules, operator's and programmer's manuals, etc. shall be type written, original product data sheets or CAD prepared drawings, ANSI size A or ANSI size B.
   4. Upon completion of the project and acceptance of systems the contractor shall provide to the Owner one set of hard copy as-built shop drawings and diskettes.

E. Shop drawings shall include riser diagram depicting locations of all controllers and workstations, with associated network wiring. Also included shall be individual schematics of each mechanical system showing all connected points with reference to their associated controller. Typical will be allowed where appropriate.

F. When the Architect/Engineer requires, the Contractor will resubmit with the corrected or additional submittal data. This procedure shall be repeated until all corrections are made to the satisfaction of the Engineer and the submittals are fully reviewed.

G. Contractor agrees that shop drawing submittals processed by the Architect/Engineer are not change orders, that the purpose of shop drawing submittals by the Contractor is to demonstrate to the
Architect/Engineer that the Contractor understands the design concept, that he demonstrates his understanding by indicating which equipment and material he intends to furnish and install, and by detailing the fabrication and installation methods he intends to use. The Contractor shall be responsible for space requirements, configuration, performance, changes in bases, supports, structural members and openings in structure, and other apparatus that may be affected by their use.

H. Contractor further agrees that if deviations, discrepancies, or conflicts between shop drawing submittals and the contract documents in the form of design drawings and specifications are discovered either prior to or after shop drawing submittals are processed by the Architect/Engineer, the design drawings and specifications shall control and shall be followed. If alternates do not meet these requirements, it shall be this Contractor's responsibility to remove them and install material originally specified, at no cost to the Owner.

1.5 DELIVERY, STORAGE AND HANDLING:

A. Provide factory shipping cartons for each piece of equipment, and control device. Maintain cartons through shipping, storage and handling as required to prevent any equipment damage, and to eliminate all dirt and moisture from equipment. Store all equipment and materials inside and protected from weather.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS AND CONTRACTORS:

A. Subject to compliance with requirements, install one of the following systems:

1. Reliable Controls Corp. installed by Unify Energy Solutions

2.2 GENERAL PRODUCTS DESCRIPTION:

A. The Building Automation System (BAS) shall be capable of integrating multiple building function including equipment supervision and control, alarm management, energy management, and historical data collection and archiving. All products and materials installed shall be suitable for the intended application requirements including but not limited to:

1. Accuracy
2. Rangeability
3. Temperature and pressure ranges
4. Shut-off pressures
5. Differential pressures
6. Repeatability
7. Materials of construction suitable with the environment and/or media in which they are in contact with
8. Code compliance
9. Velocities

B. The expansion of the BAS shall consist of the following:

1. Standalone DDC panels
2. Standalone application specific controllers (ASCs)

C. The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, standalone DDC panels, and operator devices.
D. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. Each DDC panel shall operate independently by performing its own specified control, alarm management, operator I/O, and historical data collection. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

E. Standalone DDC panels shall be able to access any data from, or send control commands and alarm reports directly to, any other DDC panel or combination of panels on the network without dependence upon a central processing device. Standalone DDC panels shall also be able to send alarm reports to multiple operator workstations without dependence upon a central processing device.

F. Shared points will not be allowed.

G. BAS shall allow third party software to operate on personal computer workstation without any degradation to the controls operating normally.

2.3 NETWORKING/COMMUNICATIONS:

A. The design of the BAS shall network operator workstations and Standalone DDC panels as shown on the attached system configuration drawing. Inherent in the system's design shall be the ability to expand or modify the network either via the local area network, or auto-dial telephone line modem connections, or via a combination on the two networking schemes.

B. Local Area Network

1. Workstation/DDC Panel Support: Operator workstations and DDC panels shall directly reside on a local area network such that communications may be executed between controllers, directly between workstations, and between controllers and workstations on a peer-to-peer basis.

2. Dynamic Data Access: All operator devices, either network resident or connected via dial-up modems, shall have the ability to access all point status and application report data, or execute control functions for any and all other devices via the local area network. Access to data shall be based upon logical identification of building equipment.

   a. Access to system data shall not be restricted by the hardware configuration of the BAS. The hardware configuration of the BAS network shall be totally transparent to the user when accessing data or developing control programs.

3. General Network Design: Network design shall include the following provisions:

   a. High speed data transfer rates for alarm reporting, quick report generation from multiple controllers and upload/download efficiency between network devices. The minimum data rate shall be 1 megabit per second.

   b. Support of any combination of controllers and operator workstations directly connected to the local area network. A minimum of 50 devices shall be supported on a single local area network.

   c. Detection and accommodation of single or multiple failures of either workstations, DDC panels, or the network media. The network shall include provisions for automatically reconfiguring itself to allow all operational equipment to perform their designated functions as effectively as possible in the event of single or multiple failures.

   d. Message and alarm buffering to prevent information from being lost.

   e. Error detection, correction, and retransmission to guarantee data integrity.

   f. Default device definition to prevent loss of alarms or data, and ensure alarms are reported as quickly as possible in the event an operator device does not respond.
g. Commonly available, multiple sourced, networking components and protocols shall be used to allow the BAS to coexist with other networking applications such as office automation. MAP, ETHERNET, IBM Token Ring and ARCNET are acceptable technologies.

h. Use of industry standard IEEE 802.x protocol. Communications must be of a deterministic nature to assure calculable performance under worst-case network loading.

i. Synchronization of the realtime clocks in all DDC panels shall be provided.

2.4 STANDALONE DDC PANELS:

A. General: Standalone DDC panels shall be microprocessor based, multi-tasking, multi-user, real-time digital control processors. Each standalone DDC panel shall consist of modular hardware with plug-in enclosed processors, communication controllers, power supplies, and input/output modules. A sufficient number of controllers shall be supplied to fully meet the requirements of this specification and the attached point list.

B. Memory: Each DDC panel shall have sufficient memory to support its own operating system and databases including:

1. Control Processes
2. Energy Management Applications
3. Alarm Management
4. Historical/Trend Data for all points
5. Maintenance Support Applications
6. Custom Processes
7. Operator I/O
8. Dial-Up Communications
9. Manual Override Monitoring

C. Point Types: Each DDC panel shall support the following types of point inputs and outputs:

1. Digital Inputs for status/alarm contacts
2. Digital Outputs for on/off equipment control
3. Analog Inputs for temperature, pressure, humidity, flow and position measurements
4. Analog Outputs for valve and damper position control, and capacity control of primary equipment
5. Pulse inputs for pulsed contact monitoring

D. Expandability: The system shall be modular in nature, and shall permit easy expansion through the addition of software applications, workstation hardware, field controllers, sensors and actuators.

E. The system architecture shall support a minimum spare capacity of 20% for all types of DDC panels, and a minimum of at least two point types included as spare in the initial installation.

F. Serial Communication Ports: Standalone DDC panels shall provide at least two RS-232C serial data communication ports for simultaneous operation of multiple operator I/O devices such as industry standard printers, laptop workstations, PC workstations, and panel mounted or portable DDC panel Operator's Terminals. Standalone DC panels shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers, or network terminals.

G. Hardware Override Switches: The operator shall have the ability to manually override automatic or centrally executed commands at the DDC panel via local, point discrete, onboard hand/off/auto operator override switches for analog control type points. These override switches shall be operable whether the panel is powered or not.
H. Hardware Override Monitoring: DDC panels shall monitor the status or position of all overrides, and include this information in logs and summaries to inform the operator that automatic control has been inhibited. DDC panels shall also collect override activity information for daily and monthly reports.

I. Local Status Indicator Lamps: The DDC panel shall provide local status indication for each binary input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device.

J. Integrated On-Line Diagnostics: Each DDC panel shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all subsidiary equipment. The DDC panel shall provide both local and remote annunciation of any detected component failures, or repeated failure to establish communication. Indication of the diagnostic results shall be provided at each DDC panel, and shall not require the connection of an operator I/O device.

K. Surge and Transient Protection: Isolation shall be provided at all network terminations, as well as all field point terminations to suppress induced voltage transients consistent with the latest IEEE Standard 587.

1. Provide ISLATROL active tracking filters or equal, which provides both high and low voltage transients, non-linear characteristics, capable of instantaneously responding to spikes or transients without degradation to the filter or its performance. Power protection device shall be UL listed and have reliability in excess of 100,000 hours of mean time between failures.
2. Signal wiring shall not be installed in same conduit as high voltage wiring.

L. Powerfail Restart: In the event of the loss of normal power, there shall be an orderly shutdown of all standalone DDC panels to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data, and battery back-up shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours.

1. Upon restoration of normal power, the DDC panel shall automatically resume full operation without manual intervention.
2. Should DDC panel memory be lost for any reason, the user shall have the capability of reloading the DDC panel via the local area network, via the local RS-232C port, or via telephone line dial-in.

2.5 SYSTEM SOFTWARE FEATURES:

A. General

1. All necessary software to form a complete operating system as described in this specification shall be provided.
2. The software programs specified in this section shall be provided as an integral part of the DDC panel and shall not be dependent upon any higher level computer for execution.

B. Control Software Description

1. Pre-Tested Control Algorithms: The DDC panels shall have the ability to perform the following pre-tested control algorithms.
   a. Two Position Control
   b. Proportional Control
   c. Proportional plus Integral Control
   d. Proportional, Integral, plus Derivative Control
   e. Automatic Control Loop Tuning
2. Equipment Cycling Protection: Control software shall include a provision for limiting the number of times each piece of equipment may be cycled within any one-hour period.

3. Heavy Equipment Delays: The system shall provide protection against excessive demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.

4. Powerfail Motor Restart: Upon the resumption of normal power, the DDC panel shall analyze the status of all controlled equipment, compare it with normal occupancy scheduling, and turn equipment on or off as necessary to resume normal operation.

C. Energy Management Applications: DDC panels shall have the ability to perform any or all of the following energy management routines.

1. Time of Day Scheduling
2. Calendar Based Scheduling
3. Holiday Scheduling
4. Temporary Schedule Overrides
5. Optimal Start
6. Optimal Stop
7. Night Setback Control
8. Temperature Compensated Load Rolling

D. All programs shall be executed automatically without the need for operator intervention, and shall be flexible enough to allow user customization. Programs shall be applied to building equipment as described in the Execution portion of this specification.

E. Custom Process Programming Capability: DDC panels shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.

1. Process Inputs and Variables: It shall be possible to use any of the following in a custom process:
   
   a. Any system-measured point data or status
   b. Any calculated data
   c. Any results from other processes
   d. User-Defined Constants
   e. Arithmetic functions (+, -, *, /, square root, exp, etc.)
   f. Boolean logic operators (and, or, exclusive or, etc.)
   g. On-delay/Off-delay/One-shot timers.

2. Process Triggers: Custom processes may be triggered based on any combination of the following:

   a. Time interval
   b. Time of day
   c. Date other processes
   d. Time programming
   e. Events (e.g., point alarms)

3. Dynamic Data Access: A single process shall be able to incorporate measured or calculated data from any and all other DDC panels on the local area network.

4. In addition, a single process shall be able to issue commands to points in any and all other DDC panels on the local area network.

5. Advisory/Message Generation: Processes shall be able to generate operator messages and advisories to operator I/O devices. A process shall be able to directly send a message to a
specified device, buffer the information in a follow-up file, or cause the execution of a dial-up connection to a remote device such as a printer or pager.

6. Custom Process Documentation: The custom control programming feature shall be self-documenting. All interrelationships defined by this feature shall be documented via graphical flowcharts and English language descriptors.

F. Alarm Management: Alarm management shall be provided to monitor, buffer, and direct alarm reports to operator devices and memory files. Each DDC panel shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic, and prevent alarms from being lost. At no time shall the DDC panel's ability to report alarms be affected by either operator activity at a PC Workstation or local I/O device, or communications with other panels on the network.

1. Point Change Report Description: All alarm or point change reports shall include the point's English language description and the time and date of occurrence.

2. Prioritization: The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of three priority levels shall be provided. Each DDC panel shall automatically inhibit the reporting of selected alarms during system shutdown and start-up. Users shall have the ability to manually inhibit alarm reporting for each point.

3. The user shall also be able to define under which conditions point changes need to be acknowledged by an operator, and/or sent to follow-up files for retrieval and analysis at a later date.

4. Report Routing: Alarm reports, messages, and files will be directed to a user-defined list of operator devices, or PCs used for archiving alarm information. Alarms shall also be automatically directed to a default device in the event a primary device is found to be off-line.

5. Alarm Messages: In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a 65-character alarm message to more fully describe the alarm condition or direct operator response.

6. Each standalone DDC panel shall be capable of storing a library of a least 250 Alarm Messages. Each message may be assignable to any number of points in the panel.

7. Auto-Dial Alarm Management: In Dial-up applications, only critical alarms shall initiate a call to a remote operator device. In all other cases, call activity shall be minimized by time-stamping and saving reports until an operator scheduled time, a manual request, or until the buffer space is full. The alarm buffer must store a minimum of 50 alarms.

G. Historical Data and Trend Analysis: A variety of Historical Data collection utilities shall be provided to automatically sample, store, and display system data in all of the following ways.

1. Continuous Point Histories: Standalone DDC panels shall store Point History Files for all analog and binary inputs and outputs.

2. The Point History routine shall continuously and automatically sample the value of all analog inputs at half hour intervals. Samples for all points shall be store for the past 24 hours to allow the user to immediately analyze equipment performance and all problem related events for the past day. Point History files for binary input or output points and analog output points shall include a continuous record of the last ten status changes or commands for each point.

3. Control Loop Performance Trends: Standalone DDC panels shall also provide high resolution sampling capability with an operator-adjustable resolution of 10-300 seconds in one second increments for verification of control loop performance.

4. Extended Sample Period Trends: Measured and calculated analog and binary data shall also be assignable to user-definable trends for the purpose of collecting operator-specified performance data over extended periods of time. Sample intervals of one minute to two hours, in one-minute intervals, shall be provided. Each standalone DDC panel shall have a dedicated buffer for trend data, and shall be capable of storing a minimum of 500 data samples.
5. Data Storage and Archiving: Trend data shall be stored at the Standalone DDC panels, and uploaded to hard disk storage when archival is desired. Uploads shall occur based upon either user-defined interval, manual command, or when the trend buffers become full. All trend data shall be available in disk file form for use in 3rd Party person computer applications.

H. Runtime Totalization: Standalone DDC panels shall automatically accumulate and store runtime hours for binary input and output points as specified in the Execution portion of this specification.

   1. The Totalization routine shall have a sampling resolution of one minute or less.
   2. The user shall have the ability to define a warning limit for Runtime Totalization. Unique, user-specified messages shall be generated when the limit is reached.

I. Analog/Pulse Totalization: Standalone DDC panels shall automatically sample, calculate, and store consumption totals on a daily, weekly, or monthly basis for user-selected analog and binary pulse input-type points.

   1. Totalization shall provide calculation and storage of accumulations of up to 99,999.9 units (e.g. KWH, gallons, KBTU, tons, etc.).
   2. The Totalization routine shall have a sampling resolution of one minute or less.
   3. The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.

J. Event Totalization: Standalone DDC panels shall have the ability to count events such as the number of times a pump or fan system is cycled on and off. Event totalization shall be performed on a daily, weekly, or monthly basis.

   1. The Event Totalization feature shall be able to store the records associated with a minimum of 9,999,999 events before reset.
   2. The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.

2.6 APPLICATION OF SPECIFIC CONTROLLERS - HVAC APPLICATIONS:

A. Each Standalone DDC Controller shall be able to extend its performance and capacity through the use of remote Application Specific Controllers (ASCs).

B. Each ASC shall operate as a Standalone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each ASC shall be a microprocessor-based, multi-tasking, real-time digital control processor. Points shall not be shared between controllers.

C. Each ASC shall have sufficient memory to support its own operating system and database including:

   1. Control Processes
   2. Energy Management Applications
   3. Operator I/O (Portable Service Terminal)

D. The operator interface to any ASC point data or programs shall be through any network-resident PC workstation, or any PC or portable operator's terminal connected to any DDC panel in the network.

E. Application Specific Controllers shall directly support the temporary use of a portable service terminal. The capabilities of the portable service terminal shall include, but not be limited to, the following:
1. Display temperatures
2. Display status
3. Display setpoints
4. Display control parameters
5. Override binary output control
6. Override analog setpoints
7. Modification of gain and offset constants

F. Powerfail Protection: All system setpoints, proportional bands, control algorithms, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the controller.

2.7 OPERATOR INTERFACE:

A. Basic Interface Description:


2. The operator interface shall minimize the use of a typewriter style keyboard through the use of a mouse or similar pointing device, and "point and click" approach to menu selection. Users shall be able to start and stop equipment or change setpoints from graphical displays through the use of a mouse or similar pointing device.

3. Graphical and Text-Based Displays: At the option of the user, Operator Workstations shall provide consistent graphical or text-based displays of all system point and applications data described in this specification. Point identification, engineering units, status indication, and application naming conventions shall be the same at all workstations.

4. Multiple, Concurrent Displays: The Operator Interface shall provide the ability to simultaneously view several different types of system displays in overlapping windows to speed building analysis. For example, the interface shall provide the ability to simultaneously display a graphic depicting an air handling unit, while displaying the trend graph of several associated space temperatures to allow the user to analyze the system performance. If the interface is unable to display several different types of displays at the same time, the BAS Contractor shall provide at least two operator stations.

5. Password Protection: Multiple-level password access protection shall be provided to allow the user/manager to limit workstation control, display, and data base manipulation capabilities as deemed appropriate for each user, based upon an assigned password.

a. Passwords shall be exactly the same for all operator devices, including portable or panel-mounted network terminals. Any additions or changes made to password definition shall automatically cause passwords at all DDC panels on a network to be updated and downloaded to minimize the task of maintaining system security. Users shall not be required to update passwords for DDC panels individually.

b. A minimum of five levels of access shall be supported:

1) Level 1 = Data Access and Display
2) Level 2 = Level 1 + Operator Overrides
3) Level 3 = Level 2 + Database Modification
4) Level 4 = Level 3 + Database Generation
5) Level 5 = Level 4 + Password Add/Modification

c. A minimum of 50 passwords shall be supported at each DDC panel.

d. Operators will be able to perform only those commands available for their respective passwords. Menu selections displayed at any operator device, including portable or
panel mounted devices, and shall be limited to only those items defined for the access level of the password used to log-on.

e. User-definable, automatic log-off timers from 1 to 60 minutes shall be provided to prevent operators from inadvertently leaving devices on-line.

6. Operator Commands: The operator interface shall allow the operator to perform commands including, but not limited to, the following:

   a. Start-up or shutdown selected equipment
   b. Adjust setpoints
   c. Add/Modify/Delete time programming
   d. Enable/Disable process execution
   e. Lock/Unlock alarm reporting for each point
   f. Enable/Disable Totalization for each point
   g. Enable/Disable Trending for each point
   h. Override PID loop setpoints
   i. Enter temporary override schedules
   j. Define Holiday Schedules
   k. Change time/date
   l. Enter/Modify analog alarm limits
   m. Enter/Modify analog warning limits
   n. View limits
   o. Enable/Disable demand limiting for each meter
   p. Enable/Disable duty cycle for each load.

7. Logs and Summaries: Reports shall be generated automatically or manually, and directed to either CRT displays, printers, or disk files. As a minimum, the system shall allow the user to easily obtain the following types of reports:

   a. A general listing of all points in the network
   b. List of all points currently in alarm
   c. List of all off-line points
   d. List all points currently in override status
   e. List of all disabled points
   f. List all points currently locked out
   g. List of all items defined in "Follow-Up" file
   h. List all weekly Schedules
   i. List all Holiday Programming
   j. List of limits and deadbands

B. Summaries shall be provided for specific points, for a logical point group, for a user-selected group of groups, or for the entire facility without restriction due to the hardware configuration of the facility management system. Under no conditions shall the operator need to specify the address of hardware controller to obtain system information.

C. Dynamic Color Graphic Displays: Color graphic floor plan displays, and system schematics for each piece of mechanical equipment, including air handling units, chilled water systems, and hot water boiler systems, shall be provided as specified in the Execution portion of this specification to optimize system performance analysis and speed alarm recognition.

1. System Selection/Penetration: The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu selection, or text-based commands.
2. Dynamic Data Displays: Dynamic temperature values, humidity values, flow values, and status indication shall be shown in their actual respective locations, and shall automatically update to represent current conditions without operator intervention.

3. Windowing: The windowing environment of the PC Operator Workstation shall allow the user to simultaneously view several graphics at the same time to analyze total building operation, or to allow the display of a graphic associated with an alarm to be viewed without interrupting work in progress.

4. Graphics Definition Package: Graphic generation software shall be provided to allow the user to add, modify, or delete system graphic displays.

   a. The BAS Contractor shall provide libraries of pre-engineered screens and symbols depicting standard air handling unit components (i.e. fans, cooling coils, filters, dampers, etc.), complete mechanical systems (i.e. constant volume-terminal reheat, VAV, etc.) and electrical symbols.

   b. The graphic development package shall use a mouse or similar pointing device in conjunction with a drawings program to allow the user to perform the following:
      
      1) Define symbols
      2) Position and size symbols
      3) Define background screens
      4) Define connecting lines and curves
      5) Locate, orient, and size descriptive text
      6) Define and display colors for all elements
      7) Establish correlation between symbols or text and associated system points or other displays.

   c. Graphical displays can be created to represent any logical grouping of system points or calculated data based upon building function, mechanical system, building layout, or any other logical grouping of points which aid the operator in the analysis of the facility.

D. To accomplish this, the user shall be able to build graphic displays that include point data from multiple DDC panels, including application specific controllers used for DDC unitary or VAV terminal unit control.

E. System Configuration and Definition: All temperature and equipment control strategies and energy management routines shall be definable by the Operator. System definition and modification procedures shall not interface with normal system operation and control.

1. The system shall be provided complete with all equipment and documentation necessary to allow an operator to independently perform the following functions:

   a. Add/Delete/Modify Standalone DDC Panels
   b. Add/Delete/Modify Operator Workstations
   c. Add/Delete/Modify Application Specific Controllers
   d. Add/Delete/Modify points of any type, and all associated point parameters, and tuning constants
   e. Add/Delete/Modify alarm reporting definition for each point.
   f. Add/Delete/Modify control loops
   g. Add/Delete/Modify energy management applications
   h. Add/Delete/Modify time and calendar-based programming
   i. Add/Delete/Modify Totalization for every point
   j. Add/Delete/Modify Historical Data Trending for every point
   k. Add/Delete/Modify custom control processes
   l. Add/Delete/Modify any and all graphic displays, symbols, and cross-references to point data
m. Add/Delete/Modify dial-up telecommunication definition
n. Add/Delete/Modify all operator passwords
o. Add/Delete/Modify Alarm Messages

2. Programming Description: Definition of operator device characteristics, DDC panels, individual points, applications and control sequences shall be performed through fill-in-the-blank templates and graphical programming approach.

F. Graphical programming shall allow the user to define the software configuration of DDC control logic for HVAC system control sequences, fan interlocks, pump interlocks, PID control loops, and other control relationships through the creation of graphical logic flow diagrams.

a. Graphical Programming: Control sequences are created by using a mouse input device to draw interconnecting (comparisons and mathematical calculations), and outputs of a control sequence. As a minimum, graphic symbols shall be used to represent:

1) Process Inputs, such as temperature, humidity, or pressure values, status, time, date, or any other measured or calculated system data.
2) Mathematical Process Operators, such as addition, subtraction, multiplication, or greater than, equal to, less than, etc.
3) Logical Process Operators such as AND, OR, Exclusive OR, NOT, etc.
4) Time Delays
5) Process Control Outputs such as start/stop control points, analog adjust points, etc.
6) Process Calculation Outputs
7) Text file Outputs and Advisories

b. Network-Wide Strategy Development: Inputs and outputs for any process shall not be restricted to a single DDC panel, but shall be able to allow the development of all other DDC panels to allow the development of network-wide control strategies. Processes shall also allow the operator to use the results of one process as the input to any number of other processes (cascading).

c. Sequencing, Testing, and Simulation: A software tool shall be provided, which allows a user to simulate control sequence execution to test strategies before they are actually applied to mechanical systems. Users shall be able to enter hypothetical input data, and verify desired control response and calculation results via graphical displays and hardcopy printouts.

2. System Definition/Control Sequence Documentation: All portions of system definition shall be self-documenting to provide hardcopy printouts of all configuration and application data. Control process and DDC control loop documentation shall be provided in logical, graphical flow diagram format to allow control sequences to be easily interpreted and modified at any time in the future.

3. Database Save/Restore/Back-Up: Back-up copies of all standalone DDC panel databases shall be stored in at least one personal computer operator workstation.

4. Continuous supervision of the integrity of all DDC panel databases shall be provided. In the event that any DDC panel on the network experiences a loss of its data base for any reason, the system shall automatically download a new copy of the respective database to restore proper operation. Database back-up/Download shall occur over the local area network without operator intervention. Users shall also have the ability to manually execute downloads of any or all portions of a DDC panel's database.

G. Operator Workstation (OWS): Existing OWS(s) shall be updated to incorporate new controls devices and graphics.
H. Existing Portable Work Station (PWS) shall be updated to incorporate new controls devices and graphics.

I. Standalone DDC panel Local or Portable Operator's Terminals: Each DDC panel shall be capable of supporting an operator's terminal for local command entry, instantaneous and historical data display, and program additions and modifications.

1. There shall be a provision for both permanently mounting the standalone DDC panel Operator Terminal, or using it as a portable handheld unit.

2. The DDC panel Operator Terminal shall simultaneously display a minimum of 6 points with full English identification to allow an operator to view single c\screen dynamic displays depicting entire mechanical systems.

3. The operator functions provided by the DDC panel Operator Terminal shall include, but not be limited to, the following:

   a. Start and stop Points
   b. Modify Setpoints
   c. Modify PID Loop Setpoints
   d. Override PID Control
   e. Change Time/Date
   f. Add/Modify Start/Stop Weekly Scheduling
   g. Add/Modify Setpoint Weekly Scheduling
   h. Enter Temporary Override Schedules
   i. Define Holiday Schedules
   j. View Analog Limits
   k. Enter/Modify Analog Warning Limits
   l. Enter/Modify Analog Alarm Limits
   m. Enter/Modify Analog Differentials
   n. View Point History Files

4. The DDC panel Operator Terminal shall provide access to all real or calculated points in the controller to which it is connected, or any other controller in the network. This capability shall not be restricted to a subset of predefined "global points", but shall provide totally open exchange of data between the operator terminal and any DDC panel in the network.

5. Operator access at all DDC panel operator Terminals shall be identical to each other, as well as identical to the PC or Laptop Operator Workstations. Any password changes shall automatically be downloaded to all controllers on the network.

6. The DDC panel operator terminal shall provide English language prompting to eliminate the need for the user to remember command formats or point names. Prompting shall be provided consistent with a user's password clearance and the types of points being displayed, to eliminate the possibility of operator error.

7. A multi-function touchpad shall be provided for point and command selection, as well as parameter entry. To minimize the possibility of operator error, the DDC panel Operator Terminal shall change and limit touchpad functions based upon an operator's password clearance, the function being performed, and types of points being displayed. Screen displays shall clearly indicate only valid touchpad functions.

8. Context-Sensitive Help: On-line, interactive user's "Help" manuals and tutorials shall be provided. Based upon operator request, the *help* function shall provide general system operating instructions, and specific descriptions of commands available in the currently displayed menus.

9. Identification for all real or calculated points shall be consistent for all network devices. The same English language names used at PC workstations shall be used to access points at the DDC panel Operator's Terminal to eliminate cross-reference or look-up tables.

10. In addition to instantaneous summaries, the DDC panel Operator's Terminal shall allow a user to view a Point History file for system points. Point History files shall provide a record of value
of analog points over the last 24 hours, at 30-minute intervals, or a record of the last ten status changes for binary type points.

2.8 UNINTERRUPTED POWER SUPPLY (UPS):

A. General:

1. Provide one or more Uninterrupted Power Supply (UPS) dedicated to the BAS to accommodate interruptions in building power supply.
2. General Requirements shall include the following:
   a. All mechanical equipment which is supplied with emergency power shall have the associated DDC controller supplied with emergency power.
   b. UPS shall include LAN port and modem line surge protection.
   c. UPS shall be sized to carry the BAS and all connected components at full-load runtime through power outage and activation of generator and automatic transfer switch with a typical runtime of up to 60 minutes.
   d. UPS shall provide a minimum 480-joule suppression rating. Suppression response time shall be instantaneous.
   e. Batteries supplied shall be of the type not requiring dedicated exhaust ventilation per the Fire Code for this project.
   f. UPS shall be capable of hot-swapping batteries while simultaneously providing clean power out to the BAS.
   g. Typical recharge time shall be 2-4 hours.
   h. Maximum incremental size for a UPS shall be 5000VA. Multiple units shall be required for loads exceeding 5000VA.
   i. Setup UPS programming to meet the requirements for all connected components.
   j. Provide all software, cables, peripherals, etc., for a complete system.

2.9 MATERIALS AND EQUIPMENT:

A. General: The Contractor shall provide control products in the sizes and capacities indicated. The existing control system shall remain and be reused as is. Additional controllers, sensors, and devices which are required to make a complete control system shall be the responsibility of the controls contractor.

B. Automatic Control Valves:

1. Control valves shall have equal percentage plugs.
2. Control Valve Construction:
   a. Small Valves 1/2" through 1": Valves shall be constructed with a cast brass body and screwed ends. Trim shall consist of a removable cage providing valve plug guiding throughout the entire travel range. A stainless steel stem shall be provided. Bonnet, cage and the stem and plug assembly shall be removable for servicing. Body rating shall be 400 psi at 150 deg. F.
   b. Valves - 1/2" through 2": Valves shall be constructed with a cast brass body and screwed ends. For special duty, valves may be selected by the control manufacturer to have either bronze or cast iron bodies with screwed or flanged ends.
   c. Valves - 2 - 1/2" and above: Valves shall be constructed with a cast iron body and have flanged connections.
   d. For motorized plug, butterfly and ball valves, the operator shall be provided with the valve by the valve manufacturer. See Section 23 05 23.
3. Control Valve Operators/Actuators:
a. All automatic control valves shall be fully proportioning with modulating plugs for equal percentage of linear flow characteristics and shall be provided with actuators of sufficient power for the duty intended. Valve body and actuator selection shall be sufficient to handle system pressure which will be encountered on the project.

b. Where required by the sequence of operation, valves shall be capable of being sequenced either with other valves or other pneumatically actuate devices. Where such sequencing is required the actual spring range, when adjusted for spring shift, shall be such that no overlapping occurs. In the event that spring shift can cause an overlap, a pilot positioning operator shall be furnished.

c. Actuator housings shall be cast aluminum, with synthetic rubber diaphragm, spring return type.

4. Temperature control contractor and manufacturer shall size control valves for proper control characteristics for each application.

5. Water control valves shall be sized for a pressure drop between 4 to 6 psig at full flow condition.

6. Select valves to fail in normally open or closed position as follows:

a. Boiler Warm-up By-pass Valve:
   
   N.C.

b. Chilled water automatic isolation valve at HX-PP1:
   
   N.O.

2.10 INPUTS:

A. All input accuracies required by this section shall be end-to-end (from sensing point to BAS display). End-to-end accuracy includes all errors due to the sensor, transmitter, wiring and BAS signal measurement and A/D conversion.

B. Thermistors or solid state sensors shall be provided for temperature sensing applications except where accuracies or ranges required cannot be met by these devices, RTD's shall be used. The sensors shall be powered by the BAS panel or Dedicated Controller. The solid state sensors shall be accurate to within ±0.5\(^\circ\)F. over the following ranges and meet the following requirements:

1. Water Temperature Applications: 30\(^\circ\)F to 230\(^\circ\)F.

C. Where RTD's are required, they shall be 1000 ohm platinum type and be supplied with a 4-20 mA DC transmitter. The sensor and transmitter shall be a single unit. They shall be accurate to within ±1.0\(^\circ\)F. over the range of 32deg F. to 600deg F.

D. Where thermocouples are required, they shall be type J and be supplied with a 4-20 mA DC transmitter. They shall be accurate to within ±2.0\(^\circ\)F over the range of 32 deg F to 1300 deg F.

E. Provide matched temperature sensors for applications which require both inlet and outlet temperatures of any device.

F. Thermowells shall be monel, brass or copper for use in copper water lines; and 300 series stainless steel for all other applications.

G. Outdoor Air Temperature & Humidity Transmitter:
1. Provide Vaisala HMD60Y0 relative humidity and temperature probe with membrane filters and UV stabilized solar radiation shield. Probe shall have a temperature measuring range of -40 deg F. to +120 deg F. with an accuracy of ±.54 deg F at 68 deg F. and relative humidity measuring range of 0 to 100% RH with an accuracy of 2% 0 to 90% RH with a repeatability better than 1% RH per year. RH and temperature probe shall be capable of a continuous temperature operating range of -40 deg F. to +120 deg F. Provide necessary transmitter for output signals.

2. Provide 1 spare set of protective filters for each transmitter Viasala No. 17039.

H. Pressure Sensors, Transmitters and Differential Switches:

1. Pump/Liquid (wet) differential pressure switches shall be as manufactured by BARKSDALE with neoprene diaphragm, stainless steel internal parts, NEMA 4 housing.

2. Water/Liquid Pressure Transmitter: Kele & Associates Model SA, stainless pressure transmitter with 4-20 mA output signal, watertight enclosure with stainless steel bulkhead fitting, accuracy of ±1% full scale, temperature compensated, 300 series stainless steel wetted parts.

   a. Provide Model 47S pressure snubber for applications where the transmitter is subjected to fluid hammer, pressure surge or pulsation.
   b. Provide Model PT steam syphon pigtail steam applications and where the fluid temperature is higher than the maximum operating temperature rating of the transmitter.

I. Output Devices:

1. Control Relays: Control relay contacts shall be rated for the application, with a minimum of 2 sets of Form C contacts enclosed in a dustproof enclosure. Relays shall be rated for a minimum life of one million operations. Operating time shall be 20 milliseconds or less, with release time of 10 milliseconds or less. Relays shall be equipped with coil transient suppression devices to limit transients to 150% of rated coil voltage. Provide with LED to indicate status.

2. Analog output transducers shall be of positioning type with position feedback and control internal to the transducer. As an option, position feedback may also be input to the BAS.

3. Analog output transducers shall meet the following requirements:

   a. 4-20 mA DC output.
   b. Two-pipe electromechanical design or microprocessor-based design.
   c. 3-15 psi output range adjustable to a 0-20 psi range minimum.
   d. Linearity, repeatability and hysteresis no greater than 2% of full scale.
   e. Air capacity of 1000 SCIM minimum.
   f. Air consumption of no more than 100 SCIM.
   g. Pressure gauges shall be installed on the branch and supply lines.
   h. Acceptable transducers are the Bellofram T1000, Fairchild T5700, Johnson N6810, Mamac EP-310 or an equivalent.

4. Electronic analog output transducers shall output a signal to match the controlled device. The Contractor shall be responsible for verifying the required signals for all controlled devices. Transducers shall be completely solid-state with no mechanical parts.

5. Time Delay Relays: Time delay relay contacts shall be rated for the application with a minimum of 2 sets of Form C contacts enclosed in a dustproof enclosure. Relays shall be rated for a minimum life of one million operations. Relays shall be equipped with coil transient suppression, devices to limit transients to 150% of rated coil voltage. Delayed contact openings or closing shall be adjustable from 1 to 60 seconds with a minimum accuracy of ±2% of setting.
6. Latching Relays: Latching Relay contacts shall be rated for the application with a minimum of 2 sets of Form C contacts enclosed in a dustproof enclosure. Relays shall be rated for a minimum life of one million operations. Operating time shall be 20 milliseconds or less, with release time of 10 milliseconds or less. Relays shall be equipped with coil transient suppression devices to limit transients to 150% of rated coil voltage.

2.11 POSITIONERS:

A. Positive positioning relays shall be provided on valve actuators and damper operators when required to provide sufficient power, sequencing and repeatability.

B. Provide for smooth gradual operation over operating span adjustment of 0 to 15 psi and start point adjustment of 3 to 10 psi.

2.12 CUMULATORS, SWITCHES AND MISCELLANEOUS ITEMS:

A. Provide all cumulators, switches and other miscellaneous items as may be required for the successful operation of the temperature regulation systems specified herein and/or shown on Drawings.

B. Cumulators shall be of the positive and gradual acting type.

C. Provide suitable indicating plates with all switches.

D. Pressure/Electric switches shall be micro switch type.

E. Range shall be 0 - 20 psi with electrical rating of 10 amperes minimum for 115V/1/60.

2.13 POWER MONITORING:

A. General: Provide current switches, current transducers, voltage transducers, current transformers as required to meet the specified sequence of operation and indicated below.

B. Current Operated Switches: AC current switch, Neilsen - Kuljian Model PD50AC, or PD75, solid state, 5 year warranty, three selectable ranges for optimum adjustability and resolution. Provide external current transformer where required.

C. Current Transducers: AC current to DC current output, ±.5% accuracy, 4-20 mA output signal, Kele and Associates Model 4CMA. Provide external current transformer where required.

D. Voltage Transducers: Kele & Associates Model PVM or LVM as required for each application, ±1/2% accuracy, 4-20 mA DC output.

2.14 VIBRATION MONITORING:

A. Vibration Switch: Kele & Associates Model 502 vibration switch, frequency range of 120 to 30,000 CPM, 3 second time delay to prevent triggering due to transients 4-20 mA output signal, capable of being wired for automatic reset or latch and remote reset, ±5% accuracy, alarm setpoint and shutdown limit, NEMA 4 enclosure, capable of being mounted with the sensitive axis in any plane including inverted position and a velocity range of .15 to 1.5 in/sec.

2.15 TEMPERATURE CONTROL CABINETS:

A. General: All controllers and field interface devices shall be installed in control panel cabinet/enclosure as described below.
B. Cabinets shall be UL listed, 14 gauge furniture grade steel, finished with baked enamel painted finish inside and out, cabinet doors shall have piano hinge and standard key cylinder locking latch.

C. Cabinets shall include Lexan windows to view controls without opening the door.

D. Control panels located outdoors shall be NEMA 4X.

E. All devices installed in or on the control cabinet shall be labeled with a fixed mounted, color contrasted, engraved laminated plastic tags, including describing the function of the device, similar to the following example:

```
ΔP
TRANSMITTER
DEVICE
```

F. All electrical devices within the panel shall be prewired to terminal strips with all inter-device wiring within the panel completed prior to installation of the system.

G. Mount control panels adjacent to associated equipment on vibration free walls or free standing steel angle supports or "Unistrut" support stand.

**2.16 VARIABLE FREQUENCY DRIVES:**

A. Variable frequency drives shall be arranged so that it can be operated in an open circuit mode, disconnected from the motors, for start-up adjustments and trouble shooting.

B. Automatic operation shall be from a 4-20 milliamp signal follower, which shall follow a transducer signal. The signal follower shall contain the following design features.

1. Shall accept a transducer output signal and condition it to produce a speed reference signal for the inverter.

C. Wire all safeties to operate both in hand and auto positions as well as drive and by-pass sections.

D. Provide communication cabling and interface necessary to forward VFD computer communication information to and from the BAS/VFD. See Section 23 05 07.

**2.17 ELECTRICAL MATERIALS:**

A. All wiring shall be installed in conduit. See Division 26 for conduit installation requirements. Where wiring is exposed in plenum locations (i.e. open cable tray, wiring shall be plenum rated.

B. Conduit and Conductors: Types as indicated in Division 26 sized per Division 26 except for low-voltage twisted pair or single jacketed cable (1/2" minimum). All low voltage conductors shall be stranded 22 gauge copper minimum; twisted pair.
C. Fittings per Division 26: Bushings or nylon insulated throats are not required for jacketed cables.

D. All J-boxes shall be identified and labeled per Division 26.

E. All conductors and cables shall be labeled per Division 26.

F. Conduit and box supports shall be per Division 26.

G. Junction boxes shall be of types and sizes as indicated in Division 26.

H. Conduits shall not exceed 40% maximum fill for single conductor and jacketed cables.

I. Fiber Optic Cable:
   1. Acceptable fiber optic cable shall include the following sizes; 50/125, 62.5/125 or 100/140. Only glass fiber is acceptable, no plastic.
   2. Fiber optic cable shall only be installed and terminated by an experienced contractor. The BAS contractor shall submit to the Engineer the name of the intended contractor of the fiber optic cable with his submittal documents.

J. Coaxial Cable:
   1. Coaxial cable shall conform to RG62 or RG59 rating.
   2. Provide plenum rated coaxial cable when running in return air plenums.

K. All temperature control panels & controllers shall be provided with fuse protection on both incoming power load supply (primary side) and on low voltage side of control transformer (secondary side).

L. Provide lightning arresters Kele & Associates Model 392-SVSR2 or equal, at all points where communication cables exit or enter the building.

M. All communication cabling shall be shielded type.

2.18 END SWITCHES:

A. All end switches shall be NEMA rated contacts and NEMA 4X enclosure, either SPDT, DPDT DPST as required to meet the sequence of operation, complete the points list and necessary interlocks or safeties control wiring. End switches shall be as manufactured by Cutler-Hammer or Allen-Bradley.

B. All end switches shall be designed and configured to provide positive indication of a control device (i.e. damper or valve) position for the service intended.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. The Contractor shall install all equipment, conduit and wiring parallel to building lines.

B. All automatic control valves furnished by the Temperature Control Contractor shall be installed under his supervision by the Mechanical Contractor.

C. GENERAL INSTALLATION REQUIREMENTS:
1. Spare conductor capacity, equal to a minimum of (2) additional sensors shall be provided to each underfloor sensor and pendant type sensors.

2. Wiring shall be installed in conduit throughout.

3. Horizontal runs of conduit, trays, tubing or wiring shall be hung from structural members using new supports, or where feasible, utilizing existing temperature control conduit and piping. The Contractor shall verify adequacy of existing systems and warrant these systems as if they were new. Single runs of conduit, tubing or wire shall be by clevis ring and all thread rod. Multiple runs shall be by "Trapeze" or "Unistrut" supports. "Plumber's Strap" shall not be allowed. Maximum distance between supports shall be per the NEC. Existing supports shall only be used upon written concurrence by the Architect, Engineer or Owner.

4. All vertical runs of conduit or tubing shall be through new core drills. Existing core drills may be used if approved by the Owner. The installation shall be supported above each floor penetration using clamps to "Unistrut".

5. All wire that enters or leaves a building structure shall be installed with lightning protection per NEC.

6. All wire terminations shall be with compression type round hole spade lugs under a pan head screw landing; Stay-Kon or equivalent. All wire splices shall be with compression type insulated splice connectors or properly sized "wire-nut" connectors. Hand twisted, soldered and/or taped terminations or splices are not acceptable.

7. Where tubing, wiring or conduit penetrates floors or walls, sleeves with bushings shall be provided for tubing and wires. The conduit or sleeve opening shall be sealed with fire proof packing so the smoke and fire rating of the wall or floor is maintained.

8. All the material installed under this contract must be mounted on, or supported from the building structure or supports furnished by this Contractor.

D. Control Wiring:

1. Run wiring in metallic conduit, tubing or raceways. Exceptions are as follows:
   a. NEC Class 2 low voltage wiring where not exposed to view such as above suspended ceilings, in shafts, etc., may be run in cable (when approved by code authority).
   b. Wiring enclosed in temperature control panels.

2. Where conduit is used, provide steel fittings.

3. Low Voltage Conductors: 18 gauge minimum, except 19 gauge may be used for home runs to central panels and 22 gauge minimum for resistance or thermistor sensing element connections.

4. Wire control interlocks and control panels, except one 120V power circuit to each temperature control panel shown on drawings and schedules shall be provided under Division 1.

5. All wiring shall comply with the requirements of local and national electrical codes.

6. Do not interlock alarms with starter switching to bypass alarm when equipment is manually disconnected.

7. Variable frequency drives shall be arranged so that it can be operated in an open circuit mode, disconnected from the motors, for start-up adjustments and trouble shooting.

8. All costs of controls, wiring conduit and associated labor shall be included in the temperature control bid. The control wiring shall be installed under the supervision of this Contractor.

3.2 ENCLOSURES:

A. The wiring within all enclosures shall be run in plastic trays. Wiring within BAS panels may be run using adhesive-backed tie wraps.

B. Mount all enclosures, including those which house BAS Panels, Slaves and Field Device Panels, so that the top of the enclosure does not exceed six feet, six inches (6'-6"); and the center of any...
kepad/LCD combination does not exceed five foot, six inches (5' 6") from the floor or is less than four feet zero inches (4' 0") from the floor.

C. Field Device Panels contain related Field Devices such as relays, control power (24V) transformers, output transducers, etc., that are outboard of the BAS Panels or Dedicated Controllers. Each Field Device Panel shall be mounted within an enclosure. The enclosures shall be provided with lockable latches that will accept a single key common to all Field Device Panels, BAS Panels and Slaves.

3.3 EXISTING CONTROLS:

A. Remove all existing controls, controllers, receiver/controllers, thermostats, sensors, Field Devices, gauges, etc.; and all associated wiring, piping and mounting hardware whose functions are being replaced by the BAS.

1. Refer to General Conditions.

3.4 INSTALLATION PRACTICES:

A. The Contractor shall install and calibrate all Field Devices, sensors and transducers necessary for the complete operation of the I/O points described herein.

B. Sensors shall be removable without shutting down the system in which they are installed.

C. All immersion sensors shall be installed in new, welded thermowells supplied by the Contractor. Existing thermowells may be reused with concurrence from the Owner. Coordinate any required shutdown with Owner.

D. Thermistor wire leads shall be permanently terminated at panels or controllers with wire clamps.

E. Where none exist, furnish and install pressure/temperature gauges adjacent to each immersion type sensor.

F. Sensors shall be installed with the use of a wet or hot tap without draining the system if required.

3.5 IDENTIFICATION:

A. All control J-boxes, conduit and wiring shall be labeled.

B. Electrical devices, wiring, conduit and J-boxes shall be labeled and identified as required by Division 26.

1. As a minimum regardless of Division 26 requirements, all temperature control J-box covers shall be painted blue in color on both sides of cover.

C. Identification shall be provided for all enclosures, panels, junction boxes, controllers or Field Devices. Laminated, bakelite nameplates shall be used. The nameplates shall be 1/16-inch thick and a minimum of 1 inch by 2 inches. The lettering shall be white on a blue background with minimum 1/4-inch high engraved letters. The nameplates shall be installed with pop rivets.

1. All new devices will be tagged. Color code to differentiate between new devices.

D. Thoroughly clean the surface to which the label shall be applied with a solvent before applying the identification. Use an epoxy to affix the identification in addition to any adhesive backing on the identification.
E. The plan code designation shown on all shop drawing identification shall be consistent with the contract documents.

F. All I/O Field Devices that are not mounted within Field Device Panel enclosures shall be identified with engraved plastic laminated nameplates installed so that they are visible from ground level.

G. The identification shall show the designation used on the record documents and identify the function such as "mixed air temperature sensor" and "fan status DP switch".

H. Calibration settings shall be marked with paint or indelible ink.

3.6 LOCATIONS:

A. All sensing devices and locations shall be located by the Contractor as shown on the submittal shop drawings with final review by the Engineer.

B. Enclosures housing Field Devices shall be located immediately adjacent horizontally to the BAS panels or Slaves which are being interfaced to.

3.7 VALVES, WELLS, FLOW SWITCHES AND AUTOMATIC CONTROL DAMPERS:

A. The Controls Contractor shall have his control equipment on the project site when required and give the Owner 24 hour written notice when systems must be shut down for installation.

3.8 EQUIPMENT PROTECTION AND COORDINATION:

A. Where existing walls are penetrated with conduit or piping, provide a fire stop assembly which meets or exceeds the original rating of the assembly. Refer to Division 23.

B. Extreme care must be exercised while working in existing facilities and around operating equipment, particularly sensitive telephone switching and computer equipment. Close coordination with the Owner is required for the protection of this operating equipment from dust, dirt and construction material while maintaining the operational environment for the equipment. Under no circumstances shall the power or environmental requirements of the operating equipment be interrupted during the installation and check-out without submitting to the Architect, Owner and Engineer for approval.

3.9 CLEANUP:

A. At the completion of the work, all equipment pertinent to this contract shall be checked and thoroughly cleaned and all other areas shall be cleaned around equipment provided under this contract. Clean the exposed surfaces of tubing, hangers, and other exposed metal of all grease, plaster, dust, or other foreign materials.

B. Upon final completion of work in an area, vacuum and/or damp wipe all finished room surfaces and furnishings. Use extreme care in cleaning around telephone switching and computer equipment and under no circumstances shall water or solvents be used around this equipment.

C. At the completion of the work and at the end of each work day, remove from the building, the premises, and surrounding streets, etc., all rubbish and debris resulting from the operations and leave all equipment spaces absolutely clean and ready for use.
3.10 SOFTWARE, DATABASE AND GRAPHICS:

A. Software Installation: The Contractor shall provide all labor necessary to install, initialize, start-up and debug all system software as described in this section. This includes any operating system software or other third party software necessary for successful operation of the system.

B. Database Configuration: The Contractor will provide all labor to configure those portions of the database that are required by the points list and sequence of operation.

C. Color Graphics: Unless otherwise directed by the Owner, the Contractor will provide color graphic displays for all systems which are specified with a sequence of operation, depicted in the mechanical drawings for each system and floor plan. For each system or floor plan, the display shall contain the associated points identified in the point list and allow for setpoint changes as required by the Owner.

3.11 TEMPERATURE CONTROL DRAWINGS:

A. Upon completion of project and after record drawings of the temperature controls have been prepared and reviewed, the Contractor shall provide one (1) complete set of temperature controls drawings at each temperature control panel. Each set of drawings shall be laminated in a plastic coating. The drawings shall consist of only those control functions associated with the specific control panel and any relevant or pertinent network interface information.

B. The laminated drawings shall have a grommet connection attached to a metal cable or chain which is mechanically fastened to the temperature control cabinet.

3.12 START UP AND TESTING:

A. Prior to Beneficial Use of the BAS, the Contractor shall supply to Architect/Engineer two (2) debugged printouts of all software entered into the BAS. Also supply all users programming and engineering manuals required to interpret the software. Included in the printouts, though not limited to, shall be the following:

1. Point data base.
2. All custom control programs written in the BAS control language.
3. All parameters required for proper operation of BAS control and utility firmware such as start-stop routines, etc.
4. Printouts or plotted detailed copies of the complete interactive system graphics.

B. The software printout shall be fully documented for ease of interpretation by the Architect/Engineer and Owner, without assistance from the Contractor. English language descriptions shall be either integrated with or attached to the BAS printout. Specifically, the following shall be documented:

1. All point (I/O and virtual) names.
2. All BAS Programming Language commands, functions, syntax, operators, and reserved variables.
3. Use of all BAS firmware.
4. The intended actions, decisions, and calculations of each line or logical group of lines in the custom control program(s). Sequences of operation are not acceptable for use in this documentation requirement.
5. Complete descriptions of and theories explaining all software and firmware algorithms. The algorithms to be described include, but are not limited to, PID, optimum start/stop, demand limiting, etc.

C. Documentation that was supplied as part of the submittals need not be submitted at this time.
D. Upon review of software, a point-to-point test of the BAS installation shall commence. The Contractor shall provide two men equipped with two-way communication and shall test actual field operation of each control and sensing point. This procedure shall occur during off hour periods. The purpose is to test the calibration, response, and action of every point. Any test equipment required to prove the proper operation of the BAS shall be provided by and operated by the Contractor. The Owner shall be given opportunity to be present to oversee, observe, and review the test. Demonstrate compliance that system functions per the Sequence of Operation.

1. Upon review of the point-to-point demonstration, the Contractor shall start up the BAS by putting all controlled equipment in automatic and enabling software. Contractor shall commence final software and overall BAS hardware/software debugging.
2. The point-to-point demonstration shall include any existing BAS equipment if it affects the operation of the equipment included under this contract.
3. As a minimum, existing conditions shall be maintained during system changeover.

E. Final acceptance of the BAS is contingent upon a hardware/software system test. All groups of points that yield a system of control shall be tested for compliance with the sequences of operation. Included in the test, but not limited to, shall be:

1. BAS loop response. The Contractor shall supply a trend data output in graphical form showing the step response of each BAS loop. The test shall show the loop's response to a change in set point which represents a change in the actuator position of at least 25% of its full range. The sampling rate of the trend shall be from one to three minutes depending on the speed of the loop. The trend data shall show for each sample the set point, actuator position, and controlled variable values. Any loop that does not yield temperature control of + 0.2 deg F or humidity control of + 3% RH shall require further tuning by the Contractor.
2. Interlocks and other sequences.
3. BAS control under HVAC equipment failure.
4. HVAC operation under BAS equipment failure.
5. Battery backup.
6. BAS control under power failure/restart.
7. Reset schedules.
8. BAS alarm reporting capability.

F. A detailed test report as defined under Submittals shall be provided indicating its completion and proper system operation.

G. The BAS will not be accepted as meeting the requirements of Beneficial Use until all tests described in this section have been performed to the satisfaction of both the Architect/Engineer and Owner. Any tests that cannot be performed due to circumstances beyond the control of the Contractor shall be exempt from the Beneficial Use requirements if requested in writing by the Contractor and concurred by the Owner and Architect/Engineer. Such tests shall be performed as part of the BAS warranty.

1. A typed written document stating that the system has been fully checked out on a point by point basis shall be submitted to the Architect/Engineer. All documentation associated with the checkout shall be included.

3.13 PROJECT RECORD DOCUMENTS:

A. The Contractor shall be responsible for updating all existing Project Record Documents associated with the Scope of Work outlined in the Drawings and Specifications.
B. Prior to final completion of the installation, prepare a complete set of record drawings on a clear and legible set of ANSI size 'B' (11'' x 17'') Mylar reproducible prints. The content, format and procedure of the submittal shall be as described by the General Conditions.

C. Provide one laminated and framed set of control drawings for each new BAS control panel and one for the Facility Control Room, locate as directed by the Engineer.

D. Prior to final completion of the installation, prepare three (3) operation and maintenance manuals. The information is to be inserted in the existing operation and maintenance manuals or provided in a tabbed and indexed, 3 screw and post binder. The information shall include:

1. Operator's manual with step-by-step procedures for logging on/off, interrogating the system, producing reports, acknowledging alarms, overriding computer control, and changing firmware parameters.
2. Programmer's manual with complete description of the custom control language and associated editor, including sample written programs. Provide complete sets of all programming forms, applications memorandums, and addenda to the programmer's manual. All software or firmware algorithms shall be completely described and documented.
3. Maintenance, Installation, and Engineering manual(s) that clearly explains how to debug hardware problems, how to repair or replace hardware, preventive maintenance guidelines and schedules, calibration procedures, and how to engineer and install new points, panels, and Operator Interfaces.
4. Documentation of all software. List separately all software parameters that will need updating by the Owner such as, though not limited to, holiday, seasonal and start/stop schedules, comfort and duty cycling schedules.
5. All programs, code, databases, graphic files, CADD drawings and symbol libraries generated for operation of the system shall be included as a part of the system documentation. This information shall be submitted both in hard copy bound format and magnetic media format.
6. Input/output schedules, data sheets, and all other items required under Submittals. Describe all regular maintenance that will need to be performed on the BAS hardware. List replacement parts with part numbers.
7. Complete original issue documentation and software diskettes for all third party software furnished and installed as a part of the system or required for the operation of the system including text editors, control language program and compiler, database managers, graphics and CADD packages, operating systems and communications software.
8. Complete original issue documentation, installation and operational manuals and supporting software for all third party hardware furnished and installed as a part of the system or required for the operation of the system including remote terminals, user's computer workstation, monitors, graphics and memory boards, printers and modems.
9. During the warranty period, all copies of the drawings and manuals shall be updated to include all hardware and software changes. A final update at 1 year shall be provided to the Owner.

E. All of the above documentation shall record both the equipment installed under this contract and the exact termination to all other existing control or BAS equipment.

F. The record drawings shall document the complete existing control system. This includes all mechanical equipment in work area which has automatic control.

3.14 WARRANTY:

A. The Warranty period shall begin on the date of beneficial use completion as authorized by the Architect/Engineer and Owner in writing. Beneficial use shall not occur before the Contractor has performed the tests required. With these requirements met, beneficial use shall not occur until, in
the opinion of the Architect/Engineer, the BAS is sufficiently complete to be utilized for the purposes for which it is intended.

1. The warranty start date shall not begin until all phases of the Project are complete, i.e., the Project shall have a single warranty start date.

B. The BAS system shall be guaranteed to be free from defects in material and workmanship and in software design and operation for a period of the warranty after completion of the contract. The Contractor shall provide the necessary skills, labor, and parts to assure the proper operation of, and to provide all required current and preventive maintenance. This warranty shall become effective starting the date of Beneficial Use completion.

1. The hardware warranty shall include all equipment which has been purchased by the Contractor. The existing hardware is not subject to the warranty requirements.
2. All software work completed by the Contractor, associated with existing hardware, is subject to the warranty requirements outlined herein.
3. The Contractor shall respond to all calls during the warranty period for all problems or questions experienced in the operation of the installed equipment and shall take steps to correct any deficiencies that may exist.
4. The response time to any problems shall be four (4) hours maximum 24 hours per day, 7 days per week. Corrective action, temporary or permanent shall be made within one business day.

C. The Contractor shall perform a monthly on-site or via telephone MODEM inspection of the operation of the system. They shall report to the Owner in writing after each inspection, define any problems with the system and its operation, and define the procedure which will be taken to correct the problem. Contractor shall comment on the possible resolution of any problems that are out of the scope of their Contract.

1. Any problems shall be corrected as required by the warranty requirements.

D. The system shall be polled via the telephone modem for any alarm signals or "abnormal off" messages. Upon receiving such a message the Contractor shall take indicated corrective action.

E. The Contractor shall maintain a backup of all BAS software installed in the system. The backup shall be updated monthly or whenever a change to the software is made. A reload of backup software into the system shall be performed by the Contractor immediately upon notification by the Owner. The reload shall be free of charge unless it is due to a power failure of a duration longer than the battery backup.

F. The Contractor shall optimize all control software to assure acceptable operating and space conditions, and peak energy efficiency.

G. At the end of the warranty period, the Contractor shall supply updated copies of the latest versions of all Project Record Documentation. This includes final updated drawings, software documentation and magnetic media backups that include all changes that have been made to the system during the warranty period.

3.15 TRAINING:

A. The Contractor shall provide 4 hours of training for the building operators. The training session shall be made available to the Owner prior to the end of the warranty period but after final completion of the contract. The session shall be given at the Owner's facility. Scheduling shall be approved by the Owner. The training shall focus on general design, operation, and maintenance procedures of the products installed, though not necessarily the specific system designed, and shall cover:
1. Hardware configuration including PC boards, switches, communication and point wiring, and location and installation of all sensors and control devices.
2. Hardware maintenance, calibration, troubleshooting, diagnostics, and repair instructions.
3. Operation of man-machine interface including logging on/off, interrogating the system, producing reports, acknowledging alarms, overriding computer control, and changing firmware/software parameters.
4. Programming the BAS using the editor and the design of custom control software.
5. Recovery procedures from both BAS and HVAC failures.

B. The Instructor for the above session shall be an employee of the Contractor, who is qualified to provide customer training and applications support.

END OF SECTION 23 09 00
SECTION 23 09 93

SEQUENCES OF OPERATION FOR MECHANICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

A. Sequence of operation is hereby defined as the manner and method by which controls function. Requirements for each type of control system operation are specified in this section.

B. Operating equipment, devices, and system components required for control systems are specified in other Division 23 Controls' sections of these specifications.

PART 2 - PRODUCTS

2.1 SYSTEM REQUIREMENTS:

A. Provide control systems consisting of thermostats, control valves, dampers, operators, indicating devices, interface equipment, and other apparatus required to operate mechanical system and to perform functions specified.

B. Provide necessary materials and field work necessary to connect control components factory supplied as part of equipment controlled, unless specified otherwise. Generally, self-contained valves, filter gauges, liquid level controllers and similar instruments, are not to be installed under this section.

C. Unless specified otherwise, provide fully proportional components.

D. Provide all necessary relays and signal boosters to make the system a full and operable system as required by the sequence of operation.

E. All set-points, time intervals, etc. shall be adjustable.

PART 3 - EXECUTION

3.1 PHYSICAL PLANT – EXISTING CHILLED WATER PLANT WITH NEW WATER-SIDE ECONOMIZER

A. System Enable: If the weekly schedule is on and there is a call for cooling from any building served by the chilled water plant located in the Plant Operations Building, the chilled water system shall be enabled. When the weekly schedule is off or there is no call for cooling, the chilled water system shall be disabled.

1. Primary CHW Pump Sequence:

   a. The primary CHW pumps are comprised of five pumps. Upon System Enable, four of the pumps shall operate in a lead/lag sequence with the fifth pump serving as a stand-by pump – in the event one of the lead/lag pumps fails the fifth pump will take its place in the lead/lag sequence and an alarm sent to the BAS.

   1) The lead/lag/stand-by designation of the pumps shall be rotated on a weekly basis to equalize run-times.

   b. OA temperature below 60°F:
1) Lead pump shall be started.
2) After lead pump is operating for 10 minutes, 1st lag pump shall be started.
3) After 1st lag pump is operating for 10 minutes, 2nd lag pump shall be started.
4) After 2nd lag pump is operating for 10 minutes, 3rd lag pump shall be started.

c. OA temperature is 60°F or above, the delta T of the chilled water system exceeds 6°F:
   1) After 3rd lag pump has been operating for 30 minutes or longer, 4th lag pump shall be started.
   2) If the outside air temperature drops below 55°F or the delta T of the chilled water system is less than 6°F the 4th lag pump shall be cycled off.

d. Upon disabling of the chilled water system the pumps shall be disabled.

B. Chilled Water System Staging: Staging shall be activated upon System Enable.

1. Stage 1 - Water-side Economizer:
   a. Adiabatic Fluid Coolers (AFC-PP1 and AFC-PP2) shall operate under a lead/lag sequence with the lead/lag designation rotating on a weekly basis to equalize runtimes.
   b. Upon System Enable when outside air temperature is 42°F or below:
      1) Open water-side economizer chilled water isolation valve and start chilled water pump, CHWP-PP1.
      2) Enable controller of lead adiabatic fluid cooler to operate the unit as a dry-cooler to maintain WES temperature set-point (45°F).
      3) Speed of WEP-PP1 shall modulate to maintain CHWS temperature set-point (46°F) as sensed upstream of water-side economizer chilled water isolation valve.
      4) If the lead adiabatic fluid cooler is unable to maintain WES temperature set-point, enable lag adiabatic fluid cooler controller so the lead and lag units operate in unison as dry-coolers to maintain WES temperature set-point.
   c. Upon System Enable when outside air temperature is above 42°F:
      1) Open water-side economizer chilled water isolation valve and start chilled water pump, CHWP-PP1.
      2) Start water-side economizer pump WEP-PP1.
      3) Enable controller of lead adiabatic fluid cooler to operate the unit as a dry-cooler to maintain WES temperature set-point (45°F).
      4) Speed of WEP-PP1 shall modulate to maintain CHWS temperature set-point (46°F).
      5) If the lead adiabatic fluid cooler is unable to maintain WES temperature set-point, enable lag adiabatic fluid cooler’s controller so the lead and lag units operate in unison as dry-coolers to maintain WES temperature set-point.
      6) If both adiabatic fluid coolers operating as dry-coolers are unable to maintain WES temperature set-point, the adiabatic fluid coolers’ controllers shall enable the adiabatic water controls.

2. Stage 2 – Water Cooled Chillers
   a. Staging of existing chillers shall be enabled when chilled water system is enabled, outside air temperature is above 47°F and both adiabatic fluid coolers are operating at 100% capacity but unable to maintain CHWS temperature set-point.
1) Disable water-side economizer functions
2) Existing point CH-X-ENA is a service switch that will put that chiller out of commission until it is enabled
3) When a chiller is requested to operate by the point CH-X-REQ, the respective condenser water sump pump and respective chilled water circulation pump with start
4) When both pumps prove status for two minutes the chiller will be started

b. Chiller sequencing (existing):

1) Enable lead chiller (always CH-1) controller to operate CH-1 to maintain CHWS temperature set-point (45°F)
2) If lead chiller (CH-1) is at full capacity and unable to maintain CHWR temperature set-point, enable 1st lag chiller’s (rotated between CH-3 and CH-4 on a weekly basis) control panel to operate chiller to maintain CHWS temperature set-point (45°F)
3) If lead chiller (CH-1) and 1st lag chiller (CH-3/CH-4) are at full capacity and unable to maintain CHWR temperature set-point, enable 2nd lag chiller’s (CH-4/CH-3) control panel to operate chiller to maintain CHWS temperature set-point (45°F)

c. Cooling Tower sequencing (existing):

1) When a chiller is requested to run, the respective cooling tower fan shall cycle on when the condenser water supply (CWS) temperature is 2°F above set-point (76°F)
2) The respective condenser sump 3-way control valve will modulate to maintain the CWS temperature set-point
3) The cooling tower fan shall cycle off when CWS temperature drops 1°F below set-point
4) When a chiller is disabled, the respective cooling tower shall be disabled

3.2 NORTH PLANT - HEATING PLANT:

A. The hot water boilers (B-1 and B-2) and their respective two-position control valves will be enabled from the DDC system. Each of the boilers will be sequenced on/off and gals valve modulated from supply water temperature sensor as required to maintain 180°F (Adjustable) supply water temperature. Each of the boilers internal factory mounted controls will control the firing of its own boiler. Whenever each boiler is shut off, its respective two-position control valve shall close and whenever each boiler is activated, its respective two-position control valve shall open.

1. The BAS will enable the lead boiler when outside air drops to 60°F or lower and proof of flow is reported.
2. The BAS will disable the boilers when outside air temperature rises to 65°F or higher.
   a. Boiler Loop Warm-up Control Valve (slow-acting and fail closed) will modulate open.

B. The hot water pumps (HWP-NP1, HWP-NP2 & HWP-NP3) will be controlled by the DDC panel. If either of the two operating pumps stop, the third pump will be started from differential pressure switch located between the discharge and suction of each pump. Two pumps will run continuously. The DDC panel will generate an alarm if any of the two running pumps stop.

C. Two duty pumps will be started anytime a boiler is activated. The pumps shall have hand-off-auto switches and pilot light on indication at the DDC panel for easy manual override operation.
1. While in auto, the pumps shall be programmed for the following cycles:

   a. Boiler Loop Warm-up Cycle
      1) Upon command from the BAS for the lead boiler to be activated, the VFDs of the two lead pumps shall operate at their minimum speed. The Boiler Loop Warm-up Control Valve shall be fully open.
      2) Once boiler discharge water temperature set-point (180°F) is reached, the VFDs for the two lead pumps shall modulate to full speed and the Boiler Loop Warm-up Control Valve shall slowly modulate fully closed.

   b. Normal Operation Cycle
      1) Once Boiler Loop Warm-up Control Valve is fully closed, the pumps will be switched to Normal Operation Cycle.
      2) The VFDs of the two lead pumps will modulate to maintain Return Water Temperature of 20°F below Supply Water Temperature set-point.
         a) Pumps will speed up when Return Water Temp. is more than 20°F below HWS set-point.
         b) Pumps will slow down when Return Water Temp. is less than 20°F below HWS set-point.

D. Building hot water supply and return temperatures will be indicated at the DDC panel.

3.3 PATHFINDER BUILDING PLANT HOT WATER PUMPS (HWP-PF1 AND HWP-PF2):

   A. The pumps are to operate in a duty/stand-by sequence with the duty designation rotating daily between the two pumps.
      1. Upon failure of the duty pump, the stand-by pump shall operate and an alarm sent to BAS.

   B. Upon a call for heating from the Pathfinder Building, the duty pump shall operate.

   C. The new 3-way valve (fail open to tunnel loop) shall modulate to maintain the existing building supply water temperature set-point (on the building side of the existing heat exchanger).

3.4 HEALTH SCIENCES BUILDING HOT WATER PUMPS (HWP-HS1 AND HWP-HS2):

   A. The pumps are to operate in a duty/stand-by sequence with the duty designation rotating daily between the two pumps.
      1. Upon failure of the duty pump, the stand-by pump shall operate and an alarm sent to BAS.

   B. Upon call for heating in the Health Sciences Building, the duty pump shall operate.

   C. The duty pump's VFD shall modulate the speed of the pump to maintain the existing differential pressure set-point.
      1. Verify existing differential pressure set-point prior to deactivating existing controls.

   D. The existing 3-way control valve upstream of HWP-HS1 and HWP-HS2 shall modulate to maintain supply water temperature set-point according to the reset schedule.
RESET SCHEDULE

<table>
<thead>
<tr>
<th>Outside Air Temperature</th>
<th>Supply Water Temperature Set-Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>0°F</td>
<td>180°F</td>
</tr>
<tr>
<td>Adjust Degree for Degree In Between</td>
<td></td>
</tr>
<tr>
<td>60°F</td>
<td>120°F</td>
</tr>
</tbody>
</table>

3.5 HEALTH SCIENCES AHU COIL PUMP (HCP-HS1):

A. HCP-HS1 shall operate anytime the existing AHU calls for heat to maintain discharge air temperature set-point.
   1. Upon failure of the pump, an alarm shall be sent to BAS.

B. The existing 3-way control valve upstream of HCP-HS1 shall modulate to maintain discharge air temperature set-point.

3.6 BTU METERS:

A. Health Sciences Building BTU Meter shall monitor and report flow (gpm), supply water temperature and return water temperature, calculate and report the year-to-date heat usage (BTU) of the building.

B. Pathfinder Building Existing BTU Meter shall monitor and report flow (gpm), supply water temperature and return water temperature, calculate and report the year-to-date heat usage (BTU) of the building.

C. BAS shall record year-to-date BTU usage for each building on a once a month basis for trending year-to-year.

END OF SECTION 23 09 93
PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

A. Extent of HVAC pumps work required by this section is indicated on drawings and schedules, and by requirements of this section.

B. Pumps furnished as part of factory-fabricated equipment, are specified as part of equipment assembly in other Division-23 sections.

C. Refer to other Division 23 sections for other work; not work of this section.

D. Refer to Division-26 sections for the following work; not work of this section.

   1. Power supply wiring from power source to power connection on pumps. Include starters, disconnects, and required electrical devices, except where specified as furnished, or factory-installed, by manufacturer.

   2. Interlock wiring between pumps; and between pumps and field-installed control devices.

      a. Interlock wiring specified as factory-installed is work of this section.

E. Provide the following electrical work as work of this section, complying with requirements of Division-26 sections:

   1. Control wiring between field-installed controls, indicating devices, and pump control panels.

      a. Control wiring specified as work of Division-23 for Automatic Temperature Controls is work of that section.

1.2 QUALITY ASSURANCE:

A. Manufacturer’s Qualifications: Firms regularly engaged in manufacture of general-use centrifugal pumps with characteristics, sizes and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:

   1. HI Compliance: Design, manufacture, and install HVAC pumps in accordance with HI “Hydraulic Institute Standards”.

   2. UL Compliance: Design, manufacture, and install HVAC pumps in accordance with UL 778 “Motor Operated Water Pumps”.

   3. UL and NEMA Compliance: Provide electric motors and components which are listed and labeled by Underwriters Laboratories and comply with NEMA standards.

C. Certification, Pump Performance: Provide pumps whose performances, under specified operating conditions, are certified by manufacturer.
1.3 SUBMITTALS:

A. Product Data: Submit manufacturer's pump specifications, installation and start-up instructions, and current accurate pump characteristic performance curves with selection points clearly indicated.

B. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to HVAC pumps. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

C. Record Drawings: At project closeout, submit record drawings of installed systems products in accordance with requirements of Division 23.

D. Maintenance Data: Submit maintenance data and parts lists for each type of pump, control, and accessory; including "trouble-shooting" maintenance guide. Include this data, product data, shop drawings, and wiring diagrams in maintenance manual; in accordance with requirements of Division 23.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING:

A. Handle HVAC pumps and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged HVAC pumps or components; replace with new.

B. Store HVAC pumps and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

C. Comply with Manufacturer's rigging and installation instructions for unloading HVAC pumps, and moving them to final location.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:

1. Vertical In-Line Pumps:
   a. Bell & Gossett

2.2 PUMPS:

A. General: Provide factory-tested pumps, thoroughly cleaned, and painted with one coat of machinery enamel prior to shipment. Type, size, and capacity of each pump is listed in pump schedule. Provide pumps of same type by same manufacturer.

B. Pump motor shall be sized so as not to be overloaded at any point along impeller curve for specified performance.

C. All pump couplers shall be suitable for both constant speed and variable speed operation.

2.3 VERTICAL IN-LINE PUMPS:

A. General: Provide bronze fitted vertical in-line pumps where indicated, and of capacities as scheduled.
B. Type: Vertical mount, in-line, close-coupled, single stage, designed for 175 psi working pressure.

C. Body: Cast iron, 125 psi ANSI flanges of equal size, tappings for gauge and drain fittings.

D. Shaft: Steel with replaceable shaft sleeve.

E. Seal: Mechanical seal with ceramic seal seat.

F. Motor: Pump motor shall be non-overloading at any point on pump curve, open and meet requirements of Section 23 05 07 “Motors, Drives, Motor Controllers and Electrical Requirements for Mech Equipment”.

G. Impeller: Bronze enclosed type, hydraulically and dynamically balanced, keyed to shaft and secured with locking screw. Assembly components shall be 304 stainless steel.

PART 3 - EXECUTION

3.1 INSPECTION:

A. Examine areas and conditions under which HVAC pumps are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF PUMPS:

A. General: Install HVAC pumps where indicated, in accordance with manufacturer’s published installation instructions, complying with recognized industry practices to ensure that HVAC pumps comply with requirements and serve intended purposes.

B. Access: Provide access space around HVAC pumps for service as indicated, but in no case less than that recommended by manufacturer.

C. Support: Install in-line pumps, supported from piping system.

D. Support: Refer to Division 23 section “Vibration Control” for support and mounting requirements of HVAC pumps.

  1. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.

E. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.

F. Piping Connections: Refer to Division 23 Section 23 05 10 "Basic Piping Materials and Methods". Provide system return connection to inlet strainer with valved bypass to drain. Provide pump discharge connections with check valve, shutoff valve, and balancing valve for each pump.

3.3 ADJUSTING AND CLEANING:

A. Alignment: Adjust shafts of all motors and pumps within recommended tolerances by manufacturer, and in presence of manufacturer's service representative.

B. Start-Up: Lubricate pumps before start-up. Start-up in accordance with manufacturer's instructions.
C. Refer to Division 23, section 23 05 93 “Testing, Adjusting and Balancing for Mechanical”, for pump system balancing; not work of this section.

D. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION 23 21 23
PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

A. Extent of water treatment system work required by this section is indicated on drawings and schedules and by requirements of this section, and includes necessary equipment, chemicals, and service for the following systems:

1. Closed Hot Water Systems
2. Closed Chilled Water Systems
3. Closed Water-side Economizer Systems
4. Cleaning of Piping Systems

B. Provide chemicals and service program for a period of one year from start-up date of equipment, including the following:

1. Initial water analysis and recommendations.
2. Systems start-up assistance.
3. Training of operating personnel.
4. Periodic field service and consultation.
5. Customer report charts and log sheets.
6. Laboratory technical assistance.

1.2 QUALITY ASSURANCE:

A. Manufacturer’s and Representative Qualifications. Firms regularly engaged in manufacture of water treatment equipment, chemical and service shall have been active in the field of industrial water treatment and whose products have been in satisfactory use in similar service for not less than 5 years, and shall have full-time service personnel located within the trading area of job site.

B. Codes and Standards:

1. ASME Compliance: Construct softener tanks in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, provide stamp and certification.
2. UL Labels: Provide water conditioners ancillary electrical components, which have been listed and labeled by UL.
3. NEMA Standards: Provide electrical controls and enclosures conforming to applicable standards of NEMA for environment where water conditioners are indicated.
4. NSE Compliance: Construct and install water conditioners in accordance with NSF Standard 44 "Cation Exchange Water Softeners Relating to Supplementary Treatment of Potable Water."
5. Chemical Standards: Provide only chemical products, which are acceptable under state and local public health and pollution control regulations.

1.3 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product including rated capacities of selected equipment clearly indicating water pressure drops, weights, installation and start-up instructions, and furnished specialties and accessories.
B. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of components.

C. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to water treatment equipment. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

D. Record Drawings: At project closeout, submit record drawings of installed systems products in accordance with requirements of Divisions 1 and 23.

E. Maintenance Data: Submit maintenance data and parts list for each item of equipment, control, and accessory; including "trouble-shooting" maintenance guide. Include this data, product data, shop drawings, and wiring diagrams in maintenance manual, in accordance with requirements of Division 23.

1.4 DELIVERY, STORAGE AND HANDLING:

A. Handle water treatment materials and components carefully to prevent damage, breaking, denting and scoring to materials and equipment. Do not install damaged water treatment materials and components; remove from site and replace with new.

1. If Contractor elects to re-use existing treated water from the system the Contractor must arrange storage and maintain existing state of cleanliness.

B. Store water treatment materials and components in an environment satisfactory to prevent their damage by the elements.

1.5 EXTENDED MAINTENANCE SERVICES:

A. Agreement to Maintain: Prior to time of final acceptance, submit four copies of "Agreement for continued Service and Maintenance" for water treatment system, for Owner's possible acceptance. Offer terms and conditions for furnishing chemicals and providing continued testing and servicing, and including replacement of materials and equipment, for one-year period with option for renewal of Agreement by Owner.

PART 2 - PRODUCTS

2.1 SUPPLIERS

A. Suppliers: Subject to compliance with requirements, provide products by one of the following:

1. Water Treatment Provider:
   a. Rocky Mountain Aquatech – (720) 373-9071

2. Filter Feeder:
   a. Neptune
   b. JL Wingert
   c. General Treatment Products
   d. Griswold Water Systems
2.2 CLOSED SYSTEMS:

A. Provide a closed system chemical feed and control system sized and equipped to treat the raw makeup water available at the project site.

B. Except as otherwise indicated, provide closed water treatment system of manufacturer's standard materials and components as indicated by published product information, and as recommended by manufacturer for application indicated.

C. By-Pass Feeder:

1. Provide a By-Pass Feeder for adding chemical to the closed water system. The Feeder shall have two 3/4inch NPT female pipe connections, and a 3-1/2inch quick top opening cap, with "0" ring seat. Capacity of the Feeder shall be 5 gallons, capable of operating at 250 psig and at a temperature up to 200 degrees F. The By-Pass feeder shall be mounted no higher from the floor than 48 inches.

   a. Neptune DBFC-5 or equal

PART 3 - EXECUTION

3.1 CLEANING OF PIPE LINES:

A. The water treatment contractor shall be responsible for furnishing the cleaning material and supervising the chemical cleaning of the heating piping.

B. The system to be cleaned shall be filled with a solution of 10 percent by weight of a heavy duty alkaline liquid cleaner. The cleaner shall be capable of wetting and penetrating heavy soil deposits of oil or grease, and keeping these products in suspension, for removal through flushing the system to drain.

C. The cleaning solution shall be circulated for a minimum of 8 hours. At the end of the eight hours, the system shall be flushed to drain, and then refilled with fresh water, taking care to remove any entrapped air from the system.

D. At the end of the cleaning period, the system shall be chemically treated to achieve conditions acceptable to manufacturer of existing boilers. In no case shall the system being cleaned be left in an untreated condition for more than 8 hours.

E. At the conclusion of the cleaning operation, the Water Treatment Contractor shall certify in writing that the system was cleaned as specified.

3.2 CHLORINATION:

A. Acceptable products are:

   Liquid Chlorine Fed. Spec. BB-C120B
   Hypochlorite Fed. Spec 0-C-114, Type 11, Grade B
   Fed. Spec. 0-S-60D, Grade A or B

B. After all pressure tests have been performed and piping has been flushed clean, the chemical treatment contractor shall be responsible for sterilizing the domestic water lines and fire protection lines.

C. Chlorination procedures shall comply with local code and health department regulations.
1. The Mechanical Contractor shall inform the General Contractor that the water system is to be chlorinated 48 hours in advance, so that arrangements can be made for other trades not to use the water.

2. Before commencing the chlorination process, the Water Treatment Contractor shall post signs at each water fountain, and on each restroom door, stating that the water is not fit for drinking, and that the water is being chlorinated.

3. Introduce sufficient chlorine into the domestic water system to provide a dosage of not less than 50 parts per million at each faucet and valve. The chlorine solution shall then be allowed to stand for a minimum of 24 hours in the system.

4. At the end of 24 hours test shall be made for residual chlorine at the extreme end of the system from the point where chlorine was introduced. If chlorine residual is less than 10 ppm, the chlorination procedure shall be repeated.

5. Flush the system with a clean supply of water until the chlorine residual in the system is reduced to less than 1 ppm, or to the chlorine residual of the supply water. During the flushing, each faucet and valve in the system shall be opened and closed a minimum of 4 times.

6. After 24 hours, the water treatment representative will have samples taken and tested by an independent laboratory. The system must be free of bacteriological contamination. If the system is contaminated, it shall be re-chlorinated until a satisfactory test is made.

7. The Water Treatment Contractor shall write a letter, informing the Mechanical Contractor that the building has been successfully chlorinated, and that the water is fit for human consumption.

3.3 TESTING

A. Closed Systems:

1. Provide a Nitrite "Drop Test" kit for determining the level of Nitrite or Molybdate in the closed system.

3.4 INSTALLATION:

A. Coordination where installation of Water Treatment equipment in piping systems is required with the other work (plumbing and heating piping) as necessary to interface components of water treatment equipment. Provide installation instructions to those firms providing installation.

3.5 INSPECTION:

A. Examine areas and conditions under which water treatment systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.6 TESTING AND CLEANING:

A. Sample all treated water systems at one-week intervals after start-up for period of 4 weeks and prepare certified test report for each system being treated.

3.7 FIELD QUALITY CONTROL:

A. Sample water softener effluent at one-week intervals after start-up for period of 3 weeks and prepare test report on the conditions of the water.
3.8 SYSTEM START-UP:

A. The Water Treatment Supplier shall put the system into operation, and make adjustments necessary for proper operation.

B. The Water Treatment Supplier shall provide a written report to the Division 23 Contractor indicating that the start-up has been completed and that all Water Treatment Equipment is operating properly.

3.9 TESTING AND CLEANING:

A. Sample all treated water systems at one-week intervals after start-up for period of 4 weeks and prepare certified test report for each system being treated.

B. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION 23 25 00
1.1 DESCRIPTION OF WORK:

A. Extent of glycol system required by this section is indicated on drawings and/or specified in other Division 23 sections.

B. Types of glycol system specialties specified in this section include the following:
   1. Fill tank
   2. Pressure sensor
   3. Pressure relief valve
   4. Check valve
   5. Propylene glycol
   6. Feed pump
   7. Transfer pump

C. Glycol systems specialties furnished as part of factory-fabricated equipment shall meet or exceed requirements of this section.

D. Refer to other Division 23 sections for mechanical insulation valves, meters and gauges and basic piping materials and methods.

1.2 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of glycol systems of types and sizes required, whose products have been in satisfactory use in similar service for not less than 10 years.

B. Glycol System Types: Provide glycol system specialties of same type by same manufacturer.

C. Codes and Standards: Provide glycol system components and materials to meet all local and national codes and standards.

1.3 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data, including installation instructions and dimensioned drawings for each type of manufactured equipment and material. Include pressure drop information. Submit schedule showing manufacturer's model or figure number, size, location and features for all equipment and material.

B. Maintenance Data: Submit maintenance data and spare parts lists for each type of manufactured equipment. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of Division 23.

C. Submit glycol solution strength test results.
PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:

1. Glycol System Tank:
   a. General Treatment Products
   b. Axiom
   c. Bell & Gossett
   d. JL Wingert Co.
   e. PSG/Neptune

2. Inhibited Propylene Glycol Solution:
   a. Dow Chemical Dowfrost
   b. Interstate Chemical Intercool NFP.

2.2 REFER TO DIVISION 23, SECTION 23 05 10 FOR TYPE OF PIPE AND FITTINGS TO BE USED.

2.3 GLYCOL SYSTEM:

A. Tank: Provide Glycol Feed System consisting of a 30 gallon polyethylene tank with a hinged polyethylene cover. Tank shall have permanent molded volume increments in gallons. A ½ inch suction and under drain with hose bib for draining the tank and a pump shut off valve shall be provided. The tank shall be supported by carbon steel frame with 4 legs with foot pads as an integral part of the tank.

B. Digital Controls: The control cabinet shall be a NEMA 4X enclosure with a large backlit LEXAN viewing window mounted in the cabinet door. The following components shall be mounted on the inside panel: Low level liquid alarm light, low level alarm silencer switch, pump test switch and indicating light, and a 0-60 psi system pressure gauge. The low level switch shall be mounted 3 inches above the bottom of the tank. A low level audible alarm shall be mounted in the side of the panel. In addition, two extra, normally open contacts shall be provided for remote low level warning light or alarm. A 3-35 psi adjustable pressure switch shall control the system pressure. 0-50mV pressure transducer.

   1. Low level dry contacts shall be provided for alarm to BAS.

C. Pump: The pump shall be an all bronze, rotary gear pump with a 1/3 hp motor mounted integrally with the pump. The pump shall be designed to produce 1.9 gpm at 40 psi. Electrical characteristics: 120V./60Hz/1 phase/1/3 HP.

D. Piping: Type L copper pump discharge, including a 3/4 inch check valve, 3/4 inch threaded female "T" for connecting the Glycol Feeder to the system piping, and a Watts pressure relief valve set at 50 psi, which will dump any system over pressure back to the glycol feed tank.

E. Transfer Pump: hand operated rotary type, 8 feet-0 inches long, 1 inch hose, with ¾ inch non-sparking nozzle, 1 inch telescoping suction pipe, adaptor with 2 inch tread.

2.4 GLYCOL SOLUTION:

A. Provide the percent glycol solution for the type of protection at the temperature indicated below.
1. 40% for burst protection at -30°F (pre-mixed).
   
B. Provide one extra 45 gallon drum of propylene glycol.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Refer to drawing and provide necessary piping to complete installation.

B. Thoroughly clean and flush system before adding propylene glycol solution.

C. Feed pre-mixed propylene glycol solution to system. Water used for dilution shall have a total hardness of less than 50 ppm, and a total chloride and sulfate of less than 25 ppm. Contractor shall assume that building potable water is suitable, unless tested to prove otherwise.

D. Perform tests determining strength of propylene glycol solution before system is turned over to the Owner. Provide test prior to end of the first year of operation and replenish as required.

E. Set up glycol feeder control for proper operation. Set pressure switch to feed glycol to system at 12 psi.

F. At time of substantial completion, glycol feeder shall be filled with a full tank of the proper solution.

END OF SECTION 23 25 50
SECTION 23 57 00
HEAT EXCHANGERS FOR HVAC

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

A. Extent of heat exchangers work required by this section is indicated on drawings and schedules, and by requirements of this section.

B. Types of heat exchangers specified in this section include the following:

1. Water-to-Water Plate and Frame Heat Exchanger.

C. Refer to other Division 23 sections for insulation of heat exchangers; piping, valves, specialties, and controls required in conjunction with heat exchangers; not work of this section.

1.2 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of heat exchangers, of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:

1. ASME Compliance: Construct heat exchangers in accordance with ASME Boiler and Pressure Vessel Code, Section VIII "Pressure Vessels", Division 1.

2. NEMA Compliance: Construct and install heat exchangers in accordance with "Standards of the Tubular Exchanger Manufacturers Association".

1.3 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data for heat exchangers including performance data, materials, dimensions, weights, and installation data. Submit Manufacturer's Data Report for Pressure Vessels, Form U-1, as required by provisions of ASME code rules.

B. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of components.

C. Record Drawings: At project closeout, submit record drawings of installed systems products in accordance with requirements of Division 23.

D. Maintenance Data: Submit maintenance data and parts list for each heat exchanger including "trouble-shooting" maintenance guide. Include this data and product data in maintenance manual; in accordance with requirements of Division 23.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING:

A. Handle heat exchangers carefully to prevent damage, breaking, denting, and scoring. Do not install damaged units or components; replace with new.

B. Store heat exchangers in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.
C. Comply with manufacturer's rigging and installation instructions for unloading heat exchangers, and moving them to final location.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:

1. Water-to-Water Plate and Frame Heat Exchangers:
   a. Alfa Laval
   b. Paul Mueller Co.
   c. Tranter, Inc.
   d. APV
   e. Plate Concepts, Inc.

2.2 PLATE AND FRAME HEAT EXCHANGER:

A. This Contractor shall provide plate and frame heat exchanger of capacity as scheduled and where shown on the drawings with embossed heat transfer plates, perimeter gaskets, guide rails, and frames and compression bolts.

B. Units shall be ASME rated for 125 psig operating pressure, 300 deg. F. (149 deg. C) maximum temperature, have a heat transfer area to be produce the conditions scheduled on the drawing.

C. Frame shall be carbon steel with baked epoxy enamel paint, zinc or cadmium plated side bolts and aluminum shroud. Plates shall be Type 304 stainless steel.

D. Gaskets shall be peroxide cured nitrile rubber or NBR. Gaskets shall be secured by a removable adhesive or other means to facilitate future disassembly.

E. Nozzles shall be studded port or grooved mechanical coupling, of the size called for on the drawings.

F. Frame shall be sized to accommodate additional plates to provide [% additional flow at the same pressure drop scheduled on the drawings. Show future expansion ability on submittals.

G. Provide a protective insulated shroud where any surface could reach a temperature of 140° F or higher.

PART 3 - EXECUTION

3.1 INSPECTION:

A. Examine areas and conditions under which heat exchangers are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF PLATE AND FRAME HEAT EXCHANGERS:

A. General: Comply with plate and frame heat exchanger manufacturer's instructions for installation.

B. Install plate and frame heat exchangers, piping and accessories in accordance with manufacturer's instructions.
C. Piping: Provide piping as indicated, including shutoff valves (butterfly valve with infinite memory stop where required for balancing), thermometers and pressure gauges at each inlet and outlet, and hose-end drain valve at lowest connectors, or unit side of valves. Arrange isolation valves and flanges/mechanical couplings to allow removal of a section of piping to facilitate cleaning.

D. Insulate areas of heat exchanger which would exceed 120°F.

3.3 ADJUSTING AND CLEANING:

A. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

3.4 SPARE PARTS:

A. General: Furnish to Owner, with receipt, one spare gasket for each flanged connection for each heat exchanger.
PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

A. Extent of factory-fabricated air-cooled dry coolers work required by this section is indicated on drawings and schedules and by requirements of this section.

B. Types of factory-fabricated air-cooled dry coolers specified in this section include the following:
   1. Factory-Fabricated Air-Cooled Dry Coolers, with Adiabatic Cooling System

C. Refer to other Division 23 sections for condenser water piping; condenser water treatment; vibration control; temperature controls; not work of this section.

D. Refer to Division 26 sections for the following work; not work of this section.
   1. Power supply wiring from power source to power connection on air-cooled dry cooler. Include starters, disconnects, and required electrical devices, except where specified as furnished, or factory-installed, by manufacturer.
   2. Interlock wiring between air-cooled dry coolers; and between air-cooled dry coolers and field-installed control devices.
      a. Interlock wiring specified as factory-installed is work of this section.

E. Provide the following electrical work as work of this section, complying with requirements of Division 26 sections:
   1. Control wiring between field-installed controls, indicating devices, and air-cooled dry cooler control panels.
      a. Control wiring specified as work of Division 23 for Automatic Temperature Controls is work of that section.

1.2 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of factory-fabricated air-cooled dry coolers, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Provide manufacturer's certification of dry cooler cooling capacity, based on factory-performance tests, and provide performance curve plotting Leaving-Water Temperature (LWT) against Wet-Bulb Temperature (WBT).

C. The cooler manufacturer shall have a Management System certified by an accredited registrar as complying with the requirements of ISO9001 to ensure consistent quality of products and services. Manufacturers that are not ISO9001 Certified shall not be acceptable.

D. Codes and Standards:
1. UL and NEMA Compliance: Provide electric motors and electrical components required as part of factory-fabricated air-cooled dry coolers, which have been listed and labeled by UL and comply with NEMA Standards.

2. NEC Compliance: Install air-cooled dry coolers in accordance with NFPA 70 "National Electrical Code".

1.3 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data, including rated capacities, pressure drop, fan performance data, weights (shipping, installed, and operating), installation and start-up instructions, and rating curves with selected points clearly indicated.

B. Shop Drawings: Submit assembly-type shop drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of all components.

C. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to air-cooled dry coolers. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

D. Record Drawings: At project closeout, submit record drawings of installed systems products in accordance with requirements of Division 23.

E. Maintenance Data: Submit maintenance data and parts list for each air-cooled dry cooler, control, and accessory; including "trouble-shooting" maintenance guide. Include this data, product data, shop drawings, and wiring diagrams, in maintenance manual; in accordance with requirements of Division 23.

F. Certifications: Submit required certifications and written tests results for required testing.

1.4 DELIVERY, STORAGE, AND HANDLING:

A. Handle air-cooled dry coolers and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged air-cooled dry coolers or components; replace with new.

B. Store air-cooled dry coolers and components in clean place. Protect from dirt, fumes, construction debris, and physical damage.

C. Comply with Manufacturer's rigging and installation instructions for unloading air-cooled dry coolers, and moving them to final location.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:

1. Factory-Fabricated Air-Cooled Dry Coolers, with Adiabatic Cooling System:

   a. Guntner
   b. Baltimore Aircoil Co., Inc.
   c. Marley Cooling Tower Co.
   d. Evapco
2.2 FACTORY-FABRICATED AIR-COOLED DRY COOLERS, CLOSED-CIRCUIT TYPE:

A. Fabricate air-cooled dry cooler mounting base with reinforcement strong enough to resist air-cooled dry cooler movement during a seismic event when air-cooled dry cooler is anchored to field support structure.

B. The cooler shall consist of an Adiabatic Cooling System, a heat exchanger, painted galvanized steel casing, and one or more low noise axial fans with maintenance-free motors. The Adiabatic Cooling System shall consist of evaporative cooling pads, water collection system, ambient temperature probe, and a water distribution and collection system with solenoid valve, strainer, balancing valves, drain valve, piping, and collection system. The heat exchanger shall consist of coils fitted with fins (copper pipe, aluminum fins), distribution and header pipes (copper) and pipe connections to the pipeline system.

C. The dry cooler coil shall have a floating coil design that prevents any contact of the fluid-carrying tubes with the supporting frame allowing for thermal expansion and contraction of the tubes without risk of tube damage at the tube sheet. The coil shall use expanded support tubes to minimize flexing during installation. Coil shall be constructed of 0.47 inch diameter copper tubes. Fins shall be constructed of aluminum, full drawn collar with tubes expanded into collar. Coil tubes shall be connected to copper headers. Coils shall be pressure tested to 261 psig (18 bar) with dry air underwater and shipped with a 25 psig (1.7 bar) dry air holding charge.

D. The dry cooler casing shall be robust, self-supporting construction of galvanized steel, varnished with RAL 7035 (light grey). Within the casing, each fan chamber shall be separated by an internal baffle to prevent windmilling during off-cycle.

E. Fan sets shall consist of a system utilizing external rotor motor with die cast aluminum sickle bladed impeller and fan guard. Impeller and rotor shall form one complete unit to ensure proper balancing. Fan sets shall be supplied with full bell mouth fan plate, optimized for highest efficiency. Wire fan guards shall be of welded construction, coated in a weather proof durable synthetic finish for maximum corrosion protection and in compliance with safety standard EN294. Fans shall be subject to balance quality Q6.3 according to VDI 2060.

F. Fan motors shall be furnished for operation on a power supply as indicated on plan sheets. Motors shall be sealed with a labyrinth seal impeding the ingress of splash water and include drain holes for condensation water drainage. Thermal contacts shall be integrated into the motor windings. Motors shall have protection class IP 54 and windings with thermal class F according to DIN EN 60 034-1.

G. The indirect adiabatic cooling system will pre-cool the entering air stream prior to the finned coil heat transfer surface. The adiabatic heat transfer surface shall incorporate wetted pads constructed of specially designed cellulose paper that is chemically treated to resist deterioration and bacterial growth. The water distribution system shall include solenoid valve, balancing valves, strainer, piping, headers, and water distribution orifices. The water collection system shall be constructed of welded type 304 stainless steel collection basins with a single drain connection. Water temperature and ambient temperature sensors are included. The adiabatic pre-cooling system shall only be activated when design ambient temperature rises above a target ambient temperature set-point, thus limiting water usage.

H. Controls: Comply with requirements in Division 23 Section "Instrumentation and Control for HVAC."

I. Control Package: Factory supplied and wired, and functionally tested at factory before shipment.

1. Dry cooler shall be supplied with Electronically Commutated (EC) fan motors and factory motor management to create an intelligent fan motor system that optimizes operation of the dry cooler and simplifies maintenance. The controller adjusts fan motor speed based on
temperature and regulating processes to provide reliability and information for the system. Motor management reduces sound emission due to no control-induced noise, especially in part-load operation. Motor management has various mode of operation for flexibility to meet demands of the system. Modes of operation include: Auto Internal for automatic control of fan speed based on factory supplied sensor; Auto External Analogous for automatic control of fan speed based on externally supplied setpoint provided via analogous input; Auto External BUS for automatic control of fan speed based on externally supplied setpoint provided via Modbus communication; Slave External Analogous for external control of fan speed sent via analogous input; and Slave External BUS for external control of fan speed sent via Modbus communication.

2. Motors shall include Bypass mode. In the event of sensor fault, or loss of communication with control signal or fault in GMM, fan motors shall initiate emergency mode and run at a configurable fan speed. Factory default bypass mode fan speed shall be 100%.

3. Motor management shall include freeze protection mode and will oscillate fans in increasing amounts of torque in the event an obstruction such as snow or ice is detected. Motor management shall take fan out of operation and indicate alarm in the event oscillation does not free fan from obstruction.

4. Low Capacity Motor Management (LCMM) shall be available in order to provide more precise control during extreme low ambient or low load conditions. The motor management shall utilize LCMM to cycle fans while maintaining capacity and minimizing fan energy consumption.

5. Motor management shall utilize cleaning function to help remove dirt and debris from coil by running the fans in reverse at configurable intervals.

6. Maintenance Run function shall be available to activate fan motors after configurable time of unit non-operation. Occasional use of fan motors is recommended during prolonged periods of non-operation.

7. Motor management shall include analog outputs for alarms, operational signal and threshold met. Additionally, motor management shall include output (0-10V signal) to indicate fan speed.

8. Motor management shall include analog inputs for enabling of unit, night limit activation signal (which limits the fan speed and hence noise during configurable times) and secondary set point.

9. Optional modes of communication with motor management shall be available including Wi-Fi, Modbus RTU or BACnet.

J. Refer to drawings for capacities and characteristics.

PART 3 - EXECUTION

3.1 INSPECTION:

A. Examine areas and conditions under which factory-fabricated air-cooled dry coolers are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION:

A. General: Install air-cooled dry coolers where indicated, in accordance with equipment manufacturer's written instructions and with recognized industry practices, to ensure that air-cooled dry coolers comply with requirements and serve intended purposes.

B. Level air-cooled dry coolers to tolerance of 1/8" in 10'0", in both directions.

C. Access: Provide access and service space around and over air-cooled dry coolers as indicated, but in no case less than that recommended by manufacturer.
D. Support: Install units on structural concrete support, 6" larger on each side than air-cooled dry cooler base. Cast anchor bolt inserts into pad.

E. Placement: Mount factory-fabricated air-cooled dry coolers on vibration isolators if recommended by air-cooled dry cooler and vibration isolation manufacturer. Install gaskets or sealants between air-cooled dry cooler cells. Level units to tolerance of 1/8" in 10'-0", in both directions.

F. Glycol/Water Piping: Provide flanged or union connections to cooling tower, with flexible pipe connections if tower is mounted on vibration isolators. Connect to inlets to dry cooler with shutoff valve, and balancing valve (if 2 or more inlets). Connect to outlets with shutoff valves.

G. Adiabatic Water Piping: Provide flanged or union connections to air-cooled dry cooler, with flexible pipe connections if unit is mounted on vibration isolators. Pitch lines so water will drain into sump. Connect to automatic fill valve with 3-valve bypass, and backflow preventer. Provide wye strainer upstream of fill valve. Provide with solenoid drain valves as indicated on drawings.

H. Drain Piping: Connect drain, overflow, and bleed lines to air-cooled dry cooler as indicated, full size of connection on air-cooled dry cooler.

I. Mount pressure gauges, valves and controls furnished by manufacturer, in accordance with manufacturer's instructions.

J. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.

1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division-26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.

3.3 ADJUSTING AND CLEANING:

A. Cleaning: Clean inside of air-cooled dry cooler thoroughly before filling for start-up. Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

B. Start-up: Comply with manufacturer's instructions for filling and start-up of operation, but not less than the following:

1. Verify lubrication of rotating parts; lubricate as needed.
2. Verify fan rotation direction.
3. Verify that motor amperage is in accordance with manufacturer's data.
4. Balance glycol/water flow to each unit, and to each inlet for multiple inlet units.
5. Adjust temperature controls and verify operation.

C. Operation Test: Test each air-cooled dry cooler to show that it will operate in accordance with indicated requirements.

3.4 CLOSEOUT PROCEDURES:

A. Provide services of manufacturer's technical representative for one 8-hour day to instruct Owner's personnel in operation and maintenance of factory-fabricated air-cooled dry coolers.

B. Schedule training with Owner, provide at least 7-day notice to Contractor and Engineer of training date.
3.5 SPARE PARTS:

A. General: Furnish to Owner, with receipt, the following spare parts:

1. One spare set of matched fan belts for each belt driven fan.
2. Six spare spray nozzles with grommets for each cell.
3. One spare gasket for each gasketed access and inspection opening.
4. One valve seat for mechanical water make-up valve.
5. Two nozzle tie cables.
6. One final strainer screen with o-ring gasket.

END OF SECTION 23 65 00
SECTION 26 05 00
COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. All drawings associated with the entire project, including the General Conditions of the Contract for Construction, General and Supplementary Conditions, and Division 01 specification sections shall apply to the Division 26 specifications and drawings. The Contractor shall be responsible for reviewing and becoming familiar with the aforementioned and all other Contract Documents associated with the project.

B. Where contradictions occur between this section and Division 01, the more stringent requirement shall apply.

C. Contractor shall be defined as any and all entities involved with the construction of the project.

1.2 SUMMARY:

A. This Section specifies the basic requirements for electrical installations and includes requirements common to more than one section of Division 26. It expands and supplements the requirements specified in other sections of Division 01 through 50.

1.3 ELECTRICAL INSTALLATIONS:

A. Drawings are diagrammatic in character and do not necessarily indicate every required conduit, box, fitting, etc.

B. Drawings and specifications are complementary. Whatever is called for in either is binding as though called for in both. Report any discrepancies to the Engineer and obtain written instructions before proceeding. Where any contradictions occur between the specifications and the drawings the more stringent requirement shall apply. The contractor shall include pricing for the more stringent and expensive requirements and the installation shall be worked out during construction.

C. Conflicting Requirements: Where compliance with two or more standards is specified, and the standards establish different or conflicting requirements for minimum quantities or quality levels, clarify uncertainties with the Engineer prior to quotation.

1. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. In complying with these requirements, indicated numeric values are minimum or maximum, as appropriate for the context of the requirements. Refer uncertainties to the Engineer for a decision before proceeding.

2. Clarification methods: At the time of bidding, bidders shall familiarize themselves with the drawings and specifications. Any questions, misunderstandings, conflicts, deletions, discontinued products, catalog number discrepancies, discrepancies between the equipment supplied and the intent or function of the equipment, etc., shall be submitted to the Engineer in writing for clarification prior to issuance of the final addendum and bidding of the project. Where discrepancies or multiple interpretations occur, the most stringent (which is generally recognized as the most costly) that meets the intent of the documents shall be enforced.
D. Drawings shall not be scaled for rough-in measurements or used as shop drawings. Where drawings are required for these purposes or have to be made from field measurement, take the necessary measurements and prepare the drawings.

E. The exact location for some items in this specification may not be shown on the drawings. The location of such items may be established by the Engineer during the progress of the work.

F. The contractor shall make the installation in such a manner as to conform to the structure, avoid obstructions, preserve headroom and keep openings and passageways clear, without further instructions or costs to the Owner. All equipment shall be installed so access is maintained for serviceability.

G. Before any work is begun, determine that equipment will properly fit the space and that conduit can be run as contemplated without interferences between systems, with structural elements or with the work of other trades.

H. Verify all dimensions by field measurements.

I. Arrange for chases, slots, and openings in other building components to accommodate electrical installations.

J. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the work.

K. Where mounting heights are not detailed or dimensioned, install electrical conduits, boxes, and overhead equipment to provide the maximum headroom possible. In general, keep installations tight to structure.

L. Install electrical equipment to facilitate maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting and removal with minimum of interference with other installations.

M. Make allowance for expansion and contraction for all building electrical components and conduit systems that are subject to such.

N. In general, all conduit systems shall be routed as high as possible. Keep all equipment in accessible areas and coordinate with systems and equipment from other sections.

O. Coordinate the installation of electrical materials and equipment above and below ceilings with suspension system, luminaires and other building components. Ductwork and piping shall not be installed above electrical panelboards, switchboards, motor control centers, and/or transformers.

1.4 COORDINATION:

A. Work out all installation conditions in advance of installation. The Contractor shall be responsible for preparing coordination drawings, showing all work, in all areas. The Contractor shall be responsible for providing all labor and material, including but not limited to all fittings, hangers, boxes, conduit, disconnects, etc., necessary to overcome congested conditions at no increase in contact sum. The Contractors base bid shall include any and all time and manpower necessary to develop such coordination efforts and drawings. Increases to contract sum or schedule shall not be considered for such effort.

B. Provide proper documentation of equipment, product data and shop drawings to all entities involved in the project. Refer to individual sections for requirements.
C. Coordination Drawings:

1. Coordination drawings shall be prepared by the Contractor for his utilization and are his responsibility to assure systems will be installed in a manner to allow all systems to function properly.

2. Prepare and submit required coordination drawings showing major elements, components, and systems of electrical equipment and materials in relationship with other building components. Prepare drawings to an accurate scale, large enough to indicate required detail, and showing the necessary dimensions. Indicate the locations of all equipment and materials, including clearances for servicing and maintaining equipment. Indicate movement and positioning of large equipment into the building during construction.

3. Coordination drawings are informational submittals. Submit coordination drawings to Engineer for information only to document proper coordination of all portions of work and that coordination issues have been identified and resolved prior to submitting to the Engineer and prior to commencing construction in each affected area. The review of the coordination drawings by the Engineer does not constitute a relief of responsibility of the Contractor or a change to the contract documents.

4. Prepare floor plans, reflected ceiling plans, elevations, sections, and details to conclusively coordinate and integrate all installations. Indicate locations where space is limited, and where sequencing and coordination of installations are of importance to the efficient flow of the work.

5. Clearly indicate solutions to space problems. Identification of space problems without solutions is not acceptable. Only areas clearly identified will be reviewed.

6. CADD Drawings: Electronic AutoCAD drawings are available for purchase by the Contractor from the Engineer. Contact Engineer for further information in acquiring CADD drawings. The Engineers Construction documents cannot be used directly for coordination drawings. They are for information and initial coordination only.

7. For projects where any portion of the electrical is sub-contracted to Greiner Electric; Cator, Ruma, and Associates will not release any shop drawings until a coordination drawing, meeting all requirements within these specifications, has been submitted and approved for every area of construction indicated on the Electrical plans. Start of work constitutes a material requirement for the aforementioned Coordination Drawings. Contractor shall bear any and all costs associated with changes that are not specifically addressed on the Coordination Drawings that were reviewed by the Engineer of Record.

D. Existing Conditions:

1. Contractor shall carefully survey existing conditions prior to bidding work.

2. Provide proper coordination of electrical work with existing conditions.

3. Contractor shall report any issues or conflicts immediately to Engineer before commencing with work and prior to purchasing equipment and materials. Start of work indicates acceptance of conditions.

1.5 COORDINATION WITH OTHER DIVISIONS:

A. General:

1. Coordinate all work to conform to the progress of the work of other trades.

2. Complete the entire installation as soon as the condition of the building will permit. No extras will be allowed for corrections of ill-timed work, when such corrections are required for proper installation of other work.

B. Support Dimensions: Provide dimensions and drawings so that equipment supports to be provided under other sections of the specifications can be built at the proper time.
C. Modifications required as result of failure to resolve interferences, provide correct coordination drawings or call attention to changes required in other work as result of modifications shall be paid for by Contractor.

1.6 DESIGN WORK REQUIRED BY CONTRACTOR:

A. The construction of this project requires the Contractor to include the detailing and design of select systems and/or subsystems. All such design work associated with the development of the coordination drawings shall be the complete responsibility of the Contractor.

B. The Contractor shall take the full responsibility to develop and complete routing strategies which will allow fully coordinated system to be installed in a fully functional manner. The Engineers’ contract drawings shall be for system design intent and general configurations.

C. Systems or subsystems which require design responsibility by the contractor include but are not limited to:
   1. Temporary Facilities
   2. Equipment supports, hangers, anchors and seismic systems

1.7 PROJECT CONDITIONS:

A. The contractor shall attend a pre-bid walk-thru with Owner and Engineer; and shall make themselves familiar with the existing conditions. No additional costs to the Owner shall be accepted for additional work associated with existing conditions that are readily available for investigation.

B. Provide field verification of all electrical conditions and possible building interferences prior to submitting bids.

C. Report any damaged equipment or systems to the Owner prior to any work.

D. Protect all work against theft, injury or damage from all causes until it has been tested and accepted.

E. Be responsible for all damage to the property of the Owner or to the work of other contractors during the construction and guarantee period. Repair or replace any part of the work which may show defect during one year from the final acceptance of all work, provided such defect is, in the opinion of the Engineer, due to imperfect material or workmanship and not due to the Owner's carelessness or improper use.

F. The Contractor shall coordinate and co-operate with Owner at all times when connecting to existing systems.

G. Coordinate all services shut-down with the Owner; provide temporary services. Coordinate any required disruptions with Owner, at a minimum one week in advance.

H. Minimize disruptions to operation of electrical systems in occupied areas.

I. After entering into contract, Contractor will be held to complete all work necessary to meet the intent of the engineered system shown on the Construction Documents and defined within these specification requirements without additional expense to the Owner.
SAFETY:
A. Refer to Division 01.

EQUAL EMPLOYMENT OPPORTUNITY REQUIREMENTS:
A. Refer to Division 01 and conform with the Owners requirements.

REQUIREMENTS OF REGULATORY AGENCIES:
A. Refer to Division 01.
B. Execute and inspect all work in accordance with Underwriters Laboratories (UL), and all local and state codes, rules and regulations applicable to the trade affected as a minimum, but if the plans and/or specifications call for requirements that exceed these rules and regulations, the more stringent requirement shall be followed. Follow application sections and requirements and testing procedures of NFPA, IEEE, NEMA, CBM, ANSI, NECA, ICEA and IETA.
C. Comply with standards in effect at the date of these Contract Documents, except where a standard or specific date or edition is indicated.
D. All material used on this project shall be UL listed and labeled and be acceptable to the authority having jurisdiction as suitable for the use intended.

PERMITS AND FEES:
A. Refer to Division 01.
B. Contractor shall arrange for and pay for all permits, inspections, licenses and certificates required in connection with the work.

PROJECT SEISMIC REQUIREMENTS:
A. Installation shall comply with the local seismic requirements for the area of installation. Provide restraints, bracing, anchors, vibration isolation, seismic snubbers, and all other components required for the installation.
B. All electrical systems shall be installed to meet NFPA and IBC Seismic requirements.

TEMPORARY FACILITIES:
A. Light, Heat, Power, Etc. Responsibility for providing temporary electricity, heat and other facilities shall be as identified in these specifications, as shown on the drawings and as specified in Division 01.
B. Building distribution equipment and devices (existing or new) shall not be used without written permission of the Owner. If used for temporary power, the equipment shall be properly maintained and any damage resulting from use shall be repaired by the Contractor. The guarantee period for new equipment shall not begin until the equipment is turned over to the Owner.
C. If AC power systems or their backup systems serving telecommunications, computer equipment, or their associated HVAC equipment and controls are taken out of service, for any reason, the Contractor shall be responsible for providing temporary systems during the period...
when the AC power systems or their backup systems are out of service. The Contractor shall be responsible for providing temporary power to all loads being interrupted.

1.14 PRODUCT OPTIONS AND SUBSTITUTIONS:

A. Refer to the Instructions to Bidders and Division 01.

B. The burden of proof that proposed equipment is equal in size, capacity, performance, and other pertinent criteria for this specific installation, or superior to that specified is up to the Contractor. Substituted equipment will only be allowed where specifically listed in a written addendum. If substitutions are not granted, the specified materials and equipment must be installed. Where substituted equipment is allowed, it shall be the Contractor's responsibility to notify all related trades of the accepted substitution and to assume full responsibility for all costs caused as a result of the substitution.

C. Materials and equipment of equivalent quality may be submitted for substituted prior to bidding. This may be done by submitting to the Engineer at least ten (10) working days prior to the bid date requesting prior review. This submittal shall include all data necessary for complete evaluation of the product.

1. Substitutions shall be allowed only upon the written approval of the Engineer. NO EXCEPTIONS.
2. The Contractor shall be responsible for removal, replacement and remedy of any system or equipment which has been installed which does not meet the specifications or which does not have prior approval.

1.15 SUBMITTALS:

A. General

1. Refer to the Conditions of the Contract listed herein as well as in Division 01.
2. Contractor shall provide a submittal schedule appropriate for the size and duration of the project. Limit the number of large submittals being reviewed at one time and coordinate timing of sections that are dependent on each other.
3. The Contractor shall identify any "long lead time" items which may impact the overall project schedule. If these submittal requirements affect the schedule, the Contractor shall identify the impacts and confer with the Engineer within two weeks of entering into the contract.
4. The front of each submittal package shall be identified with the specification section number, job name, Owner's project number, date, Prime Contractor and Subcontractor's names, addresses, and contact information, etc. Each Specification Section shall be submitted individually and shall adequate annotation to indicate the equipment/materials/etc. within the section. Submittals with incomplete information will not be reviewed and will be sent back to be corrected.
5. Submittals shall be provided electronically. All electronic submittals need to be complete with all design information and stamped for conformity by the contractor. Submittals will be reviewed, marked appropriately and returned by the same means received.
6. An index shall be provided which includes:
   a. Product
   b. Specification Section
   c. Manufacturer and Model Number

B. Basis of Design: The manufacturer's material or equipment listed first in the specifications or on the drawing key notes are the basis of design and are provided for the establishment of size, capacity, grade and quality. If alternates are used in lieu of the first names, the cost of any changes in construction required by their use shall be borne by this Contractor. Product names
used in construction details are not necessarily considered to be basis of design and specific operating parameters should be confirmed with manufacturer prior to submitting a bid.

C. Contractor Review: Submittal of shop drawings, product data, and samples will be accepted only when submitted by the Contractor. Each submittal shall be reviewed by the contractor for general conformance with contract requirements and stamped by the respective contractor prior to submittal to the Engineer. Any submittal not stamped or complete will be sent back. Data submitted from subcontractors and material suppliers directly to the Engineer will not be processed unless written prior approval is obtained by the Contractor.

D. Submittal Review Process: Before starting work, prepare and submit to the Engineer shop drawings and descriptive product data required for the project. Continue to submit in the stated format after each Engineer’s action until a "No Exception Taken" or "Make Correction Noted" action is received. When a "Make Corrections Noted" is received, make the required corrections for inclusion in the operation and maintenance manual (O&M). Submittals marked "Make Corrections Noted" shall not be resubmitted during the submittal process. Unless each item is identified with specification section and sufficient data to identify its compliance with the specifications and drawings, the item will be returned "Revise and Resubmit." Where an entire submittal package is returned for action by the Contractor, the Engineer may summarize comments in letter format and return the entire set. Submittals shall be prepared per the requirements listed in each Division 26 Section.

E. The Design Professional’s review and appropriate action on all submittals and shop drawings is only for the limited purpose of checking for conformance with the design concept and the information expressed in the contract documents. This review shall not include:

1. Accuracy or completeness of details, such as quantities, dimensions, weights or gauges, fabrication processes
2. Construction means or methods
3. Coordination of the work with other trades
4. Construction safety precautions

F. The Design Professional’s review shall be conducted with reasonable promptness while allowing sufficient time in the Design Professional’s judgment to permit adequate review. Review of a specific item shall not indicate that the Design Professional has reviewed the entire assembly of which the item is a component.

G. The Design Professional shall not be responsible for any deviations from the contract documents not brought specifically to the attention of the Design Professional in writing by the Contractor. This shall clearly identify the design and the specific element which vary from the Design. The Contractor shall be responsible for all remedy for lack of strict conformance associated with this criteria.

H. The Design Professional shall not be required to review partial submissions or those for which submissions of correlated items have not been received.

I. If more than two submittals (either for product data, shop drawings, record drawings, test reports, or O&M’s are made by the Contractor, the Owner reserves the right to charge the Contractor for subsequent reviews by their consultants. Such extra fees shall be deducted from payments by the Owner to the Contractor.

J. The contractor shall cloud all changes made on submittals that are marked “Revise and Resubmit.”
K. Mark submittals with designations as shown on the drawings and identify as required by Specification Sections. Identification shall contain the information as required in details and each label shall be submitted in list form with disconnects, MCC's, panelboards, switchboards, overcurrent protection devices and utilization equipment.

1.16 SPECIFIC CATEGORY SUBMITTAL REQUIREMENTS:

A. Product Listing:

1. Prepare listing of major electrical equipment and materials for the project, within (2) two weeks of signing the Contract Documents and transmit to the Engineer of Record.
2. Unless otherwise specified, all materials and equipment shall be of domestic (USA) manufacture and shall be of the best quality used for the purpose in commercial practice.
3. When two or more items of same material or equipment are required (lighting, wiring devices, switchgear, panelboards, protective devices, etc.) they shall be of the same manufacturer. Product manufacturer uniformity does not apply to raw materials, bulk materials steel bar stock, welding rods, solder, fasteners, except as otherwise indicated.

B. Schedule of Values

1. Provide Preliminary Schedule of Values to Engineer with product data submittal within four (4) weeks from award of contract to successful bidder. Provide according to the following descriptions:
   a. General Construction (total)
   b. Mobilization/Demobilization
   c. Demolition
   d. Power Distribution
   e. Basic Materials/Devices/Equipment Connections
   f. Testing, Acceptance, and Commissioning

2. Provide a final Schedule of Values at close-out of project including updated values based on actual installation.

C. Product Data:

1. Where pre-printed data covers more than one distinct product, size, type, material, trim, accessory group or other variation, mark submitted copy to indicate which of the variations is to be provided. Improperly marked sheets will be rejected and returned.
2. Delete or mark-out portions of pre-printed data which are not applicable.
3. Where operating ranges are shown, mark data to show portion of range required for project application.

D. Shop Drawings:

1. Shop Drawings are defined as electrical system layout drawings prepared specifically for this project, or fabrication and assembly type drawings of system components to show more detail than typical pre-printed materials.
2. Prepare Electrical Shop Drawings, except diagrams, to accurate scale, min 1/8"-1'-0", unless otherwise noted.

E. Coordination Drawings: See applicable paragraph in this specification section.

F. Test Reports:
1. Submit test reports which have been signed and dated by the accredited firm or testing agency performing the test.
2. Prepare test reports in the manner specified in the standard or regulation governing the test procedure (if any) as indicated.
3. Submit test reports as required for O & M manuals.

G. Operation and Maintenance Data: See applicable paragraph in this specification section.

H. Record Drawings: See applicable paragraph in this specification section.

1.17 DELIVERY, STORAGE AND HANDLING:

A. Refer to the Division 01, Sections on Transportation and Handling and Storage and Protection.

B. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.

C. Check delivered equipment against contract documents and submittals.

D. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage and weather.

E. Coordinate deliveries of electrical materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.

1.18 DEMOLITION/REMODEL WORK:

A. Refer to Division 01 Section on Summary of work for requirements on working in Owner-occupied areas of the existing building and Division 02 section on selective demolition. The following are additions and modifications.

B. During the demolition phase of this contract it is the responsibility of this Contractor to carefully remove existing equipment, conduits, boxes, and related items either as shown on the demolition drawings as being removed, or as required for the work. These items shall be tagged, protected from damage and stored as directed by the Owner. A list of all items stored shall be turned over to the Engineer. At the completion of the remodeling works or when directed by the Engineer, all stored items not reused or wanted by the Owner shall be removed from the premises.

C. Existing equipment that is removed and not scheduled to be reused shall remain the property of the Owner and be delivered for disposition unless specifically indicated otherwise and shall be stored in a location designated by the Owner. Items which are removed and not wanted by the Owner shall become the property of the Contractor and shall be removed from the site.

D. Existing equipment that is removed and is to be reused shall be cleaned, serviced and operable before being reinstalled.

E. Revise panelboard schedules to reflect removal or relocation of equipment. Circuit integrity of equipment in adjacent areas shall be left intact.

F. Where remodeling interferes with existing circuits and equipment which are not to be removed, such circuits and equipment shall be reworked and relocated as required to complete the project.
G. The Contractor shall remove all distribution equipment, conductors, etc., which are indicated to be removed or which must be removed to accommodate demolition. Equipment to be removed may require reworking conduit and wiring in order to maintain service to other equipment.

H. Existing equipment and circuiting shown are based on field surveys and/or Owner furnished drawings. The Contractor shall verify conditions as they exist with necessary adjustments being made to the drawing information.

I. Coordinate the routing of all conduits with the existing mechanical and plumbing systems in order to avoid conflicts with ducts, pipes, etc. Where existing electrical boxes, conduit, or equipment interfere with installation of new ducts, plumbing, walls, soffits, luminaires, outlets, etc., the Contractor shall resolve the conflict with the appropriate trade.

J. Reuse of existing luminaires, devices, conduits, boxes, or equipment will be permitted only where specifically indicated on the drawings or allowed under the appropriate section of the specifications.

K. Electrical Outages: Electrical outages must be held to a minimum. The Contractor shall submit a Method of Procedure (MOP) to the Owner for each outage, detailing the reasons for the outage, areas affected and the sequence of procedures to accomplish work; long with estimated maximum length of time along with the date and time of day outage will occur. The Contractor shall meet with the Owner to set a schedule and date for the outage based on the MOP. Due to the critical implications of power outages, the Owner may direct the Contractor as to the time of day or night and date an outage may take place.

1. The Contractor will be responsible for providing temporary power required for the duration of the outages. The required outages to connect and disconnect the temporary power will require a MOP as described above.
2. Log each approved and implemented MOP and submit with O&M Manuals.

L. Hazardous Material: If suspected hazardous material, in any form, is discovered by this Contractor in the process of his work, he shall report such occurrence to the Owner immediately. The Owner will determine the action to be taken. Hazardous material removed is not a part of the work to be done under this Division.

1.19 CUTTING AND PATCHING:

A. This Article specifies the cutting and patching of electrical equipment, components, and materials to include removal and legal disposal of selected materials, components, and equipment. Coordinate the cutting and patching of building components to accommodate the installation of electrical equipment and materials.

B. Do not endanger or damage installed Work through procedures and processes of cutting and patching.

C. Arrange for repairs required to restore other work, because of damage caused as a result of electrical installations.

D. No additional compensation will be authorized for cutting and patching Work that is necessitated by ill-timed, defective, or non-conforming installations.

E. Cut, remove and legally dispose of selected electrical equipment, components, and materials as indicated, including, but not limited to removal of conductors, conduit, luminaires, boxes, devices and other electrical items made obsolete by the new Work.
F. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.

G. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

H. Locate, identify, and protect electrical services passing through remodel or demolition area and serving other areas required to be maintained operational.

1.20 ROUGH-IN:

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Refer to equipment shop drawings and manufacturer's requirements for actual provided equipment for rough in requirements.

C. Work through all coordination before rough-in begins. See applicable Article above.

1.21 ACCESSIBILITY:

A. Install equipment and materials to provide required code clearances and access for servicing and maintenance. Coordinate the final location with piping, ducts, and equipment of other trades to insure proper access for all trades. Coordinate locations of concealed equipment, disconnects, and boxes with access panels and doors. Allow ample space for removal of parts, fuses, lamps, etc. that require replacement or servicing.

B. Extend all conduits so that junction and pull boxes are in accessible locations.

C. Furnish hinged steel access doors with concealed latch, whether shown on drawings or not, in all walls and ceilings for access to all concealed valves, shock absorbers, air vents, motors, fans, balancing cocks, and other operating devices requiring adjustment or servicing. Refer to Division 01 for access door specification and requirements.

D. The minimum size of any access door shall not be less than the size of the equipment to be removed or 12 inches x 12 inches if used for service only.

1.22 TESTING:

A. Submit test reports as outlined in Division 01 Sections on Quality Control Services and each Division 26 Section.

B. Testing as required by these specifications shall pertain to all equipment, wiring, devices, etc. installed under this contract and being reused.

C. General Scope:

1. Perform all tests and operational checks to assure that all electrical equipment, both Contractor and Owner-supplied, is operational within industry and manufacturer's tolerances and is installed in accordance with design specifications.

2. The tests and operational checks shall determine the suitability for energization.

3. Schedule tests and give a minimum of two weeks advance notice to the Engineer. Reschedule testing for Owner convenience if required.
D. Test Report: Submit electronic copy copies of the completed report to the Engineer no later than fifteen (15) days after completion of test unless directed otherwise. The test report shall be bound and its contents certified. A final compilation of all Test Reports shall be submitted with the Testing and Equipment Settings Report (Refer to Operation and Maintenance Data paragraphs).

E. Failure to Meet Test:

   1. Contractor shall replace the defective material or equipment as necessary, and have test repeated until test proves satisfactory without additional cost to the Owner.

F. The Contractor or testing agency shall have a calibration program which maintains all applicable test instrumentation within rated accuracy. The accuracy shall be traceable to the National Institute of Standards and Technology (NIST) in an unbroken chain. Instruments shall be calibrated in accordance with manufacturer recommendations. Dated calibration labels shall be visible on all test equipment.

1.23 CLEANING:

A. Refer to the Division 01 Section on project closeout or final cleaning for general requirements for final cleaning.

1.24 RECORD DOCUMENTS:

A. Refer to the Division 01 Section on Project Closeout or Project Record Documents for requirements. The following paragraphs supplement the requirements of Division 01.

B. Keep a complete set of record document prints in custody during entire period of construction at the construction site. Documents shall be updated on a weekly basis.

C. Mark Drawings to indicate revisions to conduit size and location both exterior and interior; actual equipment locations, dimensioned from column lines; concealed equipment, dimensioned to column lines; distribution and branch electrical circuitry; fuse and circuit breaker size and arrangements; support and hanger details; Change Orders; concealed control system devices, and any other relevant deviations from the Contract Documents.

D. Mark shop drawings to indicate approved substitutions; Change Orders; actual equipment and materials used.

E. Schedules:

   1. Mark luminaire schedule on drawings to indicate manufacturer and complete catalog numbers of installed equipment.
   2. Mark schedules on drawings to indicate installed equipment and materials used, and any deviations and final revisions to electrical load data and calculations.

F. Revisions to the Contract Documents shall be legible and shall be prepared using the following color scheme.

   1. Red shall indicate new items, deviations and routing.
   2. Green shall indicate items removed or deleted.
   3. Blue shall be used for relevant notes and descriptions.

G. At the completion of the project, obtain from the Engineer a complete set of the Contract Documents in a read-only electronic format (.pdf unless otherwise noted). This set will include
all revisions officially documented through the proper channels. Using the above color scheme, transfer any undocumented revisions from the construction site record drawings to this complete set. Submit completed documents for review. This contract will not be considered completed until these record documents have been received and accepted.

H. Contractor may propose methods of maintaining record documents on electronic media. Obtain approval of Engineer and Owner prior to proceeding. Marked-up .pdf format readable by Bluebeam is preferred.

1.25 OPERATION AND MAINTENANCE DATA:

A. Refer to the Division 01 Section on project closeout or operation and maintenance data for procedures and requirements for preparation and submittal of maintenance manuals.

B. No later than four (4) weeks prior to the completion of the project provide complete set of operating and maintenance manuals, or as specified in Sections of Division 01. (whichever is more stringent). Operation and Maintenance Data shall be submitted in electronic format.

C. Operation and Maintenance Data: Submit operation and maintenance data in maintenance manual in accordance with requirements of applicable Division 26 Sections and Division 01. Provide Operating and Maintenance Instructions in electronic format covering all equipment furnished. Manuals shall include all information required below, as indicated in each Division 26 Section, and the following for each piece of equipment:

1. The job name and address, contractor's name, address, and phone number, and each subcontractor's name, address, and phone number shall be identified at the front of the electronic submittal.

2. Name, address and telephone number to be contacted of the local authorized service organization/company and individual to be contacted for service and maintenance for each item of equipment.

3. Submit operation and maintenance data, schedule of recommended service and parts lists for all materials and products specified and intended for installation. Include description of function, normal operating characteristics and limitations, fuse curves, engineering data and tests, and complete nomenclature and commercial numbers of all replaceable parts.

4. Manufacturer's printed operating procedures to include routine and normal operating instructions.

5. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.

6. Servicing instructions and lubrication charts and schedules.

7. Manufacturer's service manuals for all electrical equipment provided under this contract.

8. Complete equipment and protection wiring diagrams. All wiring diagrams shall show color coding of all connections and mounting dimensions of equipment.

9. Equipment identification numbers and adjustment clearly indicated for each piece of equipment.


11. Provide manuals tabbed and divided into major sections and special equipment. Mark the individual equipment when more than one model or make is listed on a page. Provide detailed table of contents.

12. Record Set of Shop Drawings: Shop drawings corrected to show as-built conditions. Transfer modifications from field set.


D. This contract will not be considered completed nor will final payment be made until all specified material, including test reports, settings reports, and final Schedule of Values with all Electrical
change order costs included and identified is provided and the manual is reviewed by the Engineer.

1.26 PROJECT CLOSEOUT LIST:

A. In addition to the requirements specified in Division 01, complete the requirements listed below.

B. The contractor shall be responsible for providing the items listed on the Electrical Submittal Checklist prior to applying for certification of substantial completion. Refer to individual specification sections for additional requirements.

1.27 WARRANTIES:

A. Refer to the Division 01 Section on Warranties and Bonds for procedures and submittal requirements for warranties. Refer to individual equipment specifications for warranty requirements. In no case shall the warranty for the total electrical system be less than one year from date of acceptance by the Owner.

B. Compile and assemble the warranties specified in Division 26 into a separated set of vinyl covered, three ring binders, tabulated and indexed for easy reference.

C. Provide complete warranty information for each item. Information to include product or equipment description, date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

1.28 CONSTRUCTION REQUIREMENTS:

A. The contractor shall maintain and have available at the jobsite current information on the following at all times:

1. Up to date record drawings.
2. Submittals
3. Site observation reports with current status of all action items.
4. Test results; including recorded values, procedures, and other findings.
5. Outage information.

END OF SECTION 26 05 00
SECTION 26 05 19
ELECTRICAL CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY:

A. This section includes wires, cables, and connectors for power, lighting, signal, control, and related systems rated 600 volts and less.

1.2 QUALITY ASSURANCE:

A. Manufacturers: Firms regularly engaged in manufacture of electrical wire and cable products of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firm with at least 3 years of successful installation experience with projects utilizing electrical wiring and cabling work similar to that required for this project.

C. Conform to applicable code regulations regarding toxicity of combustion products of insulating materials.

1.3 SUBMITTALS:

A. See Section 26 05 00 Common Work Results for Electrical for Submittal requirements. Supplemental information is listed within this section.

B. Field Quality Control Test Reports: Submit record of testing. Refer to Section 26 05 00 – Common Work Results for additional requirements.

C. Record Documents: Record actual installed circuiting arrangements for panel feeders and underground circuits.

1.4 DELIVERY, STORAGE, AND HANDLING:

A. Deliver wire and cable properly packaged in factory-fabricated type containers, or wound on NEMA-specified type wire and cable reels.

B. Store wire and cable in clean dry space in original containers. Protect products from weather, damaging fumes, construction debris and traffic.

C. Handle wire and cable carefully to avoid abrading, puncturing and tearing wire and cable insulation and sheathing. Ensure that dielectric resistance integrity of wires/cables is maintained.

PART 2 - PRODUCTS

2.1 APPLICATIONS

A. General: Provide wire and cable suitable for the temperature, conditions, and location where installed. Wire shall be single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.

B. Dry and Exposed Interior Locations
1. Provide single conductor building wire in suitable raceway system.

C. Damp or Wet Interior Locations

1. Provide single conductor building wire in suitable raceway system.

D. Cable types that will NOT be permitted are listed as follows:

1. Metal-clad Cable assemblies (MC)
2. Armored Cable assemblies (AC)
3. Flat Cable assemblies (FC / FCC)
4. Integrated Gas Spacer cables assemblies (IGS)
5. Medium Voltage cable assemblies (MV)
6. Mineral-Insulated, metal sheathed cable assemblies (MI)
7. Nonmetallic-Sheathed cable assemblies (NM / NMC / NMS)
8. Service-Entrance cable assemblies (SE / USE)
9. Underground Feeder and branch-circuit cable assemblies (UF)

2.2 CONDUCTOR AND CABLE REQUIREMENTS

A. General Requirements

1. Provide products listed, classified, and labeled as suitable for the purpose intended.
2. Provide copper conductors only.
3. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B 787M unless otherwise indicated.
4. Tinned Copper Conductors: Comply with ASTM B33.

B. Single Conductor Building Wire

1. Description: Single conductor insulated wire.
2. Conductor Stranding:
   b. Size 8 AWG and Larger: Stranded.
3. Insulation: Type THHN/THWN or THHN/THWN-2.
4. Conductor: Copper.
5. Insulation Voltage Rating: 600 volt.

2.3 CONNECTORS:

A. Description: Provide UL-type factory-fabricated, solderless metal connectors of sizes, ampacity ratings, materials, types and classes for applications and for services indicated. Use connectors with temperatures equal to or greater than those of the wires upon which used.

B. Provide 2-hole compression lugs for all power feeder, neutral, and grounding connections when installed on bus bars. (Including phase, neutral and grounding conductors).

C. Provide connectors that are designed to accept stranded conductors where stranded conductors are used.
PART 3 - EXECUTION

3.1 INSTALLATION OF WIRES AND CABLES:

A. Per Laramie County Community College (LCCC) Construction Quality Standards:
   1. Circuits shall be furnished with a dedicated neutral conductor. Neutrals common to more than one circuit will not be permitted for this project.
   2. Copper conductors ONLY.

B. General: Install electrical cables, wires and connectors in compliance with applicable requirements of NEC, NEMA, UL, and NECA's "Standard of Installation", and in accordance with recognized industry practices.

C. Coordinate wire/cable installation work, including electrical raceway and equipment connection work, with other work.

D. Pull conductors simultaneously where more than one is being installed in same raceway. Use pulling compound or lubricant, where necessary; compound used must not deteriorate conductor or insulation.

E. Use pulling means including, fish tape, cable, rope and basket weave wire/cable grips which will not damage cables or raceway. Do not use rope hitches for pulling attachment to wire or cable.

F. Keep conductor splices to minimum. Splice only in accessible junction boxes. No splices are allowed in feeder or control wiring. Connect un-spliced wire to numbered terminal strips at each end.

G. Install splices and taps which possess equivalent or better mechanical strength and insulation ratings than conductors being spliced.

H. Use splice and tap connectors which are compatible with conductor material.

I. Tighten electrical connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Std. 486A for copper.

J. Provide adequate length of conductors within electrical enclosures and train the conductors to terminal points with no excess. Bundle multiple conductors, with conductors larger than No. 10 AWG cabled to individual circuits. Make terminations so there is no bare conductor at the terminal.

K. For wire splices and taps, 10 AWG and smaller, use insulated screw on type spring wire connectors with plastic caps, push on type are not acceptable.

L. Make splices, taps and terminations to carry full ampacity of conductors without perceptible temperature rise.

M. Thoroughly tape the ends of spare conductors in boxes and cabinets.

N. Install exposed cable, parallel and perpendicular to surfaces, or exposed structural members, and follow surface contours, where possible.

O. Make all ground, neutral and line connections to receptacle and wiring device terminals as recommended by manufacturer. Provide ground jumper from outlet box to individual ground terminal of devices.
P. Branch circuits whose length from panel to first outlet exceeds 75 feet for 120 volt circuits shall be #10 or larger.

Q. Provide wire training, lacing, labeling, and terminal blocks as required in panelboards and all control cabinets. All wiring shall be installed neat and be labeled to match wiring diagrams.

R. Color coding of switch legs, travelers, etc. shall be different and distinct from phase and neutral conductors. Where systems utilize two (2) different voltages, the color coding of switch legs, travelers, etc. shall be different and distinct for each voltage system.

3.2 FIELD QUALITY CONTROL:

A. Provide all test results to Engineer in Substantial Completion Submittals prior to scheduling Substantial Completion observations. Test results shall be tabulated to show name of tested device, measured value, expected values, acceptable standard deviation, and test conditions, as well as any miscellaneous variables that may be applicable to test being performed.

B. Test installed wires and cables with 1000 VDC megohm meter to determine insulation resistance levels to ensure requirements are fulfilled. Test shall be made on all feeders regardless of size and on all branch circuits with No. 4 AWG and larger conductors. The megger values obtained shall be compared to the minimum values listed in NETA. All phase conductors and cables shall be meggered after installation, and prior to termination.

C. Prior to energization, test wires and cables for electrical continuity and for short-circuits.

3.3 COLOR CODING SCHEDULE:

A. Color code secondary service, feeder, and branch circuit conductors as follows:

<table>
<thead>
<tr>
<th>120/208 Volts</th>
<th>Phase</th>
<th>277/480 Volts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black</td>
<td>A</td>
<td>Brown</td>
</tr>
<tr>
<td>Red</td>
<td>B</td>
<td>Orange</td>
</tr>
<tr>
<td>Blue</td>
<td>C</td>
<td>Yellow</td>
</tr>
<tr>
<td>White</td>
<td>Neutral</td>
<td>Gray</td>
</tr>
<tr>
<td>Green</td>
<td>Ground</td>
<td>Green</td>
</tr>
</tbody>
</table>

B. Conductors shall be solid color for entire length.

END OF SECTION 26 05 19
SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY:
A. This Section includes solid grounding of electrical systems and equipment. It includes basic requirements for grounding for protection of life, equipment, circuits, and systems. Grounding requirements specified in this Section may be supplemented in other sections of these Specifications.

1.2 SUBMITTALS:
A. See Section 26 05 00 Common Work Results for Electrical for Submittal requirements. Supplemental information is listed within this section.
B. Product Data: Provide manufacturer's catalog information showing dimensions and materials, for ground rods, connectors and connection materials, and grounding fittings.
C. Field Quality Control Test Reports: Submit record of testing as described below. Refer to Section 26 05 00 – Common Work Results for additional requirements.
D. Record Documents: Record actual installed circuiting arrangements. Indicate layout of ground rings, location of system grounding electrode connection, routing of grounding electrode conductors, also include diagrams for circuits and equipment grounding connections.

1.3 QUALITY ASSURANCE:
A. Listing and Labeling: Provide products specified in this Section that are listed and labeled. The terms "listed" and "labeled" shall be defined as they are in the National Electrical Code, Article 100.
B. Manufacturer's Qualifications: Firms regularly engaged in manufacture of grounding and bonding products, of types, and ratings required, and ancillary grounding materials, including stranded cable, copper braid and bus, grounding electrodes and plate electrodes, and bonding jumpers whose products have been in satisfactory use in similar service for not less than 5 years.

PART 2 - PRODUCTS

2.1 GROUNDING AND BONDING PRODUCTS:
A. Products: Of types indicated and of sizes and ratings to comply with NEC. Where types, sizes, ratings, and quantities indicated are in excess of NEC requirements, the more stringent requirements and the greater size, rating, and quantity indications govern.
B. Conductor Materials: Copper.

2.2 WIRE AND CABLE CONDUCTORS:
A. General: Comply with Division 26 Section on Conductors and Cables. Conform to NEC, except as otherwise indicated, for conductor properties, including stranding.
B. Equipment Grounding Conductor: Green insulated.
C. Grounding Electrode Conductor: Stranded cable.

D. Bare Copper Conductors: Conform to the following:
   1. Solid Conductors: ASTM B-3
   2. Assembly of Stranded Conductors: ASTM B-8
   3. Tinned Conductors: ASTM B-33

2.3 MISCELLANEOUS CONDUCTORS:
   A. Braided Bonding Jumpers: Copper tape, braided No. 30 gauge bare copper wire, terminated with copper ferrules.
   B. Bonding Strap Conductor/Connectors: Soft copper, 0.05 inch thick and 2 inches wide, except as indicated.

2.4 CONNECTOR PRODUCTS:
   A. General: Listed and labeled as grounding connectors for the materials used.
   B. Pressure Connectors: High-conductivity-plated units.
   C. Bolted Clamps: Heavy-duty units listed for the application.

2.5 GROUNDING ELECTRODES:
   A. Ground Rods: Copper-clad steel with high-strength steel core and electrolytic-grade copper outer sheath, molten welded to core.
      1. Size: 3/4 inch by 10 feet.

PART 3 - EXECUTION

3.1 APPLICATION:
   A. Equipment Grounding Conductor Application: Comply with NEC for sizes and quantities of equipment grounding conductors, except where larger sizes or more conductors are indicated.
      1. Install separate insulated equipment grounding conductors with circuit conductors for all feeders and branch circuits, in addition to those locations where required by Code.
   B. All systems shall be grounded in accordance with the NEC.

3.2 INSTALLATION:
   A. General: Ground electrical systems and equipment in accordance with NEC requirements except where the Drawings or Specifications exceed NEC requirements. Connect together system neutral, service equipment enclosures, exposed noncurrent carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, receptacle ground connectors, and plumbing systems.
   B. Route grounding conductors along the shortest and straightest paths possible without obstructing access or placing conductors where they may be subjected to strain, impact, or damage, except as indicated.
C. Labeling: Provide a phenolic tag for all grounding electrode conductors as described in section on Electrical Identification.

D. Where grounding conductors, grounding electrode conductors, or bonding conductors are non-exposed, identify each with a 6-inch band of green tape at each end and at 10 foot intervals. When run in conduits, provide color banding on conduit per section on Electrical Identification.

3.3 CONNECTIONS:

A. General: Make connections in such a manner as to minimize possibility of galvanic action or electrolysis. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to assure high conductivity and make contact points closer in order of galvanic series.
2. Make connections with clean bare metal at points of contact.
3. Coat and seal connections involving dissimilar metals with inert material such as red lead paint to prevent future penetration of moisture to contact surfaces.

B. Terminate insulated equipment grounding conductors for feeders and branch circuits with pressure-type grounding lugs. Where metallic raceways terminate at metallic housings without mechanical and electrical connection to the housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to the ground bus in the housing. Bond electrically non-continuous conduits at both entrances and exits with grounding bushings and bare grounding conductors. Terminate each conductor on an individual ground lug terminal.

C. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torqueing requirements are not indicated, tighten connections to comply with torque tightening values specified in UL 486A.

D. Compression-Type Connections: Use hydraulic compression tools to provide the correct circumferential pressure for compression connectors. Use tools and dies recommended by the manufacturer of the connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on the ground conductor.

3.4 FIELD QUALITY CONTROL:

A. Provide all test results to Engineer in Substantial Completion Submittals prior to scheduling Substantial Completion observations. Test results shall be tabulated to show name of tested device, measured value, expected values, acceptable standard deviation, and test conditions, as well as any miscellaneous variables that may be applicable to test being performed.

B. Upon completion of installation of electrical grounding and bonding systems, test ground resistance with ground resistance tester. Where tests show resistance-to-ground is over 5 ohms, take appropriate action to reduce resistance to 5 ohms, or less, by driving additional ground rods; then retest to demonstrate compliance.

C. Ground Resistance Test:

1. Grounding electrode resistance testing shall be accomplished with a clamp-on ground resistance test meter. Test at all affected points covered under NETA standards. Perform test following final termination of all grounding and bonding connections associated with scope of project. IEEE Fall of Potential Method may also be used to calculate ground resistance with a
direct read meter and two reference probes. At a minimum provide test results at the following locations:
  a. Service Entrance
  b. Bond at building steel, UFER ground, and water service
  c. Dry type transformers
  d. Panelboards
  e. Utilization equipment connection

D. Correct Deficiencies, Retest and Report:

1. Correct unsatisfactory conditions and retest to demonstrate compliance; replace conductors, units and rods as required to bring system into compliance.
2. Prepare a written report and show temperature, humidity and condition of soil at time of tests. Report shall be certified by testing agency that identifies components checked and describes results. Include notation of deficiencies detected, remedial action taken, and observations and test results after remedial action.

3.5 CLEANING AND ADJUSTING:

A. Restore surface features at areas disturbed by excavation and reestablish original grades except as otherwise indicated. Where sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other Work to their original condition. Include necessary top-soiling, fertilizing, liming, seeding, sodding, sprigging, or mulching. Restore vegetation and disturbed paving to original condition.

END OF SECTION 26 05 26
SECTION 26 05 29
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY:

A. This Section includes secure support from the building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.

1.2 SUBMITTALS:

A. See Section 26 05 00 Common Work Results for Electrical for Submittal requirements. Supplemental information is listed within this section.

B. Shop Drawings: Contractor shall indicate details of fabricated products and materials.

C. Design Data: Indicate details and engineering analysis for any suspended transformers, cable trays, and trapeze hangers for multiple conduit runs.

PART 2 - PRODUCTS

2.1 COATINGS:

A. Coating: Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic. Products for use outdoors shall be hot-dip galvanized.

2.2 MANUFACTURED SUPPORTING DEVICES:

A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps.

B. Fasteners: Types, materials, and construction features as follows:

1. Expansion Anchors: Carbon steel wedge or sleeve type.
2. Toggle Bolts: All steel springhead type.

C. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for non-armored electrical cables in riser conduits. Provide plugs with number and size of conductor gripping holes as required to suit individual risers. Construct body of malleable-iron casting with hot-dip galvanized finish.

D. U-Channel Systems: 12-gage steel channels, with 9/16 inch-diameter holes, at a minimum of 8 inches on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of the same manufacture.

E. Supports: Provide supporting devices of types, sizes and materials indicated; and having the following construction features:

1. One-Hole Conduit Straps: For supporting 1 inch and smaller rigid metal conduit; galvanized steel.
2. Two-Hole Conduit Straps: For supporting 1 inch and larger rigid metal conduit, galvanized steel; 3/4 inch strap width; and 2-1/8 inch between center of screw holes.

2.3 FABRICATED SUPPORTING DEVICES:

A. General: Shop- or field-fabricated supports or manufactured supports assembled from U-channel components.

B. Steel Brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Install supporting devices to fasten electrical components securely and permanently in accordance with NEC requirements.

B. Coordinate with the building structural system and with other electrical installation.

C. Junction Box Supports: Comply with the NEC and the following requirement:

1. Use 1/4 inch all-thread rod from structure to support junction boxes.

D. Raceway Supports: Comply with the NEC and the following requirements:

1. Conform to manufacturer's recommendations for selection and installation of supports.

2. Strength of each support shall be adequate to carry present and future load multiplied by a safety factor of at least four. Where this determination results in a safety allowance of less than 200 lbs., provide additional strength until there is a minimum of 200 lbs. safety allowance in the strength of each support.

3. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.

4. Use #9 ceiling wire to support individual conduits up to 3/4 inch with spring steel fasteners. Use of ceiling support wires is unacceptable.

5. Support parallel runs of horizontal raceways together on trapeze-type hangers. Use 3/8 inch diameter or larger threaded steel rods for support.

6. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 1-1/2 inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings only. Contractor shall use 1/4 inch-diameter or larger threaded steel for hanger rods with spring steel fasteners. Use spring steel fasteners that are specifically designed for supporting single conduits or tubing. For hanger rods supporting 1-1/2 inch or larger conduits provide 3/8 inch minimum threaded steel rods with pipe hangers.

7. Space supports for raceways in accordance with NEC.

8. In all runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on raceway terminals.

9. Threaded rod supports to have bottoms cut off at a maximum length equal to rod diameter below bottom nut.

E. Conductor or Cable Supports: Comply with the NEC and the following requirements:
1. Support individual conductors or cables by separate clamps with rubber or plastic grommet, fasten using a non-metallic bolt and nut, and secure clamps to channel supports anchored to structure (multiple clamps may be secured to a single channel support). Individual conductors or cables may be served utilizing a vinyl or fiberglass clamp which shall be anchored to the structure.

2. Install simultaneously with installation of conductors.

F. Miscellaneous Supports: Support miscellaneous electrical components separately and as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices.

G. In overhead spaces, support metal boxes directly from the building structure via 1/4 inch minimum all-thread or by bar hangers. Where bar hangers are used, attach the bar to raceways on opposite sides of the box and support the raceway with an approved type of fastener not more than 24 inches from the box. Supporting metal boxes utilizing ceiling type wire is not acceptable.

H. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including but not limited to conduits, raceways, cables, cabinets, disconnect switches, and control components in accordance with the following:

1. Fasten by means of wood screws or screw-type nails on wood, toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or solid masonry, and machine screws, welded threaded studs, or spring-tension clamps on steel. Threaded studs driven by a powder charge and provided with lock washers and nuts may be used instead of expansion bolts and machine or wood screws, where authorized by the Owner and structural engineer. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions of light steel construction, use sheet metal screws.

2. Holes cut to depth of more than 1-1/2 inches in reinforced concrete beams or to depth of more than 3/4 inch in concrete shall not cut the main reinforcing bars. Fill holes that are not used.

3. Ensure that the load applied to any fastener does not exceed 25 percent of the proof test load. Use vibration- and shock-resistant fasteners for attachments to concrete slabs.

3.2 PERSONNEL PROTECTION:

A. Where U-channel systems, angles, brackets or other standard structural metal shapes are readily accessible and exposed to personnel, provide plastic or rubber end caps.

B. Where threaded rod supports are readily accessible and exposed to personnel, provide plastic or rubber end caps.

3.3 FIRE STOPPING LOCATIONS:

A. Preparation:

1. Coordination: Coordinate the work with other trades. Fire stopping materials at penetrations of insulated pipes and ducts can be applied after insulation is in place. If insulation is composed of combustible material, the thickness of fire stopping materials must be equivalent to that of the insulation. If the insulation is composed of non-combustible material, it may be considered as part of the penetrating item.

2. Surface Preparation: Surface Preparation to be in contact with fire stopping materials shall be free of dirt, grease, oil, loose material or other substances that may affect proper fitting or the required fire resistance.
B. Installation: Install fire stopping materials in accordance with the manufacturer's instructions.

C. Cleaning: After completion of fire stopping work in any area, equipment shall be reviewed and walls, ceilings and all other surfaces shall be cleaned of deposits of firestop materials.

END OF SECTION 26 05 29
PART 1 - GENERAL

1.1 SUMMARY:

A. Extent of raceway work is indicated by drawings and schedules. Provide complete conduit systems for all conductors unless otherwise specified.

B. Types of raceways specified in this section include the following:

1. Rigid Metal Conduit (RMC)
2. Liquidtight Flexible Metal Conduit (LFMC)
3. Electrical Metallic Tubing (EMT)

C. The following raceway systems are either specified in other sections or not anticipated to be provided by this Contractor.

1. High Density Polyethylene (HDPE)
2. Rigid Polyvinyl Chloride (PVC)
3. Intermediate Metallic Conduit (IMC)
4. Flexible Metal Conduit (FMC)
5. Nonmetallic Underground Conduit with Conductors (NUCC)
6. Reinforced Thermosetting Resin Conduit (RTRC)
7. Liquidtight Flexible Nonmetallic Conduit (LFNC)
8. Flexible Metallic Tubing (FMT)
9. Electrical Nonmetallic Tubing (ENT)
10. Busways and/or Cablebus
11. Cellular Concrete Floor Raceways
12. Underfloor Raceways
13. Cable Trays
14. Auxiliary Gutters / Wireways
15. Surface Raceway

PART 2 - PRODUCTS

2.1 CONDUIT AND TUBING:

A. General: Aluminum, Brass, and Stainless Steel tubing are not allowed unless specifically noted otherwise and/or for specialty systems such as use in corrosive or special condition environments. Provide galvanizing as indicated below. All fittings shall comply with NEMA FB 1.

B. Rigid Metal Conduit (RMC)

2. Fittings: Threaded galvanized steel, bushings shall have nylon insulated throat.
3. Provide conduit and fittings with external coating of PVC when being installed underground or encased in concrete.

C. Liquid-Tight Flexible Metal Conduit (LFMC)

1. Conduit: Continuous spiral wound, interlocked zinc-coated steel with polyvinyl chloride (PVC) jacket, approved for grounding.
2. Fittings: Zinc coated malleable iron. Straight and angle connectors shall be the same as used with flexible metal conduit but shall be provided with a compression type steel ferrule and neoprene gasket sealing rings.

D. Electrical Metallic Tubing (EMT)

1. Conduit: Thinwall steel tubing, unthreaded, with zinc electroplating.
2. Fittings: Steel compression fittings for all applications. Bushings shall be threaded and have nylon insulated throat or nylon bushing.
3. Weatherproof Fittings: Steel compression fittings for rain-tight and concrete-tight applications. Steel set-screw for all other connections. Set-screw quick fit type for 2-1/2 inches and larger may be used. Bushings shall be threaded and have nylon insulated throat or nylon bushing.

2.2 CONDUIT BODIES:

A. General: Types, shapes and sizes, as required to suit individual applications and NEC requirements. Provide matching gasketed covers secured with corrosion-resistant screws.

B. Metallic Conduit and Tubing: Use malleable iron conduit bodies. Use bodies with threaded hubs for threaded raceways and in hazardous locations.

C. Nonmetallic Conduit: Use nonmetallic conduit bodies.

2.3 CONDUIT SIZES:

A. Conduit sizes shall be as shown on the drawings. If the conduit size is not given on the drawings, the conduit shall be sized in accordance with NEC based on the number of conductors enclosed plus parity sized equipment ground.

PART 3 - EXECUTION

3.1 INSPECTION:

A. Examine areas and conditions under which raceways are to be installed, and substrate which will support raceways. Provide notification in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to Installer. Start of work constitutes acceptance of conditions.

3.2 CONDUIT SCHEDULE:

A. General: Unless otherwise indicated and where not otherwise restricted, use the conduit types indicated for the specified applications. Where more than one listed application applies, comply with the most restrictive requirements. Where conduit type for a particular application is not specified, use galvanized steel rigid metal conduit (RMC).

B. Interior, Damp or Wet Locations: RMC or EMT w/ rain tight fittings.

C. Exposed Interior in utility areas or areas with open ceilings: EMT

D. Connections to Vibrating Equipment: LFMC (Max 6' length)

E. Raceways in locations subject to mechanical injury: RMC.
F. Emergency Circuits: All emergency system circuits shall be run totally in non-flexible metal conduit (RMC or EMT).

G. Rework or extensions of existing conduit shall include the use of similar materials to the existing conduit type unless otherwise noted.

3.3 INSTALLATION OF CONDUITS:

A. General: Install electrical raceways in accordance with manufacturer's written installation instruction, applicable requirements of NEC, and as follows:

1. Conceal all conduits unless indicated otherwise, within finished walls, ceilings, and floors. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot water pipes. Install raceways level and square and at proper elevations.

2. Elevation of Raceway:
   a. Where horizontal raceway is installed near water and steam piping, route raceway above piping and as close to structure as possible and practical.
   b. Route raceway as close to structure as possible.

3. Complete installation of electrical raceways before starting installation of conductors within raceways.

4. Provide supports for raceways as specified elsewhere in Division 26.

5. Prevent foreign matter from entering raceways by using temporary closure protection.

6. Make bends and offsets so the inside diameter is not effectively reduced. Unless otherwise indicated, keep the legs of a bend in the same plane and the straight legs of offsets parallel.

7. Use raceway fittings that are types compatible with the associated raceway and suitable for the use and location. Install expansion fittings across all structural construction joints and expansion/deflection couplings across all structural expansion joints.

8. Run raceways parallel and perpendicular to building elements and other equipment with a minimum of bends in the shortest practical distance considering the type of building construction and obstructions except as otherwise indicated.

9. Install exposed raceways parallel and perpendicular to nearby surfaces or structural members and follow the surface contours as much as practical.

10. Run exposed and parallel raceways together. Make bends in parallel runs from the same center line so that the bends are parallel. Factory elbows may be used only where they can be installed parallel. In other cases provide field bends for parallel raceways.

11. Make raceway joints tight. Where joints cannot be made tight, use bonding jumpers to provide electrical continuity of the raceway system. Make raceway terminations tight.

12. Where terminations are subject to vibration, use bonding bushings or wedges to assure electrical continuity. Where subject to vibration or dampness, use insulating bushings to protect conductors.

13. Tighten set screws of thread less fittings with suitable tool.

14. Terminations: Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely and install the locknuts with dished part against the box. RMC shall be secured with double locknuts and an insulated metallic bushing. EMT shall be secured with one locknut and shall have nylon insulated throats or threaded nylon bushings from 1/2" to 1. 1-1/4" and above shall be metal with nylon insulated throats. Use grounding type bushings for feeder conduits at switchboards, panelboards, pull boxes, transformers, motor control centers, VFD's, etc.

15. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed.

16. Provide nylon pull string with printed footage indicators having not less than 200 pounds tensile strength. Leave not less than 12 inches of slack at each end of the pull string.
Identify with tags at each end the origin and destination of each empty conduit and indicate same on all empty or spare conduits on the as-built drawings.

17. Flexible Connections: Use short length (maximum of 6 feet) of flexible conduit for equipment subject to vibration, noise transmission, or movement; and for all motors. Use liquid-tight flexible conduit in wet locations. Install separate ground conductor across flexible connections. PVC externally coated rigid steel conduit: Patch all nicks and scrapes in PVC coating after installing conduit.

18. Where conduits are to be installed through structural framing members, the Contractor shall provide sleeves. The Engineer's written approval must be obtained prior to cutting, notching or drilling of structural framing members.

19. Ream the ends of all cut and/or threaded conduit. Ends shall be cut square.

20. Use of running threads for rigid or intermediate metallic conduit are not permitted. When threaded couplings cannot be used, provide 3 piece union or solid coupling.

21. Route conduit through roof openings for piping and ductwork where possible; otherwise, route through jack with pitch pocket.

22. Conduits shall not cross pipe shafts or ventilation duct openings. Where conduits must penetrate air-tight spaces or plenums, seal around the conduit with a mastic acceptable to the Engineer.

23. Install an insulated ground conductor in all conduits.

24. Provide separate raceway systems for each of the following:

   a. Power Distribution
   b. Emergency Systems
   c. Building Automation/Management (BAS/BMS)

B. Install labeling as required in Division 26 section - “Electrical Identification”.

3.4 ADJUSTING AND CLEANING:

   A. Upon completion of installation of raceways, inspect interiors of raceways; clear all blockages and remove burrs, dirt and construction debris.

END OF SECTION 26 05 33
PART 1 - GENERAL

1.1 SUMMARY:

A. This section includes cabinets, boxes, and fittings for electrical installations and certain types of electrical fittings not covered in other sections. Types of products specified in this section include:

1. Outlet and device boxes
2. Pull and junction boxes
3. Cabinets and Enclosures

B. Conduit-body-type electrical enclosures and wiring fittings are specified in the Division 26 Section on Raceways.

1.2 SUBMITTALS:

A. See Section 26 05 00 Common Work Results for Electrical for Submittal requirements. Supplemental information is listed within this section.

B. Product Data: Provide manufacturer's catalog information showing dimensions, materials, colors, and configurations for any control enclosures.

C. Shop Drawings: Provide computer generated drawings of all floor boxes as well as boxes, enclosures, and cabinets that are to be shop fabricated (non-stock items). For shop fabricated boxes, show accurately scaled views and spatial relationships to adjacent equipment as well as field wiring. Show box types, dimensions, and finishes. Control panels shall include, but not be limited to; lighting and specialized fan.

PART 2 - PRODUCTS

2.1 CABINETS, BOXES, AND FITTINGS, GENERAL:

A. Electrical Cabinets, Boxes, and Fittings: Of indicated types, sizes, and NEMA enclosure classes. Where not indicated, provide units of types, sizes, and classes appropriate for the use and location. Provide all items complete with covers and accessories required for the intended use. Provide gaskets for units in damp or wet locations.

2.2 MATERIALS AND FINISHES:

A. Sheet Steel: Flat-rolled, code-gauge, galvanized steel.

B. Fasteners for General Use: Corrosion resistant screws and hardware including cadmium and zinc plated items.

C. Fasteners for Damp or Wet Locations: Stainless steel screws and hardware.

D. Cast Metal for Boxes, Enclosures, and Covers; Copper-free aluminum except as otherwise specified.

E. Exterior Finish: Gray baked enamel for items exposed in finished locations except as otherwise indicated.
F. Painted Interior Finish: Where indicated, white baked enamel. Emergency system cabinets and boxes shall be red.

G. Fittings for Boxes, Cabinets, and Enclosures: Conform to UL 514B. Malleable iron or zinc plated steel for conduit hubs, bushings and box connectors.

2.3 METAL OUTLET, DEVICE, AND SMALL WIRING BOXES:

A. General: Conform to UL 514A, "Metallic Outlet Boxes, Electrical," and UL 514B, "Fittings for Conduit and Outlet Boxes." Boxes shall be of type, shape, size, and depth to suit each location and application.

B. Steel Boxes: Conform to NEMA OS 1, "Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports." Boxes shall be sheet steel with stamped knockouts, threaded screw holes and accessories suitable for each location including mounting brackets and straps, cable clamps, exterior rings and fixture studs.

2.4 PULL AND JUNCTION BOXES:

A. General: Comply with UL 50, "Electrical Cabinets and Boxes", for boxes over 100 cubic inches volume. Boxes shall have screwed or bolted on covers of material same as box and shall be of size and shape to suit application.

B. Steel Boxes: Sheet steel with welded seams. Where necessary to provide a rigid assembly, construct with internal structural steel bracing.

C. Hot-Dipped Galvanized Steel Boxes: Sheet steel with welded seams. Where necessary to provide a rigid assembly, construct with internal structural steel bracing. Hot-dip galvanized after fabrication. Cover shall be gasketed.

2.5 STEEL ENCLOSURES WITH HINGED DOORS:

A. Comply with UL 50, "Cabinets and Enclosures" and NEMA ICS 6, "Enclosures for Industrial Controls and Systems."

B. Construction: Sheet steel, 16 gage, minimum, with continuous welded seams. NEMA class as indicated; arranged for surface mounting.

C. Doors: Hinged directly to cabinet and removable, with approximately 3/4 inch flange around all edges, shaped to cover edge of box. Provide handle operated, key locking latch. Individual door width shall be no greater than 24 inches. Provide multiple doors where required.

D. Mounting Panel: Provide painted removable internal mounting panel for component installation.

E. Enclosure: NEMA 1 except as indicated. Where door gaskets are required, provide neoprene gasket attached with oil-resistant adhesive, and held in place with steel retaining strips. For all enclosures of class higher than NEMA 1, use appropriate weatherproof raceway entrances.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL:

A. Locations: Install items where indicated and where required to suit code requirements and installation conditions.
B. Cap unused knockout holes where blanks have been removed and plug unused conduit hubs.

C. Sizes shall be adequate to meet NEC volume requirements, but in no case smaller than sizes indicated.

D. Remove sharp edges where they may come in contact with wiring or personnel.

3.2 APPLICATIONS:

A. Hinged Door Enclosures Indoor: NEMA type 1 enclosure except as indicated.

B. Outlet Boxes and Fittings: Install outlet and device boxes and associated covers and fittings of materials and NEMA types suitable for each location and in conformance with the following requirements:
   1. Interior Dry Locations: NEMA Type 1, sheet steel or nonmetallic as permitted by local code.
   2. Locations Exposed to Weather or Dampness: Cast metal, NEMA type 3R.

C. Pull and Junction Boxes: Install pull and junction boxes of materials and NEMA types suitable for each location except as otherwise indicated.

3.3 INSTALLATION OF OUTLET BOXES:

A. Gasketed Boxes: At the following locations use malleable or cast metal, threaded hub type boxes with gasketed weatherproof covers:
   1. Where surface mounted on unfinished walls, columns or pilasters. (Cover gaskets may be omitted in dry locations).
   2. Where exposed to moisture laden atmosphere.

B. Mounting: Mount outlet boxes for switches with the long axis vertical or as indicated. Mount boxes for receptacles vertically. Three or more gang boxes shall be mounted with the long axis horizontal. Locate box covers or device plates so they will not span different types of building finishes either vertically or horizontally. Locate boxes for switches near doors on the side opposite the hinges and close to door trim, even though electrical floor plans may show them on hinge side. Provide far side box supports, for electrical switch boxes installed on metal studs and provide stud to stud support for electrical receptacle boxes installed on metal studs.

C. Cover Plates for Surface Boxes: Use plates sized to box front without overlap.

D. Protect outlet boxes to prevent entrance of plaster, and debris. Thoroughly clean foreign material from boxes before conductors are installed.

3.4 INSTALLATION OF PULL AND JUNCTION BOXES:

A. Box Selection: For boxes in main feeder conduit runs, use sizes not smaller than 8 inches square by 4 inches deep. Do not exceed 6 entering and 6 leaving raceways in a single box. Quantities of conductors (including equipment grounding conductors) in pull or junction box shall not exceed the allowable limits of the NEC.

B. Size: Provide pull and junction boxes for telephone, signal, and other systems at least 50 percent larger than would be required by Article 370 of NEC, or as indicated. Locate boxes strategically and provide shapes to permit easy pulling of future wires or cables of types normal for such systems.
C. Cable Supports: Install clamps, grids, or devices to which cables may be secured. Arrange cables so they may be readily identified. Support cable at least every 30 inches inside boxes.

3.5 INSTALLATION OF CABINETS AND HINGED DOOR ENCLOSURES:

A. Mount with fronts straight and plumb.

B. Install with tops 78 inches above floor.

3.6 GROUNDING:

A. Electrically ground metallic cabinets, boxes, and enclosures. Where wiring to item includes a grounding conductor, provide a grounding terminal in the interior of the cabinet, box or enclosure.

3.7 CLEANING AND FINISH REPAIR:

A. Upon completion of installation, inspect components. Remove burrs, dirt, and construction debris and repair damaged finish including chips, scratches, abrasions and weld marks.

B. Galvanized Finish: Repair damage using a zinc-rich paint recommended by the tray manufacturer.

C. Painted Finish: Repair damage using matching corrosion inhibiting touch-up coating.

END OF SECTION 26 05 34
SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY:

A. This Section includes identification of electrical materials, equipment, and installations. It includes requirements for electrical identification components including but not limited to the following:

1. Identification labeling for raceways
2. Instruction / Warning signs
3. Equipment labels and signs

1.2 QUALITY ASSURANCE:

A. ANSI Compliance: Comply with requirements of ANSI Standard A13.1, "Scheme for the Identification of Piping Systems," with regard to type and size of lettering for raceway and cable labels.

PART 2 - PRODUCTS

2.1 ELECTRICAL IDENTIFICATION PRODUCTS:

A. Identify System Raceways with Painted Couplings & Connectors: Install painted couplings at all conduit connecting couplings including end couplings. Apply the following colors:

1. Normal Power: Unpainted
2. Emergency Power: OSHA Orange
3. BMS/Temperature Control: Blue
4. Ground: Green

B. Adhesive Marking Labels: Pre-printed, flexible, self-adhesive labels with legend indicating voltage and service.

1. Label Size for Raceways: 1 inch high by 12 inches long (minimum) with 5/8 inch minimum height letters.
2. Label Size for Boxes, Enclosures, and Utilization Equipment: See detail on electrical plans.
3. 600 Volt and Below Normal: White letters on black background indicating source equipment designation, circuit number(s), and voltage.
4. 600 Volt and Below Emergency: Black letters on OSHA Orange background indicating source equipment designation, circuit number(s), and voltage.
5. Temperature Control: Black letters on white background indicating "BAS."
6. Ground: White letters on green background indicating "GROUND."

C. Adhesive Marking Tape for banding Wires and Cables: Self-adhesive vinyl tape, not less than 3 mils thick by 1 inch to 2 inches in width. Make each color band completely encircling cables, at penetrations of walls and floors, at each junction box and at 20-foot maximum intervals in straight runs.

D. Wire/Cable Designation Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound, cable/conductor markers with preprinted numbers and letter.

E. Engraved, Plastic-Laminated Labels, Signs and Instruction Plates: Engraving stock melamine plastic laminate, 1/16 inch minimum thick for signs up to 20 square inches, or 8 inches in length; 1/8 inch
thick for larger sizes. Engraved letters on colored face and punched for mechanical fasteners. Apply the following colors.

1. Label Size for Boxes, Enclosures, and Utilization Equipment: See detail on electrical plans.
2. Normal Power: White letters on Black face
3. Emergency / Standby Power: White letters on Red face
4. Temperature Control: Black letters on white background indicating "BAS."
5. Ground: White letters on green background indicating "GROUND".

F. Fasteners for Plastic-Laminated and Metal Signs: Self-tapping stainless steel screws or number 10/32 stainless steel machine screws with nuts and flat and lock washers.

G. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18-inch minimum width, 50 lb minimum tensile strength, and suitable for a temperature range from minus 50 degrees F to 350 degrees F. Provide ties in specified colors when used for color coding.

H. Adhesive Marking Tape for Device Cover Plates: 3/8 inch adhesive tape labels with 3/16 inch minimum height letters. Tape shall have black letters on clear background for normal and red letters on clear background for emergency. Embossed Dymo-Tape labels are not acceptable.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Per Laramie County Community College (LCCC) Construction Quality Standards:
   1. All electrical devices shall be labeled including junction boxes above ceilings.
   2. Label shall comply with information and requirements as dictated on electrical plan details.

B. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification work with corresponding designations specified or indicated.

C. Install identification devices in accordance with manufacturer's written instructions and requirements of NEC.

D. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.

E. Conduit Identification: Conduits shall have painted couplings and connectors to identify system cabling contained within. Labels shall also be provided on any exposed conduits. Install labels at 10 foot intervals. Labels for multiple conduits shall be aligned and read the same direction. Where conduits enter or exit a panelboard, pull or junction box, switchboard, or other distribution equipment, conduit labels shall include circuit number in addition to feeder identification and voltage. Use the colors as identified above.

F. Identify Junction, Pull and Connection Boxes: Identification of systems and circuits shall indicate system voltage and identity of contained circuits on outside of box cover. Color code shall be same as conduits for pressure sensitive labels. Use self-adhesive marking tape labels at exposed locations and indelible black marker at concealed boxes. All control boxes (BAS/BMS) shall have covers painted blue.

G. Circuit Identification: Tag or label enclosures and conductors as follows:
   1. Multiple Circuits: Where multiple branch circuits, control wiring or communications/signal conductors are terminated or spliced in a box or enclosure, label each conductor or cable with circuit number. For control and communications/signal wiring, use wire/cable marking tape
at terminations in wiring boxes, troughs and control cabinets. Use consistent letter/number conductor designations throughout on wire/cable marking tapes.

2. Match identification markings with designations used in panelboards shop drawings, Contract Documents, and similar previously established identification schemes for the facility's electrical installations.

3. Circuit Directory: Typed and reflective of final circuit changes required to balance panel loads. Every circuit and/or circuit modification shall be uniquely identified to be distinguishable from all other circuits. The identification description shall include an “APPROVED” degree of detail as determined by the State Fire Marshall’s Office. Obtain approval before installing.

H. Apply warning, caution and instruction signs and stencils as follows:

1. Install warning, caution or instruction signs where required by NEC, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install butyrate signs with metal backing for outdoor items.

I. Install equipment/system circuit/device identification as follows:

1. Apply equipment identification labels of engraved plastic-laminate on each major unit of electrical equipment in building, including central or master unit of each electrical system. Text shall match terminology and numbering of the Contract Documents. Apply labels for each unit.

J. Apply circuit/control/item designation labels of engraved plastic laminate for disconnect switches, breakers, pushbuttons, pilot lights, motor control centers, and similar items for power distribution and control components above, except panelboards and alarm/signal components, where labeling is specified elsewhere.

K. For panelboards, provide framed, typed circuit schedules (label all spares and spaces in pencil) with explicit description and identification of items controlled by each individual breaker.

L. Tag all grounding electrode conductors, associated bonding conductors, and grounding conductors at their point of attachment to any ground bus and grounding electrode (where possible) with a 2 inch diameter round green phenolic nameplate. Lettering shall be 1/4 inch high with 1/5 inch between lines centered on the tag stating "DO NOT DISCONNECT," "MAIN GROUND." Nameplate shall attach to conductor with a short length of small chain.

M. Install labels at locations for best convenience of viewing without interference with operation and maintenance of equipment.

N. Provide tape labels for identification of individual receptacles including receptacles in furniture systems and light switch wall-plates. Locate tape on front of plate and identify panel/branch circuit serving the receptacle. Provide tape labels for identification of individual switches or thermal overload switches which serve as equipment disconnects. Locate the tape on the front of the cover-plate and identify panel/branch circuit serving the equipment.

END OF SECTION 26 05 53
PART 1 - GENERAL

1.1 SUMMARY:
A. Extent of electrical connections for equipment is indicated by drawings and schedules. Electrical connections are hereby defined to include connections used for providing electrical power to equipment.

B. Applications of electrical power connections specified in this section include the following:
   1. From electrical source to safety/control equipment
   2. From safety/control equipment to motors
   3. From motors to secondary controllers (if applicable)
   4. To grounding system
   5. Other connections as shown within the electrical drawings

1.2 SUBMITTALS:
A. See Section 26 05 00 Common Work Results for Submittal requirements. Supplemental information is listed within this section.

B. Product Data: Submit manufacturer's data on electrical connections for equipment products and materials. As a minimum, information shall include: Operating Voltage; MCA (Min. circuit amperes); FLA (Full load amperes); MFS (Max. fuse size) or MOP (Max. overcurrent protection); and SCCR (Short Circuit Current Rating) and shall match electrical equipment and protection/distribution sizes and be rated for available short circuit currents as shown on the drawings.

C. Shop Drawings: Provide wiring diagrams where specialized control is detailed on the plans. Indicate all devices and final enclosure sizes.

D. Coordination Drawings: All mechanical and plumbing equipment shall be coordinated with unit nameplate information per the actual nameplate to be included on the equipment.

E. Field Quality Control Test Reports: Submit record of testing as described below. Refer to Section 26 05 00 – Common Work Results for additional requirements.

1.3 DEFINITIONS:
A. Load voltage wiring shall be defined as:
   1. Conduit and wiring required to carry power to motors and other equipment or devices. Wiring from control devices to equipment that carry power to drive that equipment such as line voltage thermostats, etc., shall be included as load voltage wiring. Wiring that provides power to control panels, control transformers, control relays, time clocks, etc., shall also be included as load voltage wiring.

PART 2 - PRODUCTS

2.1 GENERAL:
A. Per Laramie County Community College (LCCC) Construction Quality Standards:
1. All motor starters and motor rated switches shall be manufactured by General Electric (GE) Corporation. No equals will be considered.
2. All Fuses shall be manufactured by Bussman subsidiary of Eaton Corporation. No equals will be considered.
3. All safety disconnect switches shall be manufactured by General Electric (GE). Owner will also consider product by Cutler – Hammer and/or Square D.

B. Overcurrent Protective Devices (OCPDs): Provide type, rating, and features as indicated. Comply with Division 26 Section on Low Voltage Circuit Protective Devices, with OCPDs adapted to equipment connection installation. Tandem circuit breakers shall not be used. Multiple breakers shall have common trip.

C. Provide motor controllers that are horsepower rated to suit the motor controlled.

D. Contacts shall open each ungrounded connection to the motor. Contacts shall be NEMA rated, 75 degrees C.

E. Overload relays shall be ambient-compensated type with inverse-time-current characteristic. Provide with heaters or sensors in each phase matched to nameplate full load current of the specific motor to which connected with appropriate adjustment for duty cycle and power factor correction supplied with the motor.

2.2 MATERIALS AND COMPONENTS:

A. General: For each electrical connection indicated, provide complete assembly of materials, including but not necessarily limited to, pressure connectors, terminals (lugs), electrical insulating tape, electrical solder, electrical soldering flux, heat-shrinkable insulating tubing, cable ties, solderless wire-nuts, disconnect, starter, contactor, relays, etc., and other items and accessories as needed to complete splices and terminations of types indicated.

B. Metal Conduit, Tubing and Fittings:

1. General: Provide metal conduit, tubing and fittings of types, grades, sizes and weights (wall thicknesses) indicated for each type service. Provide products complying with Division 26 section on Raceways.

C. Wires, Cables, and Connectors:

1. General: Provide wires, cables, and connectors complying with Division 26 section on Wires and Cables.
2. Wires/Cables: Unless otherwise indicated, provide wires/cables (conductors) for electrical connections which match, including sizes, ratings, and material of wires/cables which are supplying electrical power.
3. Connectors and Terminals: Provide electrical connectors and terminals which mate and match, including sizes and ratings, with equipment terminals and are recommended by equipment manufacturer for intended applications.
4. Electrical Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing and boots, electrical solder, electrical soldering flux, wire-nuts and cable ties as recommended for use by accessories manufacturers for type services indicated.

2.3 MANUAL MOTOR STARTERS:

A. Manual starters shall be flush-mounting type except where conduits are run exposed or as otherwise noted. Manual starters shall be complete with properly sized overload protection and neon pilot light.
B. Heater units in all manual motor starters shall be sized for approximately 115 percent of full load motor current. Check and coordinate all thermal protective devices with the equipment they protect.

2.4 CIRCUIT AND MOTOR DISCONNECT SWITCHES:

A. General: Provide circuit and motor disconnect switches in types, sizes, duties, features, ratings, and enclosures as indicated. All equipment with maximum fuse size listed in nameplate shall have fusible disconnect switch provided. Provide NEMA 1 enclosure. For outdoor switches and switches indicated as weatherproof, provide NEMA 3R enclosures with rain-tight hubs. For motor and motor starter disconnects, provide units with horsepower ratings suitable to the loads.

B. Fusible Switches: Provide UL type "HD" 100 percent duty rated switches, with fuses of classes and current ratings indicated. Where current limiting fuses are indicated, provide switches with non-interchangeable feature suitable only for current limiting type fuses. All disconnect switches shall be fusible unless otherwise noted.

C. Accessories:
   1. Electrical Interlocks: Provide number and arrangement of interlock contacts in switches as indicated or required.
   2. Handles shall be lockable in open and closed position without modification.
   3. Disconnect switches provided in the motor feeders between a VFD and the motor shall be provided with auxiliary contacts at the disconnect that de-energizes power to the VFD.

2.5 MOTOR STARTERS:

A. See Division 23 for Requirements.

B. Combination Disconnect Type: Equipment shall be flush-mounting type except where conduits are run exposed or as otherwise noted. Starters shall be complete with properly sized overload protection and pilot light(s). Starters shall be NEMA ICS 2, AC general-purpose Class A magnetic controller for induction motors rated in horsepower. General Electric 300 Series.
   1. Full voltage, non-reversing type.
   2. Coil Operating Voltage: 24 volts, dc (Coordinate final requirements with BAS/BMS)
   3. Overload Relays: NEMA ICS 2; electronic
   4. Overload Element: Select and install overload heater elements in motor controllers provided under this Section to match installed motor characteristics
   5. Enclosures: NEMA ICS 6, Type as required to meet conditions of installation.
   7. Auxiliary Contacts: NEMA ICS 2, 2 normally open contacts in addition to seal-in contact
   8. Cover Mounted Pilot Devices: NEMA ICS 5, heavy duty oil tight type
   9. Pushbuttons: Unguarded type
   10. Indicating Lights: Transformer, LED type
   11. Selector Switches: Rotary type

C. Auxiliary Control Devices:

   1. Built in 120 volts control circuit transformer, fused from line side, where service exceeds 120 volts.
PART 3 - EXECUTION

3.1  INSPECTION:

A. Inspect area and conditions under which electrical connections for equipment are to be installed and provide notification in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to Installer. Start of work constitutes acceptance of conditions.

3.2  INSTALLATION OF ELECTRICAL CONNECTIONS:

A. Per Laramie County Community College (LCCC) Construction Quality Standards:
   1. Circuits shall be furnished with a dedicated neutral conductor. Neutrals common to more than one circuit will not be permitted for this project.

B. Furnish, set in place, and wire (except as may be otherwise indicated) all heating, ventilating, air conditioning, plumbing and fire protection, elevator, etc., motors and controls in accordance with the following schedule and 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. Carefully coordinate with work performed under the Mechanical Division of these Specifications.

C. Coordinate with other work, including wires/cables, raceway and equipment installation, as necessary to properly interface installation of electrical connections for equipment with other work.

D. 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.

E. Maintain existing electrical service and feeders to equipment serving occupied areas and operational facilities, unless otherwise indicated, or when authorized otherwise in writing by Owner, or Engineer. Provide temporary service during interruptions to existing facilities. When necessary, schedule momentary outages for replacing existing wiring systems with new wiring systems. When that "cutting over" has been successfully accomplished, remove, relocate, or abandon existing wiring as indicated.

F. Cover splices with electrical insulating material equivalent to, or of greater insulation resistivity rating, than electrical insulation rating of those conductors being spliced.

G. 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.

H. Trim cables and wires as short as practicable and arrange routing to facilitate inspection, testing and maintenance.

I. 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 NEC Appendix I.

J. Provide suitable strain relief clamps for cord connection to outlet boxes and equipment connection boxes.
K. Make wiring connections in control panel or in wiring compartment of pre-wired equipment and interconnecting wiring in accordance with manufacturer's instructions.

L. Install disconnect switches, controllers, control stations, and control devices such as limit switches and temperature switches as indicated or per manufacturer's instructions.

M. Provide each motor with a fused disconnect switch for 3 phase motors and horsepower rated and/or thermal rated disconnect switch for single phase motors as shown on schedules or required. Coordinate with manufacturers of standalone, packaged and other equipment for factory installed and field installed motors and controllers.

N. Provide circuit and motor disconnect switches as indicated and where required by Code. Comply with switch manufacturers printed installation instructions. Install within sight of motors.

O. All splices in control panels, terminal junction boxes, low voltage control circuits and fire alarm conductors shall be on numbered terminal strips.

P. Each branch circuit shall be furnished with a dedicated neutral conductor. Neutrals common to more than one circuit shall only be permitted where specifically noted.

Q. Where conduit is not required, plenum rated cable shall be provided in ceiling, floor or other air plenum spaces.

3.3 EQUIPMENT CONNECTION SCHEDULES:

A. The exact furnishing and installation of the equipment is left to the Contractors involved. Contractor should note that the intent is to have the Contractor responsible for coordinating all wiring as outlined, whether or not specifically called for by the Division 23 or Division 26 drawings and specifications. Comply with the applicable requirements of Division 26 for all electrical work which is not otherwise specified. No extras will be allowed for contractor's failure to provide for these required items. Contractor shall refer to the Division 26 and Division 23 specifications and plans for all power and control wiring and shall advise the Engineer of any discrepancies prior to bidding.

B. Mechanical Equipment:
   1. Refer to Mechanical Equipment Schedule on the drawings.
   2. The exact furnishing and installation of the equipment is left to the Contractors involved. Comply with the applicable requirements of Division 26 for all electrical work which is not otherwise specified.
   3. It is suggested that all line voltage wiring shall be provided under Division 26 and all 24V control wiring be provided under Division 23.
   4. The exact furnishing and installation of the equipment is left to the Contractors involved. Contractor should note that the intent is to have the Contractor responsible for coordinating wiring requirements whether or not specifically called for by the Division 23 or Division 26 drawings and specifications. Comply with the applicable requirements for all electrical work which is not otherwise specified. No extras will be allowed for contractor's failure to provide for these required items. Contractor shall advise the Engineer of any discrepancies prior to bidding.

C. For factory pre-wired equipment specified under other Divisions, all wiring within the equipment shall be by the manufacturer. All required field wiring between sections or other field connection details for power and/or control shall be clearly identified on shop drawings for contractor installation. Division 26 drawings show the provided electrical characteristics for equipment.
D. Manufacturer's equipment provided under other divisions which varies from what is shown on Division 26 drawings shall be the responsibility of the Contractor to complete and pay for any costs for those variations.

END OF SECTION 26 05 83
SECTION 26 24 19
MOTOR CONTROL CENTERS

PART 1 - GENERAL

1.1 SUMMARY:

A. This Section includes motor-control centers (MCCs) and components for circuits rated 600 V or less.
B. Coordinate controls and other connections with work provided in Division 23 and/or as otherwise indicated.

1.2 SUBMITTALS:

A. See Section 26 05 00 Common Work Results for Electrical for Submittal requirements. Supplemental information is listed within this section.
B. Product Data: Provide manufacturer's catalog information showing dimensions, materials, colors, and configurations for each product and component specified.
C. Shop Drawings:
   1. Wiring Diagrams: Interconnecting wiring diagrams pertinent to the class and type specified for the MCC. Schematic diagram of each type of controller unit indicated. Clearly differentiate between factory and field installed wiring.
D. Field Quality Control Test Reports: Submit record of testing. Refer to Section 26 05 00 – Common Work Results for additional requirements.
E. Extra Materials:
   1. Spare Fuses: Furnish spares of each type and rating of fuse for fusible devices amounting to one set of 3 fuses for each 9 fuses installed but not less than 3 fuses of each type. Include spares for:
      a. Control power fuses.
      b. Overloads (heaters).
   2. Spare Indicating Lamps: Furnish 6 of each type and color installed.
F. Operation and Maintenance Data: Include detailed information on system operation, device programming and setup, replacement parts and recommended maintenance procedures and intervals. Refer to Section 26 05 00 – Common Work Results for additional requirements.

1.3 QUALITY ASSURANCE:

A. Listing and Labeling: Provide MCCs that are listed and labeled.
   1. The terms "listed" and "labeled": As defined in the National Electrical Code, Article 100.
B. Motor control centers shall conform to the requirements of NEMA ICS 1, NEMA ICS 2, NEMA ICS 4 and NEMA ICS 6.
C. Manufacturers: Components shall match existing Allen-Bradley Centerline 2100 MCC.
PART 2 - PRODUCTS

2.1 FUNCTIONAL FEATURES:

A. Per Laramie County Community College (LCCC) Construction Quality Standards:
   1. All Fuses shall be manufactured by Bussman subsidiary of Eaton Corporation. No equals will be considered.
   2. All safety disconnect switches shall be manufactured by General Electric (GE).

B. General: Provide a modular arrangement of motor controllers, control devices, overcurrent protective devices, transformers, instruments, indicating panels, blank panels, and other items mounted in the compartments of the existing motor-control center as indicated or required. Provide all items listed herein unless otherwise indicated.

C. Provide (FVNR) full-voltage magnetic motor starter with circuit-breaker/fusible disconnect type disconnects and auxiliary control devices unless otherwise indicated. Construct each starter unit with doors, unit support pans, saddles and disconnect operators. Enclose and isolate each unit from adjacent units. Design units so that faults will be contained within compartments. Design plug-in units of same NEMA size and branch feeder units of same trip rating, to be interchangeable with each other. Provide starters with the following ratings, features and accessories:

   1. Provide equipment with Short Circuit Current Rating (SCCR) above available fault current.
   2. Starters, including contacts and coils, shall be NEMA rated, fully horsepower sized, and rated. IEC sized and rated equipment will not be allowed. Contacts shall open each ungrounded connection to the motor.
   3. Equip with ambient temperature compensated, thermal/magnetic solid state overload protection devices for each motor. Electronic motor overload protection including thermal modeling type thermal protection, Ground fault protection, individual monitoring of motor current in each phase, and a wide FLA adjustment with selectable trip.

      a. Provide trip-free overload relays, set for 115 percent of motor full load amps.
      b. All 3-phase motors 3/4 hp and larger shall be protected against loss of phase and phase reversal wired into the starter or integral to the controller. Differential single phasing protection shall be provided in the overload relay with solid state 3-phase sensing circuit and isolated contracts. If the overload relay does not advance the trip point under phase loss conditions by 25 percent or more, a separate phase protection device shall be factory mounted and wired in the starter enclosure.
      c. Provide Class 10 overload for standard applications and Class 20 for high inertia loads.
      d. Over and Under voltage: The ability for automatic re-start of equipment shall be provided. Settings shall be 110% for overvoltage and 80-95% for under voltage unless stated otherwise on the motor data sheets.
      e. Voltage and current unbalance: Settings shall be 10-15% of FLA for current unbalance alarm with 5-10 second delay and 20-25% of FLA for current unbalance trip with 2-5 second delay unless otherwise stated on the motor data sheets. Phase imbalance shall be adjustable from 2 to 10% with disable setting.

   5. Provide maintained contact HAND-OFF-AUTO (H-O-A) selector switches properly arranged and wired for manual speed selection in the HAND position and for remote speed selection in the AUTO position.
7. Provide pilot lights as follows:
   a. Running - Red

8. Provide four (4) additional spare sets of auxiliary contacts with each starter, two (2) normally open and two (2) normally closed.

9. Provide control and timing relays, interlocks, pneumatic switches and similar devices as required for coordination with control requirements of Division 23. Provide additional auxiliary contacts as required to coordinate with Division 23.

10. Stop and Lockout Pushbutton Station for equipment connections where not provided in Division 23: Momentary-break pushbutton station with a factory-applied hasp arranged so a padlock can be used to lock the pushbutton in the depressed position with the control circuit open.

D. Overcurrent Protective Devices: Provide types of devices with features, ratings, and circuit assignments indicated, as specified in Division 26 Section on Overcurrent Protective Devices.

E. Spare Units: Provide type, sizes, and ratings as indicated, and installed in compartments indicated "spare."

F. Provide padlocking provisions on each overcurrent protective device and motor controller lockable in the open or closed position. Provide three (3) sets of lockout/tagout devices for each type of breaker or switch provided. Include tags, locks, and all accessories necessary.

G. Where reduced voltage starting is required, the starting method shall be part winding or closed transition auto-transformer / solid state electronic starting. Motors shall be constructed accordingly. Other methods of reduced voltage starting shall not be used unless reviewed by the Engineer prior to bid.

2.2 OTHER CIRCUIT CONTROL AND PROTECTIVE DEVICES:

A. General: Factory-installed and tested devices of types listed below, with indicated ratings, settings, and features.

B. Indicating Lights: For circuit breakers where indicated. Lights shall be oil tight type, push-to-test with lens color as indicated.

C. Control Power: Where electrically operated/shunt tripped contactors are required, provide 120 volt control circuits supplied through secondary disconnect devices from a control power transformer. Include the following features:

D. Control Wiring:
   1. Flexible Conductors: Use for size No. 8 and smaller and for conductors across hinges, and conductors for interconnections between shipping units.
   2. Conductors Sizes: In accordance with NEC for the duty required.
   3. All control wiring shall be terminated on labeled power type terminal blocks with ring terminals.
   4. Limit cable bundles to 12 cables maximum.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. General: Install MCCs in accordance with NEMA ICS 2.3 "Instructions for the Handling, Installation, Operation, and Maintenance of MCCs," and with the manufacturer's written installation instructions.
B. Limit cable bundles to a maximum of 12 cables per bundle.

C. Provide two-hole compression connections for all incoming and outgoing phase, neutral, and ground connections.

3.2 IDENTIFICATION:

A. Identify field-installed wiring and components and provide warning signs as specified in Division 26 Section on Electrical Identification.

B. Provide main nameplate as well as a nameplate for each individual “bucket”.

3.3 GROUNDING:

A. Provide equipment grounding connections for motor control centers as indicated. Tighten connections to comply with tightening torques specified in UL Std 486A to assure permanent and effective grounds.

3.4 FIELD QUALITY CONTROL:

A. Provide all test results to Engineer in Substantial Completion Submittals prior to scheduling Substantial Completion observations. Test results shall be tabulated to show name of tested device, measured value, expected values, acceptable standard deviation, and test conditions, as well as any miscellaneous variables that may be applicable to test being performed.

B. Assure MCC installation meets specified requirements, is operational within specified tolerances, and provides appropriate protection for systems and equipment.

1. Test and inspect MCCs in accordance with manufacturer's recommendations and these specifications.
2. Schedule tests and provide notification at least 1 week in advance of test commencement.
4. Labeling: On satisfactory completion of tests and related effort, apply a label to tested components indicating results, person responsible, and date.

C. Visual and Mechanical Inspection:

1. Inspect for defects and physical damage, testing laboratory labels, circuit connections, and nameplate compliance with up-to-date system drawings.
2. Perform operational test and exercise of mechanical components and other operable devices in accordance with manufacturer's instruction manual.
3. Check MCC anchorage, external clearances, and alignment and fit of components including internal elements.
4. Check tightness of bolted electrical connections with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.
5. Perform visual and mechanical inspection and related work for motor control and protective devices as specified in Division 26 Sections on Overcurrent Protective Devices and Motor Controllers.

D. Electrical Testing:

1. Make continuity tests of supply, feeder, and control circuits.
2. Verify appropriate capacity, overcurrent protection, and operating voltage of control power elements including control power transformers and control power wiring.
3. Check phasing of supply source to the bus.
4. Test overcurrent protective devices as specified in Division 26 Section "Overcurrent Protective Devices."
5. Retesting: Correct deficiencies and retest. Verify by the retests that specified requirements are met.

END OF SECTION 26 24 19
SECTION 26 28 00
ELECTRICAL CIRCUIT PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 SUMMARY:
   A. This section includes overcurrent protective devices (OCPD's) rated 600 volts and below, as well as switching devices commonly used with them.
   B. Application, installation, and other related requirements for overcurrent protective device installations in distribution equipment, such as Panelboards, Switchboards, and Motor Control Centers, are specified in other Division 26 sections.

1.2 SUBMITTALS:
   A. See Section 26 05 00 Common Work Results for Electrical for Submittal requirements. Supplemental information is listed within this section.
   B. Product Data: Provide manufacturer's catalog information showing dimensions, materials, colors, and configurations for fuses, fusible switches, circuit breakers, and OCPD accessories specified in this Section.
   C. Field Quality Control Test Reports: Submit record of testing as described below. Refer to Section 26 05 00 - Common Work Results for additional requirements.
   D. Extra Materials: Furnish the following for Owner's use in maintenance of project.
      1. Spare Fuses: Furnish spares of each type and rating of fuse for fusible devices amounting to one set of 3 fuses for each 9 fuses installed but not less than 3 fuses of each type.

PART 2 - PRODUCTS:

2.1 OVERCURRENT PROTECTIVE DEVICES (OCPDS), GENERAL:
   A. General: Provide OCPDs in indicated types, as integral components of panelboards, switchboards, motor control centers, and other related equipment; and also as individually enclosed and mounted single units.
   B. Manufacturers: When mounting overcurrent protective devices in switchboards, switchgear, panelboards, MCC's, etc., provide equipment of same manufacturer as equipment into which they are being mounted.
   C. Per Laramie County Community College (LCCC) Construction Quality Standards:
      1. All Fuses shall be manufactured by Bussman subsidiary of Eaton Corporation. No equals will be considered.
      2. All safety disconnect switches shall be manufactured by General Electric (GE).
   D. Enclosures: NEMA 250 "Enclosures for Electrical Equipment (1,000 Volts Maximum)."
   E. Where OCPD's are to be installed in existing panelboards, switchboards, and motor control centers, they shall be of the same manufacture and type as those existing in the equipment. If this is not possible, provide devices which are compatible with the existing equipment and when installed will not void the U.L. label or reduce the short circuit rating of the equipment.
F. All overcurrent devices shall be individually rated for the available fault current unless otherwise noted. Series ratings of equipment will only be allowed where specifically called out.

2.2 CARTRIDGE FUSES:

A. General: Comply with NEMA Standard FU1, "Low-Voltage Cartridge Fuses." Unless indicated otherwise, provide nonrenewable cartridge fuses of indicated types, classes, and current ratings that have voltage ratings consistent with the circuits on which used.

B. All fuses used for main, feeder, or branch-circuit protection shall be Underwriters Laboratories listed, current-limiting fuses with 200,000 ampere interrupting rating and shall be so labeled. Fuses used for supplementary protection (other than branch circuit protection) shall be as specified above or shall be U.L. approved or component recognized for such purposes. All fuses provided shall be furnished by the same manufacturer. Should equipment provided require a different U.L. Class or size of fuse, the engineer shall be furnished sufficient data to ascertain that system function will not be adversely affected.

C. In order to simplify fuse replacement, reduce spare fuse inventory and insure adequate thermal protection, all fuses 600 amperes and below shall be true dual-element time-delay fuses with separate spring-loaded thermal overload elements in all ampere ratings. All ampere ratings shall be designed to open at 400 degrees F or less when subjected to a non-load oven test.

D. To eliminate induction heating, all fuse ferrules and end caps shall be non-ferrous and shall be bronze or other alloy not subject to stress cracking.

E. Comply with UL Standards for Safety High-Interrupting-Capacity Fuses, Current-Limiting Types. UL 198C
   1. Class J Fuses: Duel Element, Time Delay, Type LPJ
   2. Class CC Fuses: Time Delay, Type LP
   3. Class G Fuses: Duel Element, Time Delay, Type SC

F. Comply with UL Standards for Safety Class R Fuses. UL 198E
   1. Class RK1 Fuses: Duel Element, Time Delay, Type LPN/LPS
   2. Class RK5 Fuses: Duel Element, Time Delay, Type FRN/FRS

2.3 MOLDED-CASE CIRCUIT BREAKERS:

A. General: UL 489, "Molded Case Circuit Breakers and Circuit Breaker Enclosures," and NEMA AB 1, "Molded Case Circuit Breakers."

B. Construction: Provide bolt-in type.

C. Characteristics: Indicated frame size, trip rating, number of poles, and a short-circuit interrupting capacity rating as indicated or required to match existing devices or equipment.

D. Tripping Device: Quick-make, quick-break toggle mechanism with inverse-time delay and instantaneous overcurrent trip protection for each pole. All 120/208 volt rated breakers shall be rated and labeled "High Magnetic".

E. Enclosure for Switchboard, Motor Control Center, or Panelboard Mounting: Suitable for mounting in equipment indicated.

2.4 OCPD ACCESSORIES:

A. Lock-Out Devices: Provide padlocking provisions on each overcurrent protective device, lockable in the open or closed position. Provide 3 sets of lockout/tagout devices for each type of breaker or switch provided. Include tags, locks and all accessories necessary.
PART 3 - EXECUTION:

3.1 INSTALLATION:

A. Per Laramie County Community College (LCCC) Construction Quality Standards:
   1. Receptacles with integral GFI protection are NOT acceptable for use on this project.
   2. All Fuses shall be manufactured by Bussman subsidiary of Eaton Corporation. No equals will be considered.

B. OCPD's in existing distribution and branch circuit equipment shall match existing for type and be provided with features as listed herein.

C. Install fuses in fusible devices as indicated. Arrange fuses so that fuse ratings are readable without removing fuse.

D. All fuses for new disconnect switches or MCC's feeding motors or motor starters shall be provided with Class J fuses.

E. OCPDs and mounting accessories installed in existing equipment shall match the existing manufacturer and be rated for the available fault current.

3.2 IDENTIFICATION:

A. Identify components in accordance with Division 26 Section on electrical identification.

B. Provide computer-generated circuit directory for each lighting and appliance panelboard and each power distribution panelboard provided with a door, clearly and specifically indicating the loads served. Identify spares and spaces.
   1. Description included on electrical panel schedules are for design purposes only. Description printed on final panel schedules must have a sufficient degree of detail that allows each circuit to be distinguished from all others, as approved by the Authority Having Jurisdiction.

3.3 CONTROL WIRING INSTALLATION:

A. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

B. Install wiring between OCPD's and control/indication devices.

3.4 CONNECTIONS:

A. Check connectors, terminals, bus joints, and mountings for tightness. Tighten field-connected connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A.

3.5 GROUNDING:

A. Provide equipment grounding connections for individually mounted OCPD units as indicated and as required by NEC. Tighten connectors to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounding.
FIELD QUALITY CONTROL:

A. Provide all test results to Engineer in Substantial Completion Submittals prior to scheduling Substantial Completion observations. Test results shall be tabulated to show name of tested device, measured value, expected values, acceptable standard deviation, and test conditions, as well as any miscellaneous variables that may be applicable to test being performed.

B. Upon completing installation of the system, perform the following tests on all new equipment and existing equipment as indicated on the drawings:

1. Visual and mechanical inspection: Include the following inspections and related work.
   a. Overcurrent-Protective-Device Ratings and Settings: Verify indicated ratings and settings to be appropriate for final system arrangement and parameters.
   b. Inspect for defects and physical damage, NRTL labeling, and nameplate compliance with current single line diagram.
   c. Exercise and perform operational tests of all mechanical components and other operable devices in accordance with manufacturer's instruction manual.
   d. Check tightness of electrical connections of OCPD's with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.
   e. Clean OCPD's using manufacturer's approved methods and materials.
   f. Verify installation of proper fuse types and ratings in fusible OCPD's.

2. Electrical Tests: Perform the following tests in accordance with manufacturer's instructions:
   a. Insulation resistance test of fused power circuit devices, insulated-case, and molded-case circuit breakers, 600-ampere frame size and over at 1000 degree V D.C. for one minute from pole to pole and from each pole to ground with breaker closed and across open contacts of each phase. Insulation resistance less than 100 megohms is not acceptable.
   b. Make insulation resistance tests of OCPD buses, components, and connecting supply, feeder, and control circuits.
   c. Make continuity tests of circuits.

C. Labeling: Upon satisfactory completion of tests and related effort, apply a label to tested components indicating test results, date, and responsible organization and person.

D. Make adjustments for final settings of adjustable-trip devices.

E. Activate auxiliary protective devices such as ground fault or under-voltage relays, to verify operation of shunt-trip devices.

F. Check operation of electrically operated OCPDs in accordance with manufacturer's instructions.

3.7 CLEANING:

A. Upon completion of installation, inspect OCPD’s. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish.

END OF SECTION 26 28 00