University of Colorado
Colorado Springs

22-013
Cragmor Hall - Chiller Replacement

PROJECT MANUAL

December 9, 2022

PROJECT MANUAL

Cragmor Hall - Chiller Replacement

UNIVERSITY OF COLORADO
COLORADO SPRINGS

COLORADO SPRINGS, COLORADO

STATE PROJECT NO. 22-013

CONTRACT DOCUMENTS

Client: University of Colorado at Colorado Springs
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Colorado Springs, Colorado 80918
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Document Date: December 9, 2022

CONSTRUCTION BID MANUAL
TABLE OF CONTENTS

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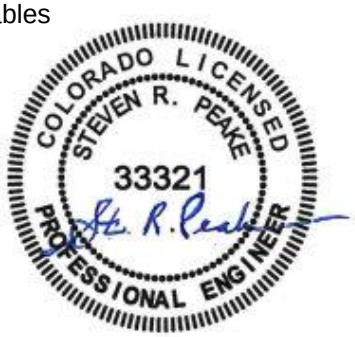
SPECIFICATIONS

Division 1 - General Requirements

Division 9 – Finishes

Division 23 – Heating Ventilating and Air Conditioning

Division 26 - Electrical



END of TABLE of CONTENTS

SECTION 01 10 00 - SUMMARY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 WORK COVERED BY CONTRACT DOCUMENTS

A. Project Identification: Project consists of removal and replacement of existing building chiller systems and associated temperature controls. The project requires the extension of an existing chiller enclosure.

1. Project Location: 1420 Austin Bluffs Pkwy, Colorado Springs, CO 80918
2. Owner: University of Colorado Colorado Springs

B. A/E Identification: The Contract Documents were prepared by Schendt Engineering Corp., 5145 Centennial Blvd. Suite 200, Colorado Springs, CO 80919, (719) 637-8850.

C. Project Manager: Jeff Reed, has been appointed by Owner to serve as Project Representative.

1.3 CONTRACT

A. Project will be constructed under a general construction contract. However, the Owner reserves the right to self-perform or separately contract some of the work.

1.4 WORK SEQUENCE

A. Chiller replacement work shall be coordinated with equipment delivery and shall not allow the building section to be open for more than 14 days. Open wall or roofing sections shall be protected from weather to the greatest extent possible.

B. After hours or weekend work with protection of existing furnishings will be required to avoid disturbance of the academic environment.

C. Electrical work to install mechanical equipment requires work outside of the respective building area designated.

1.5 USE OF PREMISES

A. General: Contractor shall have limited use of premises for construction operations as indicated on Drawings by the Contract limits.

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

1. Owner Occupancy: Allow for Owner occupancy of project site.
2. Driveways 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 storage of materials.

    a. Schedule deliveries to minimize use of driveways and entrances.
    b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.

3. Limit construction operations to those methods and procedures which will not adversely and unduly affect the working environment of the Owner's occupied spaces, including noise, dust, odors, air pollution, ambient discomfort, poor lighting, hazards and other undesirable effects and conditions.
4. Disruptive operations: Noisy and disruptive operations (such as use of jack hammers and other noisy equipment) shall not be allowed at times that will disrupt the Owner’s existing operations.

    a. Schedule and coordinate such operations with Owner.
    b. Upon notification from Owner, cease operations which are, in the opinion of the Owner, disruptive to operations. Schedule such operations as described above.

5. Power Outages: Do not interrupt power, lighting, plumbing, telephone and HVAC services to occupied areas. Coordinate and schedule any required utility outages with the Owner at least 30 days in advance of the outage; have Owner's approval.

C. Use of Existing Building: Maintain existing building in a weathertight condition throughout construction period. Repair damage caused by construction operations. Protect building and its occupants during construction period.

D. On-Site Work Hours: Work shall be generally performed inside the existing building during normal business working hours, Monday through Friday with exception noted above, and unless specifically authorized by the Owner's Representative. Work outside the building shall not begin until 8 am due to the area being surrounded by a residential neighborhood.

E. Special Campus Restrictions:

1. Areas in the vicinity of the building will be designated by the Owner's Project Representative for the purposes of Contractor's staging, stockpiling, and vehicle access.

2. No portion of the site may be used by Contractor without prior approval by Owner's Project Representative.

3. Contractor personnel are prohibited from existing building interiors except as required to execute specific work indicted on Drawings.

4. Contractor is prohibited from utilizing the building's computers, phones and internet access.

5. Contractor and associated personnel and subcontractors are not permitted to use existing toilet facilities and service sinks in the building for personal use, for cleaning tools or for disposing of construction waste materials. An area in the vicinity of the building will be designated by the Owner's Project Representative for the placement of a port-o-let.

6. Protect existing property from unauthorized access to building interiors, roofs, etc. Temporary work or storage of materials is not permitted to compromise building security.

7. Temporary work must not compromise structural integrity.

8. No construction waste materials may be disposed of in Owner's dumpsters or other Owner containers.

9. Construction areas shall be limited to the portions of the site indicated on Drawings.

10. Control smoke, dust, dirt, odors and other objectionable effects, and limit to the immediate area of construction. Contractor is responsible for cleaning other areas affected by noncompliance with this requirement, including contents of affected areas.

11. Clean work area of debris, and "broom clean" no less frequently than at the end of each work day. Remove all debris from exterior site areas which could be wind blown. Cover all furniture, computers, electronic devices and carpeted floors prior to the start of construction in each office, classroom, corridor, etc.

12. All Contractor's personnel, including but not limited to subcontractors, suppliers, inspectors, laborers, and any personnel under contract to or in the direct employ of the Contractor are not permitted to interact with students in any manner. Contractor's personnel is expected to be courteous and not stare, make rude and inappropriate noises or gestures toward students, faculty or staff.

13. Contractor's Superintendent may be subject to a full background check by UCCS authorities and may not have any prior convictions related to drug abuse, child abuse, or similar violations of applicable law.

1.6 WORK UNDER OTHER CONTRACTS

A. General: Cooperate fully with Owner and separate contractors so work on those contracts may be carried out smoothly, without interfering with or delaying work under this Contract. Coordinate the Work of this Contract with work performed under separate contracts.

1.7 SPECIFICATION FORMATS AND CONVENTIONS

A. Specification Format: The Specifications are organized into Divisions and Sections using the CSI/CSC's "MasterFormat" numbering system.

1. Section Identification: The Specifications use section numbers and titles to help cross-referencing in the Contract Documents. Sections in the Project Manual are in numeric sequence; however, the sequence is incomplete. Consult the table of contents at the beginning of the Project Manual to determine numbers and names of sections in the Contract Documents.

B. 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. Abbreviated Language: Language used in the Specifications and other Contract Documents is abbreviated. Words and meanings shall be interpreted as appropriate.

Words implied, but not stated, shall be inferred as the sense requires. Singular words shall be interpreted as plural, and plural words shall be interpreted as singular where applicable as the context of the Contract Documents indicates.

2. Imperative mood and streamlined language are generally used in the Specifications. Requirements expressed in the imperative mood are to be performed by Contractor. Occasionally, the indicative or subjunctive mood may be used in the Section Text for clarity to describe responsibilities that must be fulfilled indirectly by Contractor or by others when so noted.

    a. 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.

1.8 WORK SEQUENCE AND CONSTRUCTION PHASING

A. Sequencing of Construction Plan: Before start of construction on site, submit three copies of construction plan regarding access to work; use of site; and scheduling and phasing of new, demolition and renovation work for acceptance by Owner and Architect. After acceptance of plan, construction sequencing shall comply with the accepted plan unless deviations are accepted in writing. No work may commence until Notice to Proceed is provided by the Owner.

1.9 EXAMINATION OF SITE

A. Failure to visit the site will in no way relieve any Contractor from the necessity of furnishing materials or performing work that may be required to complete work in accordance with the Contract Documents without additional cost to the OWNER. Bids will be accepted from only those bidders who attend the **mandatory** pre-bid conference at the job site.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 10 00

SECTION 01 23 00 - ALTERNATES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes administrative and procedural requirements for alternates.

1.2 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 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. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternate into the Work. No other adjustments are made to the Contract Sum.

1.3 PROCEDURES

A. Coordination: Modify 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. Notification: Immediately following award of the Contract, notify each party involved, in writing, of the status of each alternate. Indicate if alternates have been accepted, rejected, or deferred for later consideration. Include a complete description of negotiated modifications to alternates.

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

D. Schedule: A Schedule of Alternates for each Project 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 BASE BID SCOPE

A. Provide the following scope of work:

1. Replace existing building chiller CH-1 with new CH-1 with all associated appurtenances as specified in the Contract Documents.
2. Replace existing chilled water pumps with new CWP-1 and CWP-2, glycol feeder GF-2, expansion tank, and all associated appurtenances as specified in the Contract Documents.
3. Extend existing chiller enclosure and pad as shown on sheets S1.01 and M1.01. Modify sprinkler
4. Paint new enclosure walls to match existing.
5. Remove and replaced damaged insulation as shown on sheets M1.01

3.2 SCHEDULE OF ADDITIVE ALTERNATES

A. No alternates

END OF SECTION 01 23 00

SECTION 01 25 00 – CONTRACT MODIFICATION PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. The General Conditions of the Contract provide the primary requirements for contract modification procedures.

B. This Section augments administrative and procedural requirements for handling and processing Contract modifications. Where conflicts between this Section and the General Conditions of the Contract, the General Conditions shall take precedence.

C. See Division 0 Section “Unit Prices” for administration requirements for using unit prices, if applicable.

D. See Division 1 Section “Product Requirements” for substitution procedures.

1.2 MINOR CHANGES IN THE WORK

A. The Architect will issue supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or Contract Time, on Architect’s Supplemental Instructions form.

1.3 CHANGE ORDER PROPOSAL REQUESTS

A. Owner-Initiated Proposal Requests: Architects will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include Supplemental or revised Drawings and Specifications.

1. Change Order Bulletins issued by the Architect are for information only. Do not consider them as an instruction either to stop Work in progress or to execute the proposed change.
2. Within 10 days of receipt of a Change Order Bulletin, prepare a Change Order Proposal and submit an estimate of cost adjustments to the Contract Sum and the Contract Time necessary to execute the change to the Architect for the Owner’s review.

    a. Include a list of quantities of products required and unit cost, with the total amount of purchases to be made. Where requested, furnish survey data to substantiate quantities.
    b. Indicate delivery charges, equipment rental, and amounts of trade discounts.
    c. Include costs of labor and supervision directly attributable to the change.
    d. Include an updated Contractor’s Construction Schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.

B. Contractor-Initiated Proposals: If latent or unforeseen conditions require modifications to the Contract, the Contractor may propose changes by submitting a request for a change to the Architect.

1. Include a statement outlining the reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.
2. Include a list of quantities of products required and unit costs, with the total amount of purchases to be made. If requested, furnish survey data to substantiate quantities.
3. Indicate delivery charges, equipment rental, and amounts of trade discounts.
4. Include costs of labor and supervision directly attributable to the change.
5. Include an updated Contractor's Construction Schedule that indicates the duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
6. Comply with requirements in Division 1 "Product Requirements" if the proposed change requires substitution of one product or system for a product or system specified.

C. Change Order Proposal Form: Use forms provided by the General Contractor for Change Order Proposals.

1.4 DISPUTED CONSTRUCTION CHANGE

A. Disputed Construction Change: When the Owner and the Contractor disagree on the terms of a Proposal Request, the Architect and Owner may issue a unilateral Change Order as referenced in Article 35 A.2. The unilateral Change Order shall instruct the Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.

1. The unilateral Change Order shall contain a complete description of the change in the Work and also designate the method to be followed to determine change to the Contract Sum or Contract Time.

B. Documentation: Maintain detailed records on a time and material basis of Work required by the unilateral Change Order.

1. After completion of the change, submit an itemized account and supporting data necessary to substantiate cost and time adjustment to the Contract.

1.5 EMERGENCY CHANGE ORDERS

A. Emergency Change Orders: Architect may issue an Emergency Change Order as described in the General Conditions of the Contract. Emergency Change Orders instruct the Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.

B. Documentation: Maintain detailed records on a time and material basis of work required by the Change Order.

1. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustment to the Contract.

1.6 CHANGE ORDER PROCEDURES

A. Upon the Owner's approval of a Change Order Proposal, the Architect will issue a Change Order for signatures of the Owner and the Contractor on State Form SC-6.31 Rev. 09/2006.

PART 2 - PRODUCTS

A. Not Applicable

PART 3 - EXECUTION

A. Not Applicable

END OF SECTION 01 25 00

SECTION 01 29 00 – PAYMENT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. The General Conditions of the Contract provide the primary requirements for payment procedures.

B. This Section specifies administrative and procedural requirements necessary to prepare and process Applications for Payment.

1.2 SCHEDULE OF VALUES

A. Coordination: Coordinate preparation of the Schedule of Values with preparation of Contractor's Construction Schedule.

1. Correlate line items in the Schedule of Values with other required administrative forms and schedules, including Submittals Schedule and Application for Payment forms with Continuation Sheets.
2. Submit the Schedule of Values to Architect at earliest possible date but no later than ten (10) days before the date scheduled for submittal of initial Applications for Payment.
3. Subschedules: Where the Work is separated into phases requiring separately phased payments, provide subschedules showing values correlated with each phase of payment.

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

1. Identification: Include the following Project identification on the Schedule of Values:

a. Project name and location.
b. Name of Architect.
c. Architect's project number.
d. Contractor's name and address.
e. Date of submittal.

2. Arrange the Schedule of Values in tabular form with separate columns to indicate the following for each item listed:

a. Related Specification Section or Division.
b. Description of the Work.
c. Name of subcontractor.
d. Name of Manufacturer, fabricator or supplier
e. Dollar value.
f. Percentage of the Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent.

3. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with the Project Manual table of contents. Provide several line items for principal subcontract amounts, where appropriate.

4. Round amounts to nearest whole dollar; total shall equal the Contract Sum.
5. General Conditions (including supervision), mobilization costs, costs of bonds and insurance, and Contractor's Fee should be assigned as separate line items. The General Contractor may divide such overhead costs into further line items at their discretion.
6. Provide a separate line item in the Schedule of Values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed. [Note: All requests for payment for materials stored off-site shall be subject to documentation and insurance as may be requested by Owner or Architect per General Conditions Article 31.]
7. Provide separate line items in the Schedule of Values for initial cost of materials, for each subsequent stage of completion, and for total installed value of that part of the Work.
8. Allowances: Provide a separate line item in the Schedule of Values for each allowance. Show line-item value of unit-cost allowances, as a product of the unit cost, multiplied by measured quantity. Use information indicated in the Contract Documents to determine quantities.
9. Each item in the Schedule of Values and Applications for Payment shall be complete.
10. Schedule Updating: Update and resubmit the Schedule of Values before the next Applications for Payment when Change Orders result in a change in the Contract Sum.

1.3 APPLICATIONS FOR PAYMENT

A. Each Application for Payment shall be consistent with Articles 31 and 32 of the General Conditions and previous applications and payments as certified by Architect and paid for by Owner.

1. Initial Application for Payment, Application for Payment at time of Substantial Completion, and final Application for Payment involve additional requirements.

B. Payment Application Times: The date for each progress payment is indicated in the Agreement between Owner and Contractor. The period of construction Work covered by each Application for Payment is the period indicated in the Agreement.

C. Payment Application Forms: Use standard State forms provided by Owner**,** as form for Applications for Payment.

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

1. Entries shall match data on the Schedule of Values and Contractor's Construction Schedule. Use updated schedules if revisions were made.
2. Include amounts of Change Orders issued before last day of construction period covered by application. Each Change Order shall be shown as a separate line item on the Continuation Sheet with supplemental breakdown of items within each Change Order to the degree necessary for the Architect to further evaluate the pay application.

E. Transmittal of DRAFT: Submit one copy of a Draft without signatures to each the Architect and Owner's designated representative, for preliminary approval. Upon notification from the Architect of necessary revisions or if no notification is given after five (5) business days, submit certified originals as indicated below.

F. Transmittal: Submit four (4) signed and notarized original copies of each Application for Payment to Architect by a method ensuring receipt within 2 business days. One copy shall be complete including back-up attachments, supplemental insurance and similar attachments if required.

1. Transmit each copy with a transmittal form listing attachments and recording appropriate information about application.

G. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:

1. List of subcontractors, principal suppliers and fabricators.
2. Schedule of Values.
3. Contractor's Construction Schedule (preliminary if not final).
4. Schedule of Unit Prices
5. Submittals Schedule (preliminary if not final).
6. List of Contractor's staff assignments.
7. Copies of building, electrical, plumbing or other required permits.
8. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.
9. Certificates of insurance and insurance policies.
10. Performance and payment bonds.

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

1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
2. This application shall reflect Certificates of Partial Substantial Completion issued previously for Owner occupancy of designated portions of the Work.
3. Submission of occupancy permits and similar approvals shall precede or coincide with this application for payment.

I. Final Payment Application: Submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:

1. Evidence of completion of Project closeout requirements including warranties, Test/adjust/balance records and Operation & Maintenance Manuals.
2. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
3. Advice on shifting insurance coverage.
4. Updated final statement, accounting for final changes to the Contract Sum.
5. AIA Document G706, "Contractor's Affidavit of Payment of Debts and Claims."
6. AIA Document G707, "Consent of Surety to Final Payment."
7. Evidence that claims have been settled.
8. Confirmation of completion of all punchlist items and items identified for completion after Final Acceptance.
9. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Substantial Completion or when Owner took possession of and assumed responsibility for corresponding elements of the Work.
10. Final, liquidated damages settlement statement.
11. Transmittal of required Project Construction Records to the Owner.
12. Removal of temporary facilities and services.
13. Removal of surplus materials, rubbish, and similar elements.
14. Change of door locks to Owner’s access.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 29 00

SECTION 01 31 00 - 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 1 Specification Sections, apply to this Section.

1.2 SUMMARY

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

1. General project coordination procedures.
2. Conservation.
3. Coordination Drawings.
4. Administrative and supervisory personnel.
5. Project meetings.

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

C. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 1 Section "Closeout Procedures" for coordinating Contract closeout.

1.3 COORDINATION

A. Coordination: Coordinate construction operations included in various 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.

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 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 accessibility for required maintenance, service, and repair.
3. Make adequate provisions to accommodate items scheduled for later installation.

C. If necessary, 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 and activities of other contractors to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:

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. Start-up and adjustment of systems.
8. Project closeout activities.

E. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials.

1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work.

1.4 SUBMITTALS

A. Coordination Drawings: Prepare Coordination Drawings if limited space availability necessitates maximum utilization of space for efficient installation of different components or if coordination is required for installation of products and materials fabricated by separate entities.

1. Indicate relationship of components shown on separate Shop Drawings.
2. Indicate required installation sequences.
3. Refer to Division 23 Section "Basic Mechanical Materials and Methods" and Division 26 Section "Basic Electrical Materials and Methods" for specific Coordination Drawing requirements for mechanical and electrical installations.

B. Staff Names: Within 10 days of starting construction operations, submit a list of principal staff assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home and office telephone numbers. Provide names, addresses, and telephone numbers of individuals assigned as standbys in the absence of individuals assigned to Project.

1. Post copies of list in Project meeting room, in temporary field office, and by each temporary telephone.

1.5 ADMINISTRATIVE AND SUPERVISORY PERSONNEL

A. General: In addition to Project superintendent, provide other administrative and supervisory personnel as required for proper performance of the Work.

1. Include special personnel required for coordination of operations with other contractors.

1.6 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 Architect of scheduled meeting dates and times.
2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
3. Minutes: Record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Architect, within 3 days of the meeting.

B. Preconstruction Conference: Schedule a preconstruction conference before starting construction, at a time convenient to Owner and Architect, but no later than 15 days after execution of the Agreement. Hold the conference at Project site or another convenient location. Conduct the meeting to review responsibilities and personnel assignments.

1. Attendees: Authorized representatives of Owner, Architect, and their consultants; Contractor and its superintendent; major subcontractors; manufacturers; suppliers; and other concerned parties shall attend the conference. All 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. Tentative construction schedule.
b. Phasing.
c. Critical work sequencing.
d. Designation of responsible personnel.
e. Procedures for processing field decisions and Change Orders.
f. Procedures for processing Applications for Payment.
g. Distribution of the Contract Documents.
h. Submittal procedures.
i. Preparation of Record Documents.
j. Use of the premises.
k. Responsibility for temporary facilities and controls.
l. Parking availability.
m. Office, work, and storage areas.
n. Equipment deliveries and priorities.
o. First aid.
p. Security.
q. Progress cleaning.
r. Working hours.

C. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity that requires 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 Architect 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:

a. Contract Documents.
b. Options.

c. Related Change Orders.
d. Purchases.
e. Deliveries.
f. Submittals.
g. Possible conflicts.
h. Compatibility problems.
i. Time schedules.
j. Weather limitations.
k. Manufacturer's written recommendations.
l. Warranty requirements.
m. Compatibility of materials.
n. Acceptability of substrates.
o. Temporary facilities and controls.
p. Space and access limitations.
q. Regulations of authorities having jurisdiction.
r. Testing and inspecting requirements.
s. Required performance results.
t. Protection of construction and personnel.

3. Record significant conference discussions, agreements, and disagreements.
4. 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. Progress Meetings: Conduct progress meetings at monthly intervals. Coordinate dates of meetings with preparation of payment requests.

1. Attendees: In addition to representatives of Owner and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
2. 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.
b. Review present and future needs of each entity present, including the following:

1) Interface requirements.
2) Sequence of operations.
3) Status of submittals.
4) Deliveries.
5) Off-site fabrication.
6) Access.
7) Site utilization.
8) Temporary facilities and controls.
9) Work hours.
10) Hazards and risks.
11) Progress cleaning.

12) Quality and work standards.
13) Change Orders.
14) Documentation of information for payment requests.

3. Reporting: Distribute minutes of the meeting to each party present and to parties who should have been present. Include a brief summary, in narrative form, of progress since the previous meeting and report.

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.

E. 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: In addition to representatives of Owner and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the conference 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) Status of submittals.
4) Deliveries.
5) Off-site fabrication.
6) Access.
7) Site utilization.
8) Temporary facilities and controls.
9) Work hours.
10) Hazards and risks.
11) Progress cleaning.
12) Quality and work standards.
13) Change Orders.

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 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 31 00

SECTION 01 32 00 – SCHEDULES AND REPORTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS AND SECTIONS

A. The Project Schedule shall be in accordance with this Section, and the General Conditions.

1.2 SUMMARY

A. Work covered by this Section includes the following:

1. The Contractor shall provide all information and input required for development of the Project Schedule for the work in accordance with the requirements of this Section and related sections. The purpose of the Project Schedule shall be to:

   a. Assure adequate planning, scheduling and reporting by the Contractor during execution of its work;
   b. Assure coordination of the work of the Contractor and the various subcontractors, suppliers at all tiers, owner-performed work (as needed), owner-provided equipment, and facility staffing;
   c. Assist the Contractor and the Owner in monitoring the progress of the work and evaluating proposed changes to the Contract and the Project Schedule;
   d. Assure milestone completion dates are met; and,
   e. Assist the Contractor and the Owner in the preparation and evaluation of the Contractor's monthly Application for Payment.

2. The Project Schedule shall utilize a method of scheduling which will adequately demonstrate the planning, scheduling, and reporting of work to be performed under the contract.
3. Required planning, scheduling and reporting will be produced through the use of computer scheduling software program which is capable of clearly showing the project milestones and the flow of work required under the contract. Schedule to show all activities from Notice of Award through Contract Completion date as shown on original contract.

1.3 DEFINITIONS

A. Definitions applicable to this Section include the following:

1. Project Schedule - the computer-generated plan for construction and associated reports as outlined in the requirements of this Section, prepared using the Critical Path Method and showing the sequence and interdependence of the activities, and planned and actual progress by activity required for complete performance of the work.
2. Activity – any portion or element of work, action, and/or reaction that is precisely described, readily identifiable and is a function of a logical sequential process.
3. Milestone – an activity that represents a significant point in time and has no duration.
4. Working Day - any calendar day scheduled for active performance of contract requirements.

5. Data Date – the date on which project progress status is updated, which becomes the starting point for schedule calculations of remaining work.
6. Contract Execution – period during which the Contract is processed and executed, starting with the Notice of Award and ending with the Notice to Proceed.
7. Notice of Award – the milestone marking the end of the negotiation period and start of the contract execution process.
8. Notice to Proceed – the milestone marking the end of the contract execution process and the beginning of the 10-day mobilization period and the start of actual construction.
9. Phased Occupancy – in multi-building projects, possession by the State of discreet elements of the project.
10. Substantial Completion – physical portion of the Work fully usable and safe for public use as defined in Article 41. C of the General Conditions of the Contract (State Form SC-6.23 Rev. 07/2008).
11. Notice of Acceptance – the milestone marking the official end to the actual construction period, occurring when the only remaining work consists of a punchlist of less than ten minor items and completion of the closeout checklist.
12. Contract Completion – the date as shown in the original contract, changed only by change order or amendment to the executed agreement. This date is calculated from the Notice to Proceed and includes the required 10-day mobilization period, and the contractual construction duration.
13. Occupancy – possession of the building by the State.

1.4 SUBMITTALS

A. Project Schedule

1. Within twenty one (21) calendar days after the date of the Notice to Proceed, the Contractor shall submit for review to the Owner its proposed Project Schedule covering the entire Contract period. Refer to Paragraph 3.3 A.1 of this Section for complete requirements of this submittal.

PART 2 - NOT APPLICABLE

PART 3 - EXECUTION

3.1 PROJECT MILESTONES

A. The Contractor shall show all Project milestones, including, but not limited to:

1. Notice of Award,
2. Notice to Proceed
3. Project Schedule Review and Acceptance,
4. Shop Drawings, Product Data and sample submittal and review dates,
5. Requirements of the Owner,
6. Permanent Power,
7. Others as appropriate to the specific Contract (including phased occupancy),
8. Required Operational Training,
9. Substantial Completion,
10. Notice of Acceptance,
11. Contract Completion,
12. Occupancy,

13. Closeout.

3.2 SCHEDULE ORIENTATION

A. The pre-construction conference shall include discussion to ensure the Contractor's understanding of the requirements of this Section. The Contractor shall be prepared to discuss the Project Schedule and sequence of operations.

1. Those in attendance for this discussion should include:

   a. Contractor's project manager, superintendent and scheduling representative
   b. Any other key personnel, including subcontractors as needed, the Contractor deems advisable to attend
   c. Representatives of the Owner and its consultants

2. Procedures will be reviewed for the following, including but not limited to:

   a. Development of the Project Schedule by the Contractor
   b. Monthly updating of schedule of activities and method of determining schedule percent complete
   c. Schedule revisions
   d. Distribution of reporting requirements
   e. Data exchange and communication
   f. Establishing procedures to analyze and incorporate change orders
   g. Methodology of submitting and analyzing time impacts
   h. The format and use of the Schedule of Values.
   i. The method of establishing target schedules and evaluating schedule performance.

3.3 SCHEDULE REQUIREMENTS

A. Project Schedule

1. Schedule development by Contractor:

   a. Within twenty one (21) calendar days after the date of the Notice to Proceed, the Contractor shall submit an electronic copy of its proposed Project Schedule to the Owner. The Project Schedule shall cover the entire Contract period. The Project Schedule shall, at a minimum, accomplish the following :

      1) Identify proposed procurement activities.
      2) Identify all proposed construction activities (construction activities shall not exceed 10 working days in duration).
      3) Identify proposed durations for activities.
      4) Indicate proposed sequencing of activities, through relationships and logic ties between activities. Open-ended activities will not be permitted.
      5) Detail activities for each milestone to show the plan for completion of the work for each milestone within the time specified by the executed Contract.
      6) Indicate area (i.e., building, sitework, site utilities, playfield, etc.) of activities.
      7) Indicate the specified number of days for developing punchlist(s), completion of punchlist items, and final clean-up for the work.
      8) Indicate the interfaces with the work of outside contractors or agencies (i.e., utilities, government agencies, State, etc.), including delivery of owner-furnished material and equipment, and training activity.

9) For all major equipment and materials fabricated or supplied for this Project, the Project Schedule shall indicate a sequence of activities, including, but not necessarily limited to:

a) Preparation of shop drawing and sample submissions
b) Review of shop drawings and samples
c) Shop fabrication and delivery
d) Erection or installation

b. The following shall be depicted on the Project Schedule for each activity:

1) Each activity shall have a unique number, and all activities in a certain sequence of work shall be numbered in a logical sequential manner.
2) Each activity shall have a concise, unique description of the work represented by the activity. The work related to each activity shall be limited to one work trade and one area.

c. The Contractor shall be responsible for ensuring that all subcontractor and supplier work, at all tiers, is included in the Project Schedule.
d. The Project Schedule as developed shall show the sequence and interdependence of activities required for complete performance of the work. The Contractor shall be responsible for ensuring that all work sequences are logical and the Project Schedule shows a coordinated plan of the work.
e. The level of detail of the Project Schedule shall be a function of the complexity of the work involved.
f. The Project Schedule shall show the Contract Completion Date reflected in the Contract Documents.
g. Proposed durations assigned to each activity shall be the Contractor's best estimate of time required to complete the activity considering the scope and resources planned for the activity.
h. Failure by the Contractor to include any element of work required for performance of the contract, to properly sequence such work, or meet an individual activity duration shall not excuse the Contractor from completing all work within the Contract period.
i. The Project Schedule shall reflect a plan of work demonstrating that the Contractor has coordinated its work and that of its subcontractors in maintaining orderly progress toward completion of the work as scheduled.
j. Seasonal weather conditions shall be considered and included in the planning and scheduling of all work influenced by high or low ambient temperatures and/or precipitation to ensure completion of all work within the Contract period.

2. Initial submission of the proposed Project Schedule shall be presented in hard copy format not to exceed 11" x 17" in size.

3.4 WEEKLY PROGRESS MEETING

A. Discussion of the status of the Project Schedule will be included in the weekly progress meeting, as noted in the "Project Meetings" section of this manual.

3.5 Project Schedule Updating

A. The Project Schedule shall be updated on a monthly basis throughout the entire Contract period and in conjunction with the submission of the Application for Payment.

B. Each Project Schedule Update, submitted with the Application for Payment, shall depict the following:

1. All activities completed during the preceding month.
2. All activities started but not completed during the preceding month, including percent complete.
3. All activities that were scheduled to start during the preceding month but didn't.
4. Any changes to the schedule logic or original activity durations.

3.6 Project Schedule Revisions

A. Updating the Project Schedule to reflect actual progress made up to the date of a schedule update shall not be considered revisions to the Project Schedule.

B. If, as a result of the monthly Schedule Update, it appears the Project Schedule no longer represents the actual prosecution and the progress of the work, the Owner will request, and the Contractor shall submit, a revision to the Project Schedule.

C. If the Contractor desires to make changes in the Project Schedule to reflect revisions in its method of operating and scheduling of the work, the Contractor shall notify the Owner in writing, stating the reason for the proposed revisions. Accepted revisions will be incorporated into the Project Schedule at the next monthly Schedule Update.

D. Any change to the accepted Project Schedule must be reviewed and accepted by the Contractor and the Principal Representative.

E. Neither the updating nor revision of the Contractor's Project Schedule, nor the submission, updating, change or revision of any report or schedule submitted to the Owner by the Contractor under this Section, nor the Owner's review or nonexistence of any such report or schedule shall have the effect of amending or modifying, in any way the Contract period, any Contract Completion date, Contract Milestone dates, modifying or limiting in any way Contractor's obligations under this Contract or constitute additional work.

3.7 Time Impact Analysis for Change Orders, Delays, and Contractor Requests

A. When change orders are initiated, the Contractor shall prepare a revised schedule demonstrating how the additional work is to be incorporated into the existing Project Schedule.

B. When delays are experienced as the result of the issuance of a change order, the Contractor shall submit to the Owner an analysis illustrating the influence of each change order on the Contract period. Each analysis shall demonstrate how the Contractor proposes to incorporate the delay into the Project Schedule. The time analysis shall demonstrate the time impact, based on the date the change order is given to the Contractor, the status of construction at that point in time, on all affected activities.

C. Activity delays shall not automatically mean that an extension of the Contract period is warranted or due the Contractor. It is possible that a change order or delay will not affect existing critical activities or cause non-critical activities to become critical.

D. In cases where the Contractor does not submit a time impact analysis within the time required by the General Conditions, it is mutually agreed that the particular change order, delay or Contractor request does not require an extension of the Contract period.

E. Approval or rejection of each time impact analysis by the Owner shall be made within seven (7) calendar days after receipt. Upon acceptance, a formal change will be issued and incorporated into the Project Schedule.

F. Failure of subcontractors to meet their schedules shall not be justification for an extension of time by the General Contractor. Requirements of the General Conditions of the Contract regarding extensions of time and extra work shall apply.

G. Time impact analysis related to an extension of the Contract period and/or change order work shall be incorporated into and attached to the applicable change order.

3.8 Responsibility for Completion

A. The Contractor shall furnish sufficient forces, offices, facilities and equipment, and shall work such hours, including night shift and overtime operations, as necessary to ensure the prosecution of the work in accordance with the current monthly Project Schedule update. If, in the opinion of the Owner, the Contractor falls behind in meeting the Project Schedule as presented in the current monthly Project Schedule update, the Contractor shall take any and all steps as may be required to improve its progress without additional cost to the State, including but not limited to the following:

1. Increased construction manpower in such quantities and crafts as will substantially eliminate the lag in scheduled progress;
2. Increased working hours per shift, shifts per working day, working hours per week, or the amount of construction equipment, or any combination of the foregoing, sufficient to substantially eliminate lag in scheduled progress;
3. Rescheduled sequence activities to achieve maximum practical concurrent accomplishment of work activities; and
4. Other steps as may be necessary to improve progress.

B. The Contractor may also be required to submit for acceptance and at no additional cost to the State such supplementary progress schedules as may be deemed necessary to demonstrate the manner in which the accepted Project Schedule will be recovered.

END OF SECTION 01 32 00

SECTION 01 33 00 - 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 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other miscellaneous submittals.

B. Related Sections include the following:

1. Division 1 Section "Project Management and Coordination" for submitting Coordination Drawings.
2. Division 1 Section "Quality Requirements" for submitting test and inspection reports and Delegated-Design Submittals.
3. Division 1 Section "Closeout Procedures" for submitting warranties Project Record Documents and operation and maintenance manuals.

1.3 DEFINITIONS

A. Action Submittals: Written and graphic information that requires Architect/Engineer's responsive action.

B. Informational Submittals: Written information that does not require Architect/Engineer’s approval. Submittals may be rejected for not complying with requirements.

1.4 SUBMITTAL PROCEDURES

A. General: At Contractor's written request, copies of Architect/Engineer’s CAD files may be provided to Contractor for Contractor's use in connection with Project, subject to the following conditions:

1. Limited to drawings that already exist.
2. Used by Contractor as background information only.
3. Contractor includes a statement absolving the Architect or Engineer of all liability in connection with the use of said CAD drawing. This statement shall be included on all published drawings that include elements from the copied CAD files.
4. Architect or Engineer will not be held responsible for delays in Contractor’s submittals as a result of delivery or non-delivery of any CAD file.

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. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.

    a. Architect/Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

C. Submittals Schedule: Comply with requirements for list of submittals and time requirements for scheduled performance of related construction activities.

D. Processing Time: Allow enough time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect/Engineer's receipt of submittal.

1. Initial Review: Allow 10 days for initial review of each submittal. Allow additional time if processing must be delayed to permit coordination with subsequent submittals. Architect will advise Contractor when a submittal being processed must be delayed for coordination.
2. Concurrent Review: Where concurrent review of submittals by Architect/Engineer's consultants, Owner, or other parties is required, allow 15 days for initial review of each submittal.
3. If intermediate submittal is necessary, process it in same manner as initial submittal.
4. Allow 10 days for processing each resubmittal.
5. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing.

E. Identification: Place a permanent label or title block on each submittal for identification.

1. Indicate name of firm or entity that prepared each submittal on label or title block.
2. Provide a space approximately 4 by 5 inches on label or beside title block to record Contractor's review and approval markings and action taken by Architect/Engineer.
3. Include the following information on label for processing and recording action taken:

    a. Project name.
    b. Date.
    c. Name and address of Architect/Engineer.
    d. Name and address of Contractor.
    e. Name and address of subcontractor.
    f. Name and address of supplier.
    g. Name of manufacturer.
    h. Unique identifier, including revision number.
    i. Number and title of appropriate Specification Section.
    j. Drawing number and detail references, as appropriate.
    k. Other necessary identification.

F. Deviations: Highlight, encircle, or otherwise identify deviations from the Contract Documents on submittals.

G. Additional Copies: Unless additional copies are required for final submittal, and unless Architect/Engineer observes noncompliance with provisions of the Contract Documents, initial submittal may serve as final submittal.

1. Submit one copy of submittal to concurrent reviewer in addition to specified number of copies to Architect/Engineer.
2. Additional copies submitted for maintenance manuals will be marked with action taken and will be returned.

H. Transmittal: Package each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form. Architect/Engineer will return submittals, without review, received from sources other than Contractor.

1. On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Architect/Engineer on previous submittals, and deviations from requirements of the Contract Documents, including minor variations and limitations. Include the same label information as the related submittal.
2. Include Contractor's certification stating that information submitted complies with requirements of the Contract Documents.
3. Transmittal Form: Provide locations on form for the following information:

a. Project name.
b. Date.
c. Destination (To:).
d. Source (From:).
e. Names of subcontractor, manufacturer, and supplier.
f. Category and type of submittal.
g. Submittal purpose and description.
h. Submittal and transmittal distribution record.
i. Remarks.
j. Signature of transmitter.

I. 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.

J. Use for Construction: Use only final submittals with mark indicating action taken by Architect/Engineer in connection with construction.

PART 2 - PRODUCTS

2.1 ACTION SUBMITTALS

A. General: Prepare and submit Action Submittals required by individual Specification Sections.

1. Number of Copies: Submit four copies of each submittal, unless otherwise indicated. Architect/Engineer will return two copies. Mark up and retain one returned copy as a Project Record Document.

B. 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 printed data are not suitable 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 written recommendations.
    b. Manufacturer's product specifications.
    c. Manufacturer's installation instructions.
    d. Standard color charts.
    e. Manufacturer's catalog cuts.
    f. Wiring diagrams showing factory-installed wiring.
    g. Printed performance curves.
    h. Operational range diagrams.
    i. Mill reports.
    j. Standard product operating and maintenance manuals.
    k. Compliance with recognized trade association standards.
    l. Compliance with recognized testing agency standards.
    m. Application of testing agency labels and seals.
    n. Notation of coordination requirements.

C. 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.

1. Preparation: Include the following information, as applicable:

    a. Dimensions.
    b. Identification of products.
    c. Fabrication and installation drawings.
    d. Roughing-in and setting diagrams.
    e. Wiring diagrams showing field-installed wiring, including power, signal, and control wiring.
    f. Shopwork manufacturing instructions.
    g. Templates and patterns.
    h. Schedules.
    i. Design calculations.
    j. Compliance with specified standards.
    k. Notation of coordination requirements.
    l. Notation of dimensions established by field measurement.

2. Wiring Diagrams: Differentiate between manufacturer-installed and field-installed wiring.
3. 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 24 by 36 inches.
4. Number of Copies: Submit four blue- or black-line prints of each submittal, unless prints are required for operation and maintenance manuals. Architect/Engineer will retain two prints; remainder will be returned. Mark up and retain one returned print as a Project Record Drawing.

D. Coordination Drawings: Comply with requirements in Division 1 Section "Project Management and Coordination."

E. Product Schedule or List: 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.
2. Number and name of room or space.
3. Location within room or space.

F. Delegated-Design Submittal: Comply with requirements in Division 1 Section "Quality Requirements."

G. 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, and telephone number 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.

2.2 INFORMATIONAL SUBMITTALS

A. General: Prepare and submit Informational Submittals required by other Specification Sections.

1. Number of Copies: Submit two copies of each submittal, unless otherwise indicated. Architect/Engineer will not return copies.
2. Certificates and Certifications: Provide a notarized 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.
3. Test and Inspection Reports: Comply with requirements in Division 1 Section "Quality Requirements."

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

C. Product Certificates: Prepare written statements on manufacturer's letterhead certifying that product complies with requirements.

D. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements. Submit record of Welding Procedure Specification (WPS) and Procedure Qualification Record (PQR) on AWS forms. Include names of firms and personnel certified.

E. Installer Certificates: Prepare written statements on manufacturer's letterhead certifying that Installer complies with requirements and, where required, is authorized for this specific Project.

F. Manufacturer Certificates: Prepare written statements on manufacturer's letterhead certifying that manufacturer complies with requirements. Include evidence of manufacturing experience where required.

G. Material Certificates: Prepare written statements on manufacturer's letterhead certifying that material complies with requirements.

H. Material Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements.

I. Preconstruction Test Reports: Prepare 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.

J. Compatibility Test Reports: Prepare 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.

K. Field Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, 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.

L. Product Test Reports: Prepare written reports indicating current product produced by manufacturer complies with requirements. 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.

M. Research/Evaluation Reports: Prepare 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:

1. Name of evaluation organization.
2. Date of evaluation.
3. Time period when report is in effect.
4. Product and manufacturers' names.
5. Description of product.
6. Test procedures and results.
7. Limitations of use.

N. Maintenance Data: Prepare written and graphic instructions and procedures for operation and normal maintenance of products and equipment. Comply with requirements in Division 1 Section "Closeout Procedures."

O. Design Data: Prepare written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.

P. Manufacturer's Instructions: Prepare written or published information that documents manufacturer's recommendations, guidelines, and procedures for installing or operating a product or equipment. Include name of product and name, address, and telephone number of manufacturer. Include the following, as applicable:

1. Preparation of substrates.
2. Required substrate tolerances.
3. Sequence of installation or erection.
4. Required installation tolerances.
5. Required adjustments.
6. Recommendations for cleaning and protection.

Q. Manufacturer's Field Reports: Prepare written information documenting factory-authorized service representative's tests and inspections. Include the following, as applicable:

1. Name, address, and telephone number of factory-authorized service 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.

R. Insurance Certificates and Bonds: Prepare written information indicating current status of insurance or bonding coverage. Include name of entity covered by insurance or bond, limits of coverage, amounts of deductibles, if any, and term of the coverage.

S. Material Safety Data Sheets: Submit information directly to Owner. If submitted to Architect/Engineer, Architect/Engineer will not review this information but will return it with no action taken.

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

A. Review each submittal and check for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect/Engineer.

B. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, 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.

3.2 ARCHITECT/ENGINEER'S ACTION

A. General: Architect/Engineer will not review submittals that do not bear Contractor's approval stamp and will return them without action.

B. Action Submittals: Architect/Engineer will review each submittal, make marks to indicate corrections or modifications required, and return it. Architect/Engineer will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action taken, as follows:

1. NO EXCEPTIONS TAKEN
2. REJECTED
3. SUBMIT SPECIFIED ITEM
4. MAKE CORRECTIONS NOTED
5. REVISE & RESUBMIT

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

D. Submittals not required by the Contract Documents will not be reviewed and may be discarded.

END OF SECTION 01 33 00

SECTION 01 40 00 - 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 1 Specification Sections, apply to this Section.

1.2 SUMMARY

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

B. Testing and inspecting 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-control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
2. Specified tests, inspections, and related actions do not limit Contractor's quality-control procedures that facilitate compliance with the Contract Document requirements.
3. Requirements for Contractor to provide quality-control services required by Construction Manager, or authorities having jurisdiction are not limited by provisions of this Section.

C. Related Sections include the following:

1. Division 1 Section "Cutting and Patching" for repair and restoration of construction disturbed by testing and inspecting activities.
2. Divisions 2 through 33 Sections for specific test and inspection requirements.

1.3 DEFINITIONS

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

B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that completed construction complies with requirements. Services do not include contract enforcement activities performed by Construction Manager.

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

1.4 DELEGATED DESIGN

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 Architect.

1.5 CODE AND REGULATORY REQUIREMENTS

A. Copies of Regulations: Obtain copies of the following codes and regulations and retain at Project site to be available for reference by parties who have a reasonable need:

1. International Building Code (IBC) – 2021 Edition.
2. International Mechanical Code (IMC) – 2021 Edition.
3. International Plumbing Code (IPC) – 2018 Edition.
4. International Fuel Gas Code (IFGC) – 2018 Edition.
5. International Energy Conservation Code (IPCC) – 2021 Edition.
6. International Fire Code (IFC) – 2021 Edition.
7. National Electrical Code (NEC) – 2020 Edition.

1.6 SUBMITTALS

A. Qualification Data: 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.

B. Delegated-Design 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.

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

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

D. Reports: Prepare and submit certified written reports that include the following:

1. Date of issue.
2. Project title and number.
3. Name, address, and telephone number 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.
7. Identification of product and Specification Section.
8. Complete test or inspection data.
9. Test and inspection results and an interpretation of test results.
10. Ambient conditions at time of sample taking and testing and inspecting.
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.

E. Permits, Licenses, and Certificates: For Owner's records, 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.

1.7 QUALITY ASSURANCE

A. 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.

B. 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.

C. Installer Qualifications: A firm or individual experienced in installing, erecting, 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.

D. 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.

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 to those indicated for this Project in material, design, and extent.

F. Specialists: Certain sections of the Specifications 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. Requirement for specialists shall not supersede building codes and similar regulations governing the Work, nor interfere with local trade-union jurisdictional settlements and similar conventions.

G. Testing Agency Qualifications: An agency with the experience and capability to conduct testing and inspecting indicated, as documented by ASTM E 548, and that specializes in types of tests and inspections to be performed.

H. Preconstruction Testing: Testing agency shall perform preconstruction testing for compliance with specified requirements for performance and test methods.

1. Contractor responsibilities include the following:

    a. Provide test specimens and assemblies representative of proposed materials and construction. Provide sizes and configurations of assemblies to adequately demonstrate capability of product to comply with performance requirements.
    b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
    c. Fabricate and install test assemblies using installers who will perform the same tasks for Project.
    d. When testing is complete, remove assemblies; do not reuse materials on Project.

2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Construction Manager, 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.

I. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:

1. Build mockups in location and of size indicated or, if not indicated, as directed by Construction Manager.
2. Notify Construction Manager seven days in advance of dates and times when mockups will be constructed.
3. Demonstrate the proposed range of aesthetic effects and workmanship.
4. Obtain Construction Manager's approval of mockups before starting work, fabrication, or construction.
5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
6. Demolish and remove mockups when directed, unless otherwise indicated.

1.8 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 the types of testing and inspecting they are engaged to perform.
2. Payment for these services will be made from testing and inspecting allowances, as authorized by Change Orders.
3. Costs for retesting and reinspection of 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: Unless otherwise indicated, provide quality-control services specified and required by authorities having jurisdiction.

1. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.

    a. Contractor shall not employ the same entity engaged by Owner, unless agreed to in writing by Owner.

2. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
3. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
4. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
5. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.

C. Special Tests and Inspections: Owner will engage a testing agency to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of Owner.

1. Testing agency will notify Construction Manager, and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
2. Testing agency will submit a certified written report of each test, inspection, and similar quality-control service to Construction Manager, with copy to Contractor and to authorities having jurisdiction.
3. Testing agency will submit a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
4. Testing agency will interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.
5. Testing agency will retest and reinspect corrected work.

D. 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.

E. Retesting/Reinspection: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspection, for construction that revised or replaced Work that failed to comply with requirements established by the Contract Documents.

F. Testing Agency Responsibilities: Cooperate with Construction Manager, and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.

1. Notify Construction Manager, and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
2. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
3. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
4. Do not release, revoke, alter, or increase requirements of the Contract Documents or approve or accept any portion of the Work.
5. Do not perform any duties of Contractor.

G. Associated Services: Cooperate with agencies 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 inspecting. 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 inspecting 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 inspecting.

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. Submit schedule within 30 days of date established for the Notice to Proceed.

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

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 REPAIR AND PROTECTION

A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.

1. Provide materials and comply with installation requirements specified in other Sections of these Specifications. Restore patched areas and extend restoration into adjoining areas in a manner that eliminates evidence of patching.
2. Comply with the Contract Document requirements for Division 1 Section "Cutting and Patching."

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 01 40 00

SECTION 01 46 00 – REGULATORY REQUIREMENTS

PART 1 - GENERAL

1.1 PERMITS AND FEES

A. See General Conditions Article 9B.

1.2 CODES AND ORDINANCES

A. All Contractors shall comply with all applicable codes, ordinances and regulations in effect at the time of bid opening including but not necessarily limited to the following:

1. Refer to the STATE BUILDINGS PROGRAMS BUILDING CODE COMPLIANCE POLICY as Exhibit G. to the Contractor's Agreement (SC-6.21). Included in the Policy is Exhibit A – Approved Building Codes.

B. If discrepancies occur between these specifications, local codes, local utility requirements, etc., the most stringent requirements shall apply.

END OF SECTION 01 46 00

SECTION 01 49 10 – REFERENCE STANDARDS

PART 1 - GENERAL

1.1 QUALITY ASSURANCE

A. Reference Standards: For products or workmanship specified by association, trade or federal standards, comply with requirements of standard, except when more rigid requirements are specified or are required by applicable codes.

1. No provision of any referenced standard specification, manual or code (whether or not specifically incorporated by reference in the Contract Documents) shall be effective to change duties and responsibilities of Owner, Contractor or Architect or any of their consultant, agents or employees from those set forth in Contract Documents, nor shall it be effective to assign to Architect or any of Architect's consultants, agents or employees any duty or authority to supervise or direct furnishing or performance of work or any duty or authority to undertake responsibilities contrary to provisions of General and Supplementary Conditions.

B. Effective Date: Date of standard is that in effect as of documents date except when specific date is specified or when standard is part of applicable code which includes edition date.

C. Copies: When required by individual sections, obtain copy of standard. Maintain copy at job site during work.

END OF SECTION 01 49 10

SECTION 01 49 20 – ABBREVIATIONS

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Drawing or Schedule Abbreviations:

1. Drawings or schedule.

1.2 SPECIFICATION LANGUAGE EXPLANATION

A. These Specifications are of abbreviated, simplified, or streamlined type and include incomplete sentences.

1. Omissions of words or phrases such as "the contractor shall", "in conformity therewith", "shall be", "as noted on the drawings", "a", "the", are intentional.
2. Supply omitted words or phrases by inference in same manner as they are when "NOTE" occurs on drawings.
3. Supply words "shall be" or "shall" by inference when colon is used within sentences or phrases.
4. Supply words "on the drawings" by inference when "as indicated" is used with sentences or phrases.
5. "Provide" shall mean furnish and install.

1.3 ABBREVIATIONS

A. Reference in Contract Documents to trade associations, technical societies, recognized authorities and other institutions include following organizations which are sometimes referred to only by corresponding abbreviations.

1. AA Aluminum Association
2. AAMA American Architectural Manufacturer's Association
3. ACI American Concrete Institute
4. AISC American Institute of Steel Construction
5. AISI American Iron and Steel Institute
6. AITC American Institute of Timber Construction
7. ANSI American National Standards Institute
8. APA American Plywood Association
9. ASHRAE American Society of Heating, Refrigerating, and Air Conditioning Engineers
10. ASTM American Society for Testing and Materials
11. AWI Architectural Woodwork Institute
12. AWPA American Wood Preservers Association
13. AWS American Welding Society
14. BIA Brick Institute of America
15. CDA Copper Development Association, Inc.
16. CRA California Redwood Association
17. CRSI Concrete Reinforcing Steel Institute
18. CS Commercial Standard (U.S. Department of Commerce)

19.	DFPA	Douglas Fir Plywood Association
20.	FGMA	Flat Glass Marketing Association
21.	FM	Factory Mutual Engineering Division
22.	FS	Federal Specification
23.	GA	Gypsum Association
24.	MIA	Marble Institute of America
25.	MIL	Military Specification
26.	MLMA	Metal Lath Manufacturer's Association
27.	NAAMM	National Association of Architectural Metal Manufacturers
28.	NBS	National Bureau of Standards
29.	NCMA	National Concrete Masonry Association
30.	NEC	National Electric Code (of NFPA)
31.	NEMA	National Electrical Manufacturer's Association
32.	NFPA	National Fire Protection Association
33.	NOMA	National Oak Flooring Manufacturer's Association
34.	NPVLMA	National Paint, Varnish, and Lacquer Manufacturer's Association
35.	NTMA	The National Terrazzo and Mosaic Association
36.	NWWDA	National Wood Window and Door Association
37.	OSHA	Occupational Safety and Health Administration
38.	PCA	Portland Cement Association
39.	PCI	Prestressed Concrete Institute
40.	PEI	Porcelain Enamel Institute
41.	PS	Product Standard (U.S. Department of Commerce)
42.	SDI	Steel Deck Institute
43.	SJI	Steel Joist Institute
44.	SMACNA	Sheet Metal and Air Conditioning Contractors National Association
45.	SPA	Southern Pine Association
46.	SPI	The Society of the Plastics Industry, Inc.
47.	SPR	simplified Practice Recommendation (U.S. Department of Commerce)
48.	SSPC	Steel Structures Painting Council
49.	SWI	Steel Window Institute
50.	TCA	Tile Council of America
51.	TIMA	Thermal Insulation Manufacturers Association
52.	UL	Underwriters' Laboratories, Inc.
53.	WCLA	West Coast Lumbermen's Association
54.	WRI	Wire Reinforcement Institute
55.	WWPA	Western Wood Products Association

END OF SECTION 01 49 20

SECTION 01 49 50 – REFERENCE STANDARDS AND DEFINITIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DEFINITIONS

A. General: Basic Contract definitions are included in the Conditions of the Contract.

B. Indicated: The term "indicated" refers to graphic representations, notes, or schedules on the Drawings, or other Paragraphs or Schedules in the Specifications, and similar requirements in the Contract Documents. Where terms such as "shown," "noted," "scheduled," and "specified" are used, it is to help the reader locate the reference; no limitation on location is intended.

C. Directed: Terms such as "directed," "requested," authorized," "selected," "approved," "required," and "permitted" mean "directed by the Architect," "requested by the Architect," and similar phrases.

D. Approve: The term "approved," where used in conjunction with the Architect's action on the Contractor's submittals, applications, and requests is limited to the Architect's duties and responsibilities as stated in the Conditions of the Contract.

E. Regulation: The term "Regulations" includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.

F. Furnish: The term "furnish" is used to mean "supply and deliver to the Project site, ready for unloading, unpacking, assembly, installation, and similar operations."

G. Install: The term "install" is used to describe operations at project site including the actual "unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations."

H. Provide: The term "provide" means "to furnish and install, complete and ready for the intended use."

I. Installer: An "Installer" is the Contractor or an entity engaged by the Contractor, either as an employee, subcontractor, or contractor of lower tier for performance of a particular construction activity including installation, erection, application, and similar operations. Installers are required to be experienced in the operations they are engaged to perform.

1. The term "experienced," when used with the term "Installer," means having a minimum of five previous projects similar in size and scope to this Project, being familiar with the special requirements indicated, and having complied with requirements of the authority having jurisdiction.

2. Trades: Use of titles such as "carpentry" is not intended to imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name such as "carpenter." It also does not imply that requirements specified apply exclusively to tradespersons of the corresponding generic name.
3. Assignment of Specialists: Certain Sections of the Specifications require that specific construction activities shall be performed by specialists who are recognized experts in the operations to be performed. The specialists must be engaged for those activities, and assignments are requirements over which the Contractor has no choice or option. Nevertheless, the ultimate responsibility for fulfilling Contract requirements remains with the Contractor.

    a. This requirement shall not be interpreted to conflict with enforcement of building codes and similar regulations governing the Work. It is also not intended to interfere with local trade union jurisdictional settlements and similar conventions.

J. Project Site is the space available to the Contractor for performance of construction activities, either exclusively or in conjunction with others performance other work as part of the Project. The extent of the Project Site is shown on the Drawings and may or may not be identical with the description of the land on which the Project is to be built.

K. Testing Laboratories: A "testing laboratory" is an independent entity engaged to perform specific inspections or tests, either at the Project Site or elsewhere, and to report on and, if required, to interpret results of those inspections or tests.

1.3 SPECIFICATION FORMAT AND CONTENT EXPLANATION

A. Specification Format: These Specifications are organized into Divisions and Sections based on the Construction Specifications Institute's 16-Division format and MASTERFORMAT number system.

B. Specification Content: This Specification uses certain conventions in the use of language and the intended meaning of certain terms, words, and phrases when used in particular situations or circumstances. These conventions are explained as follows:

1. Abbreviated Language: Language used in Specifications and other Contract Documents is the abbreviated type. Words and meanings shall be interpreted as appropriate. Words that are implied, but not stated shall be interpolated as the sense required. Singular words will be interpreted as plural and plural words interpreted as singular where applicable and the context of the Contract Documents so indicates.
2. Imperative and streamlined language is used generally in the Specifications. Requirements expressed in the imperative mood are to be performed by the Contractor. At certain locations in the text, for clarity, subjective language is used to describe responsibilities that must be fulfilled indirectly by the Contractor, or by others when so noted.

    a. The words "shall be" shall be included by inference wherever a colon (:) is used within a sentence or phrase.

1.4 INDUSTRY STANDARDS

A. Applicability of Standards: Except where the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if

bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

B. Publication Dates: Comply with the standard in effect as of the date of the Contract Documents.

C. Conflicting Requirements: Where compliance with two or more standards is specified, and the standards may establish or conflicting requirements for minimum quantities or quality levels. Refer requirements that are different, but apparently equal, and uncertainties to the Architect for a decision before proceeding.

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 Architect for a decision before proceeding.

D. Copies of Standards: Each entity engaged in construction on the Project is required to be familiar with industry standards applicable to that entity's construction activity. Copies of applicable standards are not bound with the Contract Documents.

1. Where copies of standards are needed for performance of a required construction activity, the Contractor shall obtain copies directly from the publication source.

E. Abbreviations and Names: Trade association names and titles of general standards are frequently abbreviated. Where such acronyms or abbreviations are used in the Specifications or other Contract Documents, they mean the recognized name of the trade association, standards generating organization, authority having jurisdiction, or other entity applicable to the context of the text provision. Refer to the "Encyclopedia of Associations," published by Gale Research Co., available in most libraries.

1.5 GOVERNING REGULATIONS/AUTHORITIES

A. The Architect has contacted authorities having jurisdiction where necessary to obtain information necessary for preparation of Contract Documents. Contact authorities having jurisdiction directly for information and decisions having a bearing on the Work.

B. Copies of Regulations: Obtain copies of the following regulations and retain at the Project Site, available for reference by parties who have a reasonable need for such reference.

1.6 SUBMITTALS

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

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 01 49 50

SECTION 01 60 00 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

B. Related Sections include the following:

1. Division 1 Section "References" for applicable industry standards for products specified.
2. Division 1 Section "Closeout Procedures" for submitting warranties for contract closeout.
3. Divisions 2 through 33 Sections for specific requirements for warranties on products and installations specified to be warranted.

1.3 DEFINITIONS

A. Products: Items purchased 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, except that products consisting of recycled-content materials are allowed, unless explicitly stated otherwise. Products salvaged or recycled from other projects are not considered new products.
3. Comparable Product: Product that is demonstrated and approved through submittal process, or where indicated as a product substitution, 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. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.

C. Basis-of-Design Product Specification: Where a specific manufacturer's product is named and accompanied by the words "basis of design," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of other named manufacturers.

D. Manufacturer's Warranty: Preprinted written warranty published by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.

E. Special Warranty: Written warranty required by or incorporated into the Contract Documents, either to extend time limit provided by manufacturer's warranty or to provide more rights for Owner.

1.4 SUBMITTALS

A. Product List: Submit a list, in tabular from, showing specified products. Include generic names of products required. Include manufacturer's name and proprietary product names for each product.

1. Coordinate product list with Contractor's Construction Schedule and the Submittals Schedule.
2. Form: Tabulate information for each product under the following column headings:

a. Specification Section number and title.
b. Generic name used in the Contract Documents.
c. Proprietary name, model number, and similar designations.
d. Manufacturer's name and address.
e. Supplier's name and address.
f. Installer's name and address.
g. Projected delivery date or time span of delivery period.
h. Identification of items that require early submittal approval for scheduled delivery date.

3. Initial Submittal: Within 15 days after date of commencement of the Work, submit 4 copies of initial product list. Include a written explanation for omissions of data and for variations from Contract requirements.

a. At Contractor's option, initial submittal may be limited to product selections and designations that must be established early in Contract period.

4. Completed List: Within 30 days after date of commencement of the Work, submit 4 copies of completed product list. Include a written explanation for omissions of data and for variations from Contract requirements.
5. Architect's Action: Architect will respond in writing to Contractor within 15 days of receipt of completed product list. Architect's response will include a list of unacceptable product selections and a brief explanation of reasons for this action. Architect's response, or lack of response, does not constitute a waiver of requirement that products comply with the Contract Documents.

B. Substitution Requests: Submit three 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: Use CSI Form 13.1A.
2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:

a. Statement indicating why specified material or product cannot be provided.

b. Coordination information, including a list of changes or modifications 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 substitution with those of the Work specified. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
e. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners.
f. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
g. Research/evaluation reports evidencing compliance with building code in effect for Project, from a model code organization acceptable to authorities having jurisdiction.
h. Detailed comparison of Contractor's Construction Schedule using proposed substitution 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 lack of availability or delays in delivery.
i. Cost information, including a proposal of change, if any, in the Contract Sum.
j. Contractor's certification that proposed substitution complies with requirements in the Contract Documents and is appropriate for applications indicated.
k. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

3. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within one week of receipt of a request for substitution. Architect will notify Contractor of acceptance or rejection of proposed substitution within 15 days of receipt of request, or 7 days of receipt of additional information or documentation, whichever is later.

a. Form of Acceptance: Change Order.
b. Use product specified if Architect cannot make a decision on use of a proposed substitution within time allocated.

C. Basis-of-Design Product Specification Submittal: Comply with requirements in Division 1 Section "Submittal Procedures." Show compliance with requirements.

1.5 QUALITY ASSURANCE

A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, product selected shall be 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, Architect will determine which products shall be used.

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. Comply with manufacturer's written instructions.

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 ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected.
5. Store products to allow for inspection and measurement of quantity or counting of units.
6. Store materials in a manner that will not endanger Project structure.
7. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
8. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
9. Protect stored products from damage.

B. Storage: 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.

B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution. Submit a draft for approval before final execution.

1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
2. Specified Form: Forms are included with the Specifications. Prepare a written document using appropriate form properly executed.
3. Refer to Divisions 2 through 33 Sections for specific content requirements and particular requirements for submitting special warranties.

C. Submittal Time: Comply with requirements in Division 1 Section "Closeout Procedures."

PART 2 - PRODUCTS

2.1 PRODUCT OPTIONS

A. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged, and unless otherwise indicated, that 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 not in conflict with requirements of the Contract Documents.
4. Where products are accompanied by the term "as selected," Architect will make selection.
5. Where products are accompanied by the term "match sample," sample to be matched is Architect's.
6. Descriptive, performance, and reference standard requirements in the Specifications establish "salient characteristics" of products.
7. Or Equal: Where products are specified by name and accompanied by the term "or equal" or "or approved equal" or "or approved," comply with provisions in "Comparable Products" Article to obtain approval for use of an unnamed product.

B. Product Selection Procedures: Procedures for product selection include the following:

1. Product: Where Specification paragraphs or subparagraphs titled "Product" name a single product and manufacturer, provide the product named.

    a. Substitutions may be considered, unless otherwise indicated.

2. Manufacturer/Source: Where Specification paragraphs or subparagraphs titled "Manufacturer" or "Source" name single manufacturers or sources, provide a product by the manufacturer or from the source named that complies with requirements.

    a. Substitutions may be considered, unless otherwise indicated.

3. Products: Where Specification paragraphs or subparagraphs titled "Products" introduce a list of names of both products and manufacturers, provide one of the products listed that complies with requirements.

    a. Substitutions may be considered, unless otherwise indicated.

4. Manufacturers: Where Specification paragraphs or subparagraphs titled "Manufacturers" introduce a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements.

    a. Substitutions may be considered, unless otherwise indicated.

5. Available Products: Where Specification paragraphs or subparagraphs titled "Available Products" introduce a list of names of both products and manufacturers, provide one of the products listed or another product that complies with requirements. Comply with provisions in "Comparable Products" Article to obtain approval for use of an unnamed product.
6. Available Manufacturers: Where Specification paragraphs or subparagraphs titled "Available Manufacturers" introduce a list of manufacturers' names, provide a product by one of the manufacturers listed or another manufacturer that complies with requirements. Comply with provisions in "Comparable Products" Article to obtain approval for use of an unnamed product.
7. Product Options: Where Specification paragraphs titled "Product Options" indicate that size, profiles, and dimensional requirements on Drawings are based on a specific product or system, provide either the specific product or system indicated or a comparable

product or system by another manufacturer. Comply with provisions in "Product Substitutions" Article.

8. Basis-of-Design Products: Where Specification paragraphs or subparagraphs titled "Basis-of-Design Products" are included and also introduce or refer to a list of manufacturers' names, provide either the specified 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 provisions in "Comparable Products" Article to obtain approval for use of an unnamed product.

    a. Substitutions will not be considered, unless otherwise indicated.

9. Visual Matching Specification: Where Specifications require matching an established Sample, select a product (and manufacturer) that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches satisfactorily.

    a. If no product available within specified category matches satisfactorily and complies with other specified requirements, comply with provisions of the Contract Documents on "substitutions" for selection of a matching product.

10. Visual Selection Specification: Where Specifications include the phrase "as selected from manufacturer's colors, patterns, textures" or a similar phrase, select a product (and manufacturer) that complies with other specified requirements.

    a. Standard Range: Where Specifications include the phrase "standard range of colors, patterns, textures" or similar phrase, Architect will select color, pattern, or texture from manufacturer's product line that does not include premium items.
    b. Full Range: Where Specifications include the phrase "full range of colors, patterns, textures" or similar phrase, Architect will select color, pattern, or texture from manufacturer's product line that includes both standard and premium items.

2.2 PRODUCT SUBSTITUTIONS

A. Timing: Architect will consider requests for substitution if received within 10 days after the Notice of Award. Requests received after that time may be considered or rejected at discretion of Architect.

B. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:

1. 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 Architect for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
2. Requested substitution does not require extensive revisions to the Contract Documents.
3. Requested substitution is consistent with the Contract Documents and will produce indicated results.
4. Substitution request is fully documented and properly submitted.
5. Requested substitution will not adversely affect Contractor's Construction Schedule.
6. Requested substitution has received necessary approvals of authorities having jurisdiction.

7. Requested substitution is compatible with other portions of the Work.
8. Requested substitution has been coordinated with other portions of the Work.
9. Requested substitution provides specified warranty.
10. 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.

2.3 COMPARABLE PRODUCTS

A. Where products or manufacturers are specified by name, submit the following, in addition to other required submittals, to obtain approval of an unnamed product:

1. Evidence that the proposed product does not require extensive revisions to the Contract Documents, that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.
2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
3. Evidence that proposed product provides specified warranty.
4. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
5. Samples, if requested.

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 60 00

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SECTION 01 70 00 – EXECUTION REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

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

1. Construction layout.
2. General installation of products.
3. Progress cleaning.
4. Starting and adjusting.
5. Protection of installed construction.
6. Correction of the Work.

B. See Division 1 Section "Closeout Procedures" for final cleaning.

C. See Division 1 Section “Hazardous Material Procedures” where existing hazardous materials are encountered.

1.2 SUBMITTALS

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

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

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

1. Before construction, verify the location and points of connection of utility services.

B. Acceptance of Conditions: 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. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
2. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.

3. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
4. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

C. Inspect materials or equipment immediately upon delivery and again prior to installation. Reject damaged and defective items.

3.2 PREPARATION

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

1. Notify Engineer & Owner not less than seven days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Engineer's or Owner's written permission.

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, submit a request for information to Engineer. Include a detailed description of problem encountered, together with recommendations for changing the Contract Documents. RFI format will be discussed at Preconstruction meeting. Engineer shall approve an acceptable written format.

3.3 CONSTRUCTION LAYOUT

A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings. If discrepancies are discovered, notify Engineer promptly.

B. General:

1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
2. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
3. Inform installers of lines and levels to which they must comply.
4. Check the location, level and plumb, of every major element as the Work progresses.
5. Notify Engineer when deviations from required lines and levels exceed allowable tolerances.
6. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.

C. Visual Effects: Provide uniform joint widths in exposed Work. Arrange joints in exposed Work to obtain the best visual effect. Refer questionable choices to the Engineer for final decision.

D. Location Of Equipment And Piping:

1. Drawings showing location of equipment, piping, ductwork, etc. are diagrammatic and job conditions shall not always duplicate conditions shown. When this situation occurs, it shall be brought to the Engineer's attention immediately and the relocation determined in a joint conference.
2. The Contractor shall be responsible for the relocating of any items without first obtaining the Engineer's approval. He shall remove and relocate such items at his own expense if so directed by the Engineer.

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 to the extent that those instructions and recommendations are more explicit or stringent than requirements contained in the Contract Documents.

C. Install products at the time and under conditions (including weather) 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. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.

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

G. Anchors and Fasteners: Provide anchors and fasteners as required to anchor each component securely in place, accurately located and aligned with other portions of the Work.

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.

H. 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.

I. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

J. Coordinate temporary enclosures with required inspections and tests to minimize the necessity of uncovering completed construction for that purpose.

3.5 PROGRESS CLEANING

A. General: Clean Project site and work areas daily, including common areas. Coordinate progress cleaning for joint-use areas where more than one installer has worked. Enforce requirements strictly. Dispose of materials lawfully.

1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
2. Do not hold materials more than 7 days during normal weather or 3 days if the temperature is expected to rise above 80 deg F.
3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.

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: Burying or burning waste materials on-site will not be permitted. Washing waste materials down sewers or into waterways will not be permitted.

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 assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

1. Excessive static or dynamic loading;
2. Excessive internal or external pressures;
3. Excessively high or low temperatures;
4. Thermal shock;
5. Excessively high or low humidity;
6. Air contamination or pollution;
7. Water or ice;
8. Solvents;
9. Chemicals;
10. Light;
11. Radiation;
12. Puncture;
13. Abrasion;
14. Heavy traffic;
15. Soiling, staining, and corrosion;
16. Bacteria;
17. Rodent and insect infestation;
18. Combustion;
19. Electrical current;
20. High speed operation;
21. Improper lubrication;
22. Unusual wear or other misuse;
23. Contact between incompatible materials;
24. Destructive testing;
25. Misalignment;
26. Excessive weathering;
27. Unprotected storage;
28. Improper shipping or handling;
29. Theft; and
30. Vandalism.

3.6 DUST CONTROL: Precaution shall be exercised at all times to control dust created as a result of any operations during the construction period. If serious problems arise due to air borne dust, and when directed by Engineer, operations causing such problems shall be temporarily discontinued and necessary steps taken to control the dust.

3.7 FIRE PROTECTION

A. Maintain good housekeeping practices to reduce the risk of fire damage and injury to workmen. All scrap materials, rubbish and trash shall be removed daily from in and about the work area and shall not be permitted to be scattered to adjacent areas.

B. Suitable storage space shall be provided outside the immediate building area for storing flammable materials and paints; no storage will be permitted in the building. Excess flammable liquids being used inside the building shall be kept in closed metal container and removed from the building during unused periods.

C. A fire extinguisher shall be available at each location where cutting or welding is being performed. Where electric or gas welding or cutting work is done, interposed shields of incombustible material shall be used to protect against fire damage due to sparks and hot metal. Provide a suitable portable welding booth to shield flash from occupants. Vent booth to the outside.

D. Provide fire extinguishers in accordance with the recommendations of NFPA Bulletins Nos. 10 and 241. However, in all cases a minimum of four fire extinguishers shall be available for each building.

3.8 STARTING AND ADJUSTING

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

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

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

D. Manufacturer's Field Service: If a factory-authorized service representative is required to inspect field-assembled components and equipment installation, comply with qualification requirements in Division 1 Section "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. Comply with manufacturer's written instructions for temperature and relative humidity.

3.10 CORRECTION OF THE WORK

A. Repair or remove and replace defective construction. Restore damaged substrates and finishes. Comply with requirements in Division 1 Section "Cutting and Patching."

1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.
2. When existing surface finish cannot be matched, refinish entire surface to nearest intersections.

B. Restore permanent facilities used during construction to their specified condition.

C. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.

D. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.

E. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

END OF SECTION 01 70 00

SECTION 01 73 10 - CUTTING AND PATCHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes procedural requirements for cutting and patching.

B. Related Sections include the following:

1. Division 1 Section "Selective Demolition" for demolition of selected portions of the building for alterations.
2. Divisions 2 through 33 Sections for specific requirements and limitations applicable to cutting and patching individual parts of the Work.

    a. Requirements in this Section apply to fire suppression, plumbing, mechanical and electrical installations. Refer to Divisions 21, 22, 23 and 26 Sections for other requirements and limitations applicable to cutting and patching fire suppression, plumbing, mechanical and electrical installations.

1.3 DEFINITIONS

A. Cutting: Removal of existing construction necessary to permit installation or performance of other Work.

B. Patching: Fitting and repair work required to restore surfaces to original conditions after installation of other Work.

1.4 SUBMITTALS

A. Cutting and Patching Proposal: Submit a proposal describing procedures at least 10 days before the time cutting and patching will be performed, requesting approval to proceed. Include the following information:

1. Extent: Describe cutting and patching, show how they will be performed, and indicate why they cannot be avoided.
2. Changes to Existing Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building's appearance and other significant visual elements.
3. Products: List products to be used and firms or entities that will perform the Work.
4. Dates: Indicate when cutting and patching will be performed.

5. Utilities: List utilities that cutting and patching procedures will disturb or affect. List utilities that will be relocated and those that will be temporarily out of service. Indicate how long service will be disrupted.
6. Structural Elements: Where cutting and patching involve adding reinforcement to structural elements, submit details and engineering calculations showing integration of reinforcement with original structure.
7. Architect's Approval: Obtain approval of cutting and patching proposal before cutting and patching. Approval does not waive right to later require removal and replacement of unsatisfactory work.

1.5 QUALITY ASSURANCE

A. Structural Elements: Do not cut and patch structural elements in a manner that could change their load-carrying capacity or load-deflection ratio.

B. 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.

1. Primary operational systems and equipment.
2. Air or smoke barriers.
3. Fire-protection systems.
4. Control systems.
5. Communication systems.
6. Electrical wiring systems.
7. Operating systems of special construction in Division 13 Sections.

C. Miscellaneous Elements: Do not cut and patch the following elements or related 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.

1. Water, moisture, or vapor barriers.
2. Membranes and flashings.
3. Exterior curtain-wall construction.
4. Equipment supports.
5. Piping, ductwork, vessels, and equipment.
6. Noise- and vibration-control elements and systems.

D. Visual Requirements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

1. If possible, retain original Installer or fabricator to cut and patch exposed Work listed below. If it is impossible to engage original Installer or fabricator, engage another recognized, experienced, and specialized firm.

a. Processed concrete finishes.
b. Stonework and stone masonry.
c. Preformed metal panels.
d. Roofing.
e. Firestopping.

f. Wall covering.
g. HVAC enclosures, cabinets, or covers.

E. Cutting and Patching Conference: Before proceeding, meet at Project site with parties involved in cutting and patching, including mechanical and electrical trades. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

1.6 WARRANTY

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

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Comply with requirements specified in other Sections of these Specifications.

B. Existing Materials: Use materials identical to existing materials. For exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible.

1. If identical materials are unavailable or cannot be used, use materials that, when installed, will match the visual and functional performance of existing materials.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces to be cut and patched and conditions under which cutting and patching are to be performed.

1. Compatibility: Before patching, verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
2. Proceed with installation only after unsafe or unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Temporary Support: Provide temporary support of Work to be cut.

B. Protection: Protect existing 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.

C. Adjoining Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.

D. Existing Services: Where existing services are required to be removed, relocated, or abandoned, bypass such services before cutting to avoid interruption of services to occupied areas.

3.3 PERFORMANCE

A. 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 existing 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. Cutting: Cut existing 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 as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
2. Existing 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 Division 31 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.

C. 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 possible. Provide materials and comply with installation requirements specified in other Sections of these Specifications.

1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate 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 eliminate evidence of patching and refinishing.
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 existing 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, apply primer and intermediate paint coats 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 existing 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.

END OF SECTION 01 73 10

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SECTION 01 73 20 - SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Demolition and removal of selected site elements.
   2. Repair procedures for selective demolition operations.

B. Related Sections include the following:

   1. Division 1 Section "Summary" for use of the premises and phasing requirements.
   2. Division 1 Section "Cutting and Patching" for cutting and patching procedures for selective demolition operations.
   3. Division 21 Sections for demolishing, cutting, patching, or relocating fire suppression items.
   4. Division 22 Sections for demolishing, cutting, patching, or relocating plumbing items.
   5. Division 23 Sections for demolishing, cutting, patching, or relocating mechanical items.
   6. Division 26 Sections for demolishing, cutting, patching, or relocating electrical items.

1.3 DEFINITIONS

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

B. Remove and Salvage: Detach items from existing construction and deliver them to Owner.

C. Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.

D. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.4 MATERIALS OWNERSHIP

A. Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, demolished materials shall become Contractor's property and shall be removed from Project site.

1.5 SUBMITTALS

A. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

B. Proposed Dust-Control and Noise-Control Measures: Submit statement or drawing that indicates the measures proposed for use, proposed locations, and proposed time frame for their operation. Identify options if proposed measures are later determined to be inadequate.

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 building manager's on-site operations are uninterrupted.
2. Interruption of utility services.
3. Coordination for shutoff, capping, and continuation of utility services.
4. Use of elevator and stairs.
5. Locations of temporary partitions and means of egress.
6. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.

D. Inventory: After selective demolition is complete, submit a list of items that have been removed and salvaged.

E. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.

1.6 QUALITY ASSURANCE

A. Demolition Firm Qualifications: An experienced firm that has specialized in demolition work similar in material and extent to that indicated for this Project.

B. Professional Engineer Qualifications: Comply with Division 1 Section "Quality Requirements."

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

D. Standards: Comply with ANSI A10.6 and NFPA 241.

E. Predemolition Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination." Review methods and procedures related to selective demolition including, but not limited to, the following:

1. Inspect and discuss condition of construction to be selectively demolished.
2. Review structural load limitations of existing structure.
3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.

1.7 PROJECT 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. Provide not less than 72 hours' notice to Owner of activities that will affect Owner's operations.

B. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities.

1. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from authorities having jurisdiction.

C. Owner assumes no responsibility for condition of areas to be selectively demolished.

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

D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.

1. Hazardous materials will be removed by Owner before start of the Work.
2. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.

E. Storage or sale of removed items or materials on-site will not be 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.

1.8 WARRANTY

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

1. If possible, retain original Installer or fabricator to patch the exposed Work listed below that is damaged during selective demolition. If it is impossible to engage original Installer or fabricator, engage another recognized experienced and specialized firm.

a. Processed concrete finishes.
b. Stonework and stone masonry.
c. Preformed metal panels.
d. Roofing.
e. Firestopping.
f. Wall covering.
g. HVAC enclosures, cabinets, or covers.

PART 2 - PRODUCTS

2.1 REPAIR MATERIALS

A. Use repair materials identical to existing materials.

1. If identical materials are unavailable or cannot be used for exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible.
2. Use materials whose installed performance equals or surpasses that of existing materials.

B. Comply with material and installation requirements specified in individual Specification Sections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped.

B. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.

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

D. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Architect.

E. Engage a professional engineer to survey condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective demolition operations.

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

3.2 UTILITY SERVICES

A. Existing Utilities: Maintain services indicated to remain and protect them against damage during selective demolition operations.

B. Do not interrupt existing utilities serving occupied or operating facilities unless authorized in writing by Owner and authorities having jurisdiction. Provide temporary services during interruptions to existing utilities, as acceptable to Owner and to authorities having jurisdiction.

1. Provide at least 72 hours' notice to Owner if shutdown of service is required during changeover.

C. Utility Requirements: Locate, identify, disconnect, and seal or cap off indicated utilities serving areas to be selectively demolished.

1. Owner will arrange to shut off indicated utilities when requested by Contractor.
2. Arrange to shut off indicated utilities with utility companies.
3. If utility services are required to be removed, relocated, or abandoned, before proceeding with selective demolition provide temporary utilities that bypass area of selective demolition and that maintain continuity of service to other parts of building.
4. Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing.

3.3 PREPARATION

A. Dangerous Materials: Drain, purge, or otherwise remove, collect, and dispose of chemicals, gases, explosives, acids, flammables, or other dangerous materials before proceeding with selective demolition operations.

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.

1. Do not close or obstruct streets, walks, walkways, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.
2. Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction.
3. Protect existing site improvements, appurtenances, and landscaping to remain.
4. Erect a plainly visible fence around drip line of individual trees or around perimeter drip line of groups of trees to remain.

C. Temporary Facilities: 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.

D. Temporary Partitions: Erect and maintain dustproof partitions and temporary enclosures to limit dust and dirt migration and to separate areas from fumes and noise.

3.4 POLLUTION CONTROLS

A. Dust Control: Use water mist, temporary enclosures, and other suitable methods to limit spread of dust and dirt. Comply with governing environmental-protection regulations.

1. Do not use water when it may damage existing construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.
2. Wet mop floors to eliminate trackable dirt and wipe down walls and doors of demolition enclosure. Vacuum carpeted areas.

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

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

C. Cleaning: 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.

3.5 SELECTIVE DEMOLITION

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, to minimize disturbance of adjacent surfaces. 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 fire watch and portable fire-suppression devices during flame-cutting operations.
5. Maintain adequate ventilation when using cutting torches.
6. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
7. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
8. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
9. Dispose of demolished items and materials promptly.
10. Return elements of construction and surfaces that are to remain to condition existing before selective demolition operations began.

B. Existing Facilities: Comply with building manager's requirements for using and protecting elevators, stairs, walkways, loading docks, building entries, and other building facilities during selective demolition operations.

C. Removed and Salvaged Items: Comply with the following:

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: Comply with the following:

1. Clean and repair items to functional condition adequate for intended reuse. Paint equipment to match new equipment.
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 Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

F. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals, using power-driven saw, then remove concrete between saw cuts.

G. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, then remove masonry between saw cuts.

H. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, then break up and remove.

I. Resilient Floor Coverings: Remove floor coverings and adhesive according to recommendations in RFCI-WP and its Addendum.

1. Remove residual adhesive and prepare substrate for new floor coverings by one of the methods recommended by RFCI.

J. Roofing: Remove no more existing roofing than can be covered in one day by new roofing. Refer to applicable Division 7 Section for new roofing requirements.

K. Air-Conditioning Equipment: Remove equipment without releasing refrigerants.

3.6 PATCHING AND REPAIRS

A. General: Promptly repair damage to adjacent construction caused by selective demolition operations.

B. Patching: Comply with Division 1 Section "Cutting and Patching."

C. Repairs: Where repairs to existing surfaces are required, patch to produce surfaces suitable for new materials.

1. Completely fill holes and depressions in existing masonry walls that are to remain with an approved masonry patching material applied according to manufacturer's written recommendations.

D. Finishes: Restore exposed finishes of patched areas and extend restoration into adjoining construction in a manner that eliminates evidence of patching and refinishing.

E. Floors and Walls: Where walls or partitions that are demolished 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 existing floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.

1. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections of these Specifications.
2. Where patching occurs in a painted surface, apply primer and intermediate paint coats over patch and apply final paint coat over entire unbroken surface containing patch. Provide additional coats until patch blends with adjacent surfaces.
3. Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.

F. Ceilings: Patch, repair, or rehang existing ceilings as necessary to provide an even-plane surface of uniform appearance.

3.7 DISPOSAL OF DEMOLISHED MATERIALS

A. General: Promptly dispose of demolished materials. Do not allow demolished materials to accumulate on-site.

B. Burning: Do not burn demolished materials.

C. Burning: Burning of demolished materials will be permitted only at designated areas on Owner's property, providing required permits are obtained. Provide full-time monitoring for burning materials until fires are extinguished.

D. Disposal: Transport demolished materials and dispose of at designated spoil areas on Owner's property.

E. Disposal: Transport demolished materials off Owner's property and legally dispose of them.

3.8 SELECTIVE DEMOLITION SCHEDULE

A. The extent of selective demolition is generally defined on the drawings. The owner reserves the right to salvage any equipment, components or devices removed during demolition. Demolition shall include removal of the following miscellaneous items not shown to be removed that would otherwise be abandoned in place:

1. Conduit and piping that has been disconnected.
2. Control wiring and devices that have been disconnected.
3. Pneumatic tubing that has been disconnected including pneumatic devices and control panels.

    a. Previously abandoned conduit, wiring, tubing, piping, and devices.

END OF SECTION 01 73 20

SECTION 01 77 00 - 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 1 Specification Sections, apply to this Section.

1.2 SUMMARY

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

1. Inspection procedures.
2. Project Record Documents.
3. Operation and maintenance manuals.
4. Warranties.
5. Instruction of Owner's personnel.
6. Final cleaning.

B. Related Sections include the following:

1. Division 1 Section "Demonstration and Training" for requirements for instruction of Owner's personnel.
2. Divisions 2 through 33 Sections for specific closeout and special cleaning requirements for products of those Sections.

1.3 SUBSTANTIAL COMPLETION

A. Preliminary Procedures: Before requesting inspection for determining date of Substantial Completion, complete the following. List items below that are incomplete in request.

1. Prepare a list of items to be completed and corrected (punch list), the value of items on the list, and reasons why the Work is not complete.
2. Advise Owner of pending insurance changeover requirements.
3. Submit specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
4. Obtain and submit releases permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
5. Prepare and submit Project Record Documents, operation and maintenance manuals, and similar final record information.
6. Deliver tools, spare parts, extra materials, and similar items to location designated by Owner. Label with manufacturer's name and model number where applicable.
7. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
8. Complete startup testing of systems.
9. Submit test/adjust/balance records.

10. Terminate and remove temporary facilities from Project site, along with construction tools, and similar elements.
11. Advise Owner of changeover in heat and other utilities.
12. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
13. Complete final cleaning requirements, including touchup painting.
14. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.

B. Inspection: Submit a written request for inspection for Substantial Completion. On receipt of request, Architect/Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect/Engineer will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Architect/Engineer, that must be completed or corrected before certificate will be issued.

1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
2. Results of completed inspection will form the basis of requirements for Final Completion.

1.4 FINAL COMPLETION

A. Preliminary Procedures: Before requesting final inspection for determining date of Final Completion, complete the following:

1. Submit a final Application for Payment.
2. Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect/Engineer. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
3. Submit evidence of final, continuing insurance coverage complying with insurance requirements.
4. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Revise paragraph and subparagraph below to comply with office policy and Project requirements.

B. Inspection: Submit a written request for final inspection for acceptance. On receipt of request, Architect/Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect/Engineer will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.

1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.5 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

A. Preparation: Submit three copies of list. Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.

1. Organize list of spaces in sequential order, starting with exterior areas first[and proceeding from lowest floor to highest floor.
2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
3. Include the following information at the top of each page:

    a. Project name.
    b. Date.
    c. Name of Architect/Engineer.
    d. Name of Contractor.
    e. Page number.

1.6 PROJECT RECORD DOCUMENTS

A. General: Do not use Project Record Documents for construction purposes. Protect Project Record Documents from deterioration and loss. Provide access to Project Record Documents for Architect's reference during normal working hours.

B. Record Drawings: Maintain and submit one set of blue- or black-line white prints of Contract Drawings and Shop Drawings.

1. 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 prepare the marked-up Record Prints.

    a. Give particular attention to information on concealed elements that cannot be readily identified and recorded later.
    b. Accurately record information in an understandable drawing technique.
    c. Record data as soon as possible after obtaining it. Record and check the markup before enclosing concealed installations.
    d. Mark Contract Drawings or Shop Drawings, whichever is most capable of showing actual physical conditions, completely and accurately. Where Shop Drawings are marked, show cross-reference on Contract Drawings.

2. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at the same location.
3. Mark important additional information that was either shown schematically or omitted from original Drawings.
4. Note Construction Change Directive numbers, Change Order numbers, alternate numbers, and similar identification where applicable.
5. Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location. Organize into manageable sets; bind each set with durable paper cover sheets. Include identification on cover sheets.
6. Submit documents electronically in Portable Document Format (PDF).

C. Record Specifications: Submit one copy of Project's Specifications, including addenda and contract modifications. Mark copy 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. Note related Change Orders, Record Drawings, and Product Data, where applicable.

D. Record Product Data: Submit one copy of each Product Data submittal. Mark one set to indicate the actual product installation where installation varies substantially from that indicated in Product Data.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
3. Note related Change Orders, Record Drawings, and Record Specifications, where applicable.

E. Miscellaneous Record Submittals: Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

1.7 OPERATION AND MAINTENANCE MANUALS

A. Assemble a complete set of operation and maintenance data indicating the operation and maintenance of each system, subsystem, and piece of equipment not part of a system. Include operation and maintenance data required in individual Specification Sections and as follows:

1. Operation Data:

a. Emergency instructions and procedures.
b. System, subsystem, and equipment descriptions, including operating standards.
c. Operating procedures, including startup, shutdown, seasonal, and weekend operations.
d. Description of controls and sequence of operations.
e. Piping diagrams.

2. Maintenance Data:

a. Manufacturer's information, including list of spare parts.
b. Name, address, and telephone number of Installer or supplier.
c. Maintenance procedures.
d. Maintenance and service schedules for preventive and routine maintenance.
e. Maintenance record forms.
f. Sources of spare parts and maintenance materials.
g. Copies of maintenance service agreements.
h. Copies of warranties and bonds.

B. Organize operation and maintenance manuals into suitable sets of manageable size. Bind and index data in heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, with pocket inside the covers to receive folded oversized sheets. Identify each binder on front and spine with the printed title "OPERATION AND MAINTENANCE MANUAL," Project name, and subject matter of contents. Submit manuals in PDF form for preapproval.

1.8 WARRANTIES

A. Submittal Time: Submit written warranties on request of Architect for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated.

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

1. Bind warranties and bonds in heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.
2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.

C. Provide 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.

PART 3 - EXECUTION

3.1 DEMONSTRATION AND TRAINING

A. Instruction: Instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.

1. Provide instructors experienced in operation and maintenance procedures.
2. Provide instruction at mutually agreed-on times. For equipment that requires seasonal operation, provide similar instruction at the start of each season.
3. Schedule training with Owner, through Architect, with at least seven days' advance notice.
4. Coordinate instructors, including providing notification of dates, times, length of instruction, and course content.

B. Program Structure: Develop an instruction program that includes individual training modules for each system and equipment not part of a system, as required by individual Specification Sections. For each training module, develop a learning objective and teaching outline. Include instruction for the following:

1. System design and operational philosophy.

2. Review of documentation.
3. Operations.
4. Adjustments.
5. Troubleshooting.
6. Maintenance.
7. Repair.

3.2 FINAL CLEANING

A. General: Provide 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 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 neither planted nor paved to a smooth, even-textured surface.
d. Remove tools, construction equipment, machinery, and surplus material from Project site.
e. 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.
f. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
g. Sweep concrete floors broom clean in unoccupied spaces.
h. Vacuum carpet and similar soft surfaces, removing debris and excess nap; shampoo if visible soil or stains remain.
i. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.
j. Remove labels that are not permanent.
k. Touch up and otherwise repair and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration.

1) Do not paint over "UL" and similar labels, including mechanical and electrical nameplates.

l. Wipe surfaces of mechanical and electrical equipment, [**elevator equipment,**] and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
m. Replace parts subject to unusual operating conditions.

n. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
o. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
p. Clean ducts, blowers, and coils if units were operated without filters during construction.
q. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs, and those noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.
r. Leave Project clean and ready for occupancy.

C. Comply with safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on Owner's property. Do not discharge volatile, harmful, or dangerous materials into drainage systems. Remove waste materials from Project site and dispose of lawfully.

END OF SECTION 01 77 00

SECTION 01 82 00 - DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1. Demonstration of operation of systems, subsystems, and equipment.
2. Training in operation and maintenance of systems, subsystems, and equipment.

1.3 SUBMITTALS

A. Instruction Program: Submit two copies of outline of instructional program for demonstration and training, including 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. At completion of training, submit two complete training manuals for Owner's use.

B. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

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.

E. Demonstration and Training Videotape: Submit two copies at end of each training module.

1.4 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 Division 1 Section "Quality Requirements," experienced in operation and maintenance procedures and training.

C. Pre-instruction Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "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.

1.5 COORDINATION

A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations.

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 has been reviewed and approved by Architect.

PART 2 - PRODUCTS

2.1 INSTRUCTION PROGRAM

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

1. Refrigeration systems, including chillers, cooling towers, pumps, and distribution piping.
2. HVAC systems, including.
3. HVAC instrumentation and controls.
4. Lighting equipment and controls.

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:

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. Operations manuals.
c. Maintenance manuals.
d. Project Record Documents.
e. Identification systems.
f. Warranties and bonds.
g. 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.

PART 3 - EXECUTION

3.1 PREPARATION

A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a combined training manual.

B. Set up instructional equipment at instruction location.

3.2 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. Architect will 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, through Construction Manager, with at least seven days' advance notice.

D. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of an oral, a written, or a demonstration performance-based test.

E. Demonstration and Training Videotape: 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.

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.

END OF SECTION 01 82 00

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SECTION 01 91 00 – COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Commissioning: Commissioning is a quality-oriented process for achieving, verifying, and documenting that the performance of facilities, systems, and assemblies meet defined objectives and criteria. The Commissioning process begins at project inception (during the pre-design phase) and continues through the life of the facility. The commissioning process includes specific tasks to be conducted during each phase in order to verify that design, construction, and training meets the Owner's project requirements.

B. Commissioning Team: The members of the commissioning team consist of the contracted commissioning agent (CxA), the Owner's representative/construction manager (CM), the general contractor (GC), the architect and design engineers, the mechanical contractor (MC), the electrical contractor (EC), the testing and balancing (TAB) contractor, the control contractor (CC), the facility operating staff, and any other installing subcontractors or suppliers of equipment. The contracted commissioning authority is hired by the Owner directly. The CxA directs and coordinates the project commissioning activities and the reports to the Owner. All team members work together to fulfill their contracted responsibilities and meet the objectives of the contract documents. Commissioning shall:

1. Verify that applicable equipment and systems are installed according to the contract documents, manufacturer's recommendations, and industry accepted minimum standards and these receive adequate operational checkout by installing contractors.
2. Verify and document proper performance of equipment and systems.
3. Verify that O&M documentation left on site is complete.
4. Verify that the Owner's operating personnel are adequately trained.

C. The commissioning process does not take away from or reduce the responsibility of the system designers or installing contractors to provide a finished and fully functioning product.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including General and Supplementary Conditions and other Division 1 specification sections, apply to this section.

B. Owner's Project Requirements and Basis of Design documents are included by reference for information only.

C. ASHRAE Guideline 0-2005

1.3 SUMMARY

A. This section includes general requirements that apply to the implementation of the commissioning process without regard to specific systems, assemblies, and components. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Submittals, Demonstration and Training, and other Division 1 Specification Sections, apply to this Section.

B. Related sections include the following:

1. Division 1 Specifications.
2. Drawings.
3. Division 23 HVAC&R Systems for commissioning process activities for heating, ventilating, air- conditioning, and refrigerating systems, assemblies, equipment, and components.

1.4 DEFINITIONS

A. Acceptance - A formal action, taken by a person with appropriate provider (which may or may not be contractually defined) to declare that some aspect of the project meets defined requirements, thus permitting subsequent activities to proceed.

B. Approval - Acceptance that a piece of equipment or system has been properly installed and is functioning in the tested modes according to the contract documents.

C. Basis of Design - A document that records the concepts, calculations, decisions, and product selections used to meet the Owner's project requirements and to satisfy applicable regulatory requirements, standards, and guidelines. The document includes both narrative descriptions and lists of individual items that support the design process.

D. Checklists - Verification checklists that are developed and used during all phases of the commissioning process to verify that the Owner's project requirements are being achieved. This includes checklists for general verification, plus testing, training, and other specific requirements.

E. Commissioning Authority (CxA) - The entity identified by the Owner who leads, plans, schedules, and coordinates the commissioning team to implement the commissioning process.

F. Commissioning Plan - An overall plan developed by the commissioning agent that provides the structure, schedule and coordination planning for the commissioning process.

G. Commissioning Process - A quality-focused process for enhancing the delivery of a project. The process focuses upon verifying and documenting that the facility and all of its systems and assemblies are planned, designed, installed, tested, operated, and maintained to meet the Owner's project requirements.

H. Commissioning Process Activities - Components of the commissioning process.

I. Commissioning Process Progress Report - A written document that details activities completed as part of the commissioning process and significant findings from those activities that is continuously updated during the course of a project. Usually it is incorporated into the commissioning plan as an ongoing appendix.

J. Commissioning Team - The individuals who through coordinated actions are responsible for implementing the commissioning process.

K. Construction Checklist - A form used by the contractor to verify that appropriate components are on-site, ready for installation, correctly installed, and functional. Also see Checklists.

L. Construction Documents - This includes a wide range of documents, which will vary from project to project, with the Owner's needs and with regulations, laws, and countries. Construction documents usually include the project manual (specifications), plans (drawings) and general terms and conditions of the contract.

M. Contract Documents - This includes a wide range of documents, which will vary from project to project, with the Owner's needs and with regulations, laws, and countries. Contract documents frequently include price agreements, construction management process, sub-contractor agreements or requirements, requirements and procedures for submittals, changes, and other construction requirements, timeline for completion, and the construction documents.

N. Coordination Drawings - Drawings showing the work of all trades to illustrate that equipment can be installed in the space allocated without compromising equipment function or access for maintenance and replacement. These drawings graphically illustrate and dimension manufacturers' recommended maintenance clearances.

O. Control system - A component of environmental, HVAC, security, and fire systems for reporting/monitoring and issuing of commands to/from field devices.

P. Data Logging -The monitoring and recording of flows, currents, status, pressures, etc., of equipment using stand-alone data recorders separate from the control system or the trending capabilities of control systems.

Q. Deferred Performance Tests (DPTs) - Performance tests that are performed, at the discretion of the CxA, after substantial completion, due to partial occupancy, equipment, seasonal requirements, design, or other site conditions that disallow the test from being performed.

R. Deficiency - A condition in the installation or function of a component, piece of equipment, or system that is not in compliance with the contract documents.

S. Factory Testing - Testing of equipment on-site or at the factory, by factory personnel, with or without an Owner's representative present.

T. Issues Log - A formal and ongoing record of problems or concerns – and their resolution – that have been raised by members of the commissioning team during the course of the commissioning process.

U. Non-Compliance - See Deficiency.

V. Non-Conformance - See Deficiency.

W. On-Going Commissioning Process - A continuation of the commissioning process well into the occupancy and operations phase to verify that a project continues to meet current and evolving Owner's project requirements. On-going commissioning process activities occur throughout the life of the facility. Some of these will be close to continuous in implementation, and others will be either scheduled or unscheduled (as needed).

X. Owner's Project Requirements - A written document that details the functional requirements of a project and the expectations of how it will be used and operated. This includes project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information. (The term "Project Intent" is used by some Owners for their commissioning process Owner's project requirements or design.)

Y. Over-ridden Value -Riding over a sensor value in the equipment's controls to observe the response of the equipment's operation. Also see Simulated Signal.

Z. Phased Commissioning - Commissioning that is completed in phases as required by the phasing plan as approved for the project and other scheduling issues.

AA. Quality Based Sampling - A process for evaluating a sub-set (sample) of the total population. The sample is based upon a known or estimated probability distribution of expected values; an

assumed statistical distribution based upon data from a similar product, assembly, or system; or a random sampling that has scientific statistical basis.

BB. Re-Commissioning - An application of the commissioning process requirements to a project that has been delivered using the commissioning process. This may be a scheduled re-commissioning developed as part of an ongoing commissioning process, or it may be triggered by use change, operations problems, or other needs.

CC. Retro-Commissioning -The commissioning process applied to an existing facility that was not previously commissioned. This guideline does not specifically address retro-commissioning. However, the same basic process needs to be followed from pre-design through occupancy and operations to optimize the benefits of implementing the commissioning process philosophy and practice.

DD. Seasonal Performance Tests - Performance tests that are deferred until the system(s) will experience conditions closer to their design conditions based on weather conditions.

EE. Simulated Condition - Condition that is created for the purpose of testing the response of a system (e.g., raising/lowering the setpoint of a thermostat to see the response in a VAV box).

FF. Simulated Signal - Disconnecting a sensor and using a signal generator to simulate a sensor value for the purpose of testing a full range of conditions.

GG. Startup - The initial starting or activating of dynamic equipment, including completing construction checklists.

HH. Systems Manual - A system-focused composite document that includes the operation manual, maintenance manual, and additional information of use to the Owner during the occupancy and operations phase. This document is required by LEED and will be assembled by the CxA. Much of the information will be extracted from the O&M's provided by the contractor, Basis of Design provided by the design team, BAS screen shots, etc.

II. Test Procedure - A written protocol that defines methods, personnel, and expectations for tests conducted on components, equipment, assemblies, systems, and interfaces among systems. The test procedures are specified in the Technical Specifications sections of the contract documents. Performance testing covers the dynamic functions and operations of equipment and systems using manual or monitoring methods. Performance testing is the dynamic testing of systems under full operation. Systems are tested under various modes, such as during low cooling loads, high loads, component failures, unoccupied, varying outside air temperatures, fire alarm, power failure, etc. The systems are run through all the control system's sequences of operation and components are verified to respond as the sequences state.

JJ. Training Plan - A written document that details the expectations, schedule, budget, and deliverables of commissioning process activities related to training of project operating and maintenance personnel, users, and occupants.

KK. Verification - The process by which specific documents, components, equipment, assemblies, systems, and interfaces among systems are confirmed to comply with the criteria described in the Owner's Project Requirements.

LL. Trending – The monitoring, by a building management system or other electronic data gathering equipment, and analyzing of the data gathered over a period of time.

MM. Vendor - Supplier of equipment.

NN. Warranty Period - Refer to Division 1 specifications.

1.5 COORDINATION

A. Project Commissioning Team - The members of the project commissioning team will consist of the commissioning authority and any support personnel, the construction manager, the Owner's facility staff (FS) or designee, the general contractor, subcontractors and/or vendors as required, and the architect/ engineer (A/E).

B. Management - The CxA coordinates the commissioning activities through the construction manager. All members shall work together to fulfill their contracted responsibilities and meet the objectives of the contract documents. Refer to Paragraph 1.6 for additional management details.

C. Scheduling - The CxA, through the Owner or CM, will provide sufficient notice to the contractor for scheduling commissioning activities with respect to the Owner's participation. The contractor will integrate all commissioning activities into the overall project schedule. All parties will address scheduling problems and make necessary notifications in a timely manner in order to expedite the commissioning process.

1.6 COMMISSIONING PLAN

A. The CxA will develop the commissioning plan which shall be included in the project schedule. The following narrative provides a brief overview of the typical commissioning tasks during construction and the general order in which they occur.

1. Commissioning during construction begins with the initial commissioning meeting conducted by the CxA where the commissioning process is reviewed with the project commissioning team members.
2. Additional meetings will be required throughout construction with necessary parties attending to plan, scope, coordinate, schedule future activities and resolve problems.
3. Equipment documentation is submitted to the CxA, through the Owner or CM, during normal submittals, including detailed startup procedures.
4. The construction checklists are to be completed by the contractor (or its subcontractors), before and during the startup process.
5. Construction checklists, TAB and startup must be completed before performance testing.
6. Items of non-compliance in material, installation, or setup shall be corrected at no expense to the Owner.
7. The contractor ensures that the subcontractors' construction checklists are executed and documented and that startup and initial checkout are performed. The CxA verifies that the TAB, construction checklists and startup were completed according to the approved plans. This includes the CxA approving TAB, checklists and startup plans. This also includes witnessing startup of selected equipment. Any testing failure is to be corrected at no additional cost to the Owner, and a re-test is to be performed, observed, and documented.
8. The CxA develops and implements equipment and system performance test procedures. The forms and procedures are approved by the Owner, CM and A/E.
9. The performance tests are executed by the contractor under the direction of the CxA with the assistance of the facility staff. All documentation is by the CxA.
10. The CxA reviews the O&M documentation for completion and provides the commissioning record for the O&M manuals.
11. Commissioning should be completed before substantial completion.
12. The CxA develops procedures, reviews, coordinates, and implements the training provided by the contractor.
13. Deferred testing is conducted as specified or required.

1.7 COMMISSIONING TEAM

A. Members appointed by Owner:

1. CxA - An entity identified by the Owner who leads, plans, schedules, and coordinates the commissioning team to implement the commissioning process. Owner will engage the CxA under a separate contract.
2. Representatives of the facility user and operation and maintenance personnel.
3. Architect and engineering design professionals.

B. Members appointed by contractor(s): Individuals, each having authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated actions. The commissioning team shall consist of, but not be limited to, representatives of each contractor, including project superintendent and subcontractors, installers, suppliers, and specialists deemed appropriate by the CxA including but not limited to General Contractor (GC), the Mechanical Contractor (MC), the Electrical Subcontractor(s) (ES), the Testing Adjusting and Balancing (TAB) subcontractor, the Controls Subcontractor (CC), Fire Protection Contractor, etc.

C. Members of the Commissioning Team, at minimum, to include:

1. Owner’s Representative
2. Owner Operations Staff Representative
3. Architect / Engineer (A/E)
4. General Contractor
5. Mechanical Subcontractor
6. Plumbing Subcontractor
7. Major HVAC, Plumbing, and Fire Protection Equipment Suppliers
8. Electrical Sub-contractor
9. Major Electrical Systems Suppliers
10. Instrumentation and Controls Sub-contractor
11. Instrumentation and Controls Supplier
12. Test and Balance Sub-contractor
13. Commissioning Authority

1.8 RESPONSIBILITIES

A. The general responsibilities of various parties in the commissioning process are provided in this sub-section. The specific responsibilities are in the Technical Specifications.

B. All Cx Team (CxT) Members:

1. Follow the commissioning plan.
2. Attend initial commissioning meeting and additional meetings as necessary.
3. Cooperate with all CxT members to carry out commissioning process.
4. Include the price of commissioning responsibilities/tasks in each CxT member’s proposal.

C. Commissioning Authority (CxA)

1. Develops a commissioning plan outlining the organization, schedule, allocation of resources, and documentation requirements of the commissioning process. CxA oversees implementation of commissioning plan.
2. Coordinates and directs the commissioning activities in a logical, sequential and efficient manner using consistent protocols and forms, centralized documentation, clear and

regular communications and consultations with all necessary parties, frequently updated timelines and schedules and technical expertise.

3. Coordinate the commissioning work and, with the GC and Owner/CM, help integrate commissioning activities into the master schedule.
4. Revise the Construction Phase Commissioning Plan as necessary.
5. Plan and conduct a commissioning scoping meeting and other commissioning meetings.
6. Request and review additional information required to perform commissioning tasks, including O&M materials, contractor startup and checkout procedures.
7. Before startup, gather and review the current control sequences and interlocks and work with contractors and design engineers until sufficient clarity has been obtained, in writing, to be able to write detailed testing procedures.
8. Review and recommend approval of normal contractor submittals applicable to systems being commissioned for compliance with commissioning needs, concurrent with the A/E reviews.
9. Write and distribute construction checklists. Prepare and maintain completed construction checklist log.
10. Develop an enhanced startup and initial systems checkout plan with subcontractors.
11. Perform site visits, as necessary, to observe component and system installations. Attend selected planning and job-site meetings to obtain information on construction progress. Review construction meeting minutes for revisions/substitutions relating to the commissioning process. Assist in resolving any discrepancies.
12. Witness all or part of the HVAC piping test and flushing procedure, sufficient to be confident that proper procedures were followed. Document this testing and include the documentation in O&M manuals. Notify Owner/CM of any deficiencies in results or procedures.
13. Develop project specific checklist for contractor to complete.
14. Recommend approval of construction checklist completion by selected site observation and spot checking. CxA shall sample 100% of checklists and provide documentation.
15. Recommend approval of systems startup by reviewing startup reports and by selected site observation.
16. Review TAB execution plan, preliminary TAB report, and final TAB report.
17. Oversee sufficient testing of the control system and recommend approval of it to be used for TAB, before TAB is executed.
18. With necessary assistance and review from installing contractors, write the performance test procedures for equipment and systems, including energy management control system trending, stand-alone data logger monitoring or manual performance testing. Submit to CM for review, and for approval if required.
19. Analyze any performance trend logs and monitoring data to verify performance.
20. Coordinate, witness, and recommend approval of manual performance tests performed by installing contractors. Coordinate retesting as necessary until satisfactory performance is achieved.
21. Maintain an Issues Log and a separate testing record. Provide the Owner/ CM with written progress reports and test results with recommended actions.
22. Review equipment warranties within the O&M to ensure that the Owner's responsibilities are clearly defined.
23. Oversee and recommend approval of the training of the Owner's operating personnel.
24. Review and recommend approval of the preparation of the O&M manuals.
25. Provide a final commissioning report (as described in this section).
26. Coordinate and supervise required seasonal or deferred testing and deficiency corrections.

D. Owner or Owner's Representative

1. Manage the contract of the A/E and of the GC.
2. Arrange for facility operating and maintenance personnel to attend various field commissioning activities and field training sessions.

3. Provide final approval for the completion of the commissioning work.
4. Facilitate the coordination of the commissioning work by the CxA, and, with the GC and CxA, ensure that commissioning activities are being scheduled into the master schedule.
5. Review and recommend approval of the final Commissioning Plan
6. Attend a commissioning scoping meeting and other commissioning team meetings.
7. Perform the normal review of contractor submittals.
8. Furnish a copy of all construction documents, addenda, change orders and approved submittals and shop drawings related to commissioned equipment to the CxA.
9. Review and recommend approval of the performance test procedures submitted by the CxA, prior to testing.
10. When necessary, observe and witness startup and performance testing of selected equipment.
11. Review commissioning progress and deficiency reports.
12. Coordinate the resolution of non-compliance and design deficiencies identified in all phases of commissioning.
13. Sign-off (final approval) on individual commissioning tests as completed and passing. Recommend completion of the commissioning process to the Project Manager.
14. Assist the GC in coordinating the training of Owner personnel.
15. Assign operation and maintenance personnel and schedule them to participate in commissioning team activities.
16. Assist the CxA as necessary in the seasonal or deferred testing and deficiency corrections required by the specifications.
17. Attend lessons learned session

E. Architect (of A/E)

1. Attend the commissioning scoping meeting and selected commissioning team meetings.
2. Perform normal submittal review, construction observation, as-built drawing preparation, O&M manual preparation, etc., as contracted.
3. Provide any design narrative documentation requested by the CxA.
4. Coordinate resolution of system deficiencies identified during commissioning, according to the contract documents.
5. Prepare and submit final as-built design intent documentation for inclusion in the O&M manuals. Review and recommend approval of the O&M manuals.

F. Mechanical and Electrical Designers/Engineers (of the A/E)

1. Perform normal submittal review, construction observation, as-built drawing preparation, etc., as contracted. One site observation should be completed just prior to system startup.
2. Provide any design narrative and sequences documentation requested by the CxA. The designers shall assist (along with the contractors) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
3. Attend commissioning scoping meetings and other selected commissioning team meetings.
4. Participate in the resolution of system deficiencies identified during commissioning, according to the contract documents.
5. Prepare and submit the final as-built design intent and operating parameters documentation for inclusion in the O&M manuals. Review and recommend approval of the O&M manuals.
6. From the contractor’s red-line drawings, edit and update one-line diagrams developed as part of the design narrative documentation and those provided by the vendor as shop drawings for the chilled and hot water, condenser water, domestic water, steam and condensate systems; supply, return and exhaust air systems and emergency power system.

7. Review and recommend approval of the construction checklists for major pieces of equipment for sufficiency prior to their use.
8. Review and recommend approval of the performance test procedure forms for major pieces of equipment for sufficiency prior to their use.
9. Participate in the resolution of non-compliance, non-conformance and design deficiencies identified during commissioning during warranty-period commissioning.

G. Each Contractor and their subcontractors and vendors shall assign representatives with expertise and authority to act on their behalf and schedule them to participate in and perform commissioning process activities including, but not limited to, the following:

1. Facilitate the coordination of the commissioning and incorporate commissioning activities (the Commissioning Plan) into the Overall Project Schedule.
2. Provide detailed startup procedures
3. Include the cost of commissioning in the total contract price.
4. Ensure that all subcontractors and vendors execute their commissioning responsibilities according to the contract documents and the OPS.
5. Provide copies of all submittals as required by contract documents including all changes thereto. Attend and participate in commissioning team meetings. No later than 60 days prior to startup of the first piece of major equipment, meet with the CxA, CM, A/E, and PM and Owner to finalize the detailed commissioning procedures/ schedule.
6. Provide the training of Owner personnel.
7. Review and accept construction checklists provided by the commissioning authority.
8. Complete construction checklists as work is completed and provide to CxA.
9. Accomplish commissioning process test procedures.
10. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.
11. Cooperate with the CxA for resolution of issues recorded in the “Issues Log”.
12. Prepare O&M manuals, according to the contract documents, including clarifying and updating the original sequences of operation to as-built/as-tested conditions.
13. Ensure that subcontractors provide assistance for seasonal or deferred performance testing, performed by the CxA, according to the specifications.
14. Ensure that subcontractors correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.
15. Perform all guarantee work for materials furnished under the contract for the time specified in the contract, including all warranties and curing all latent defects within the time period provided in the contract.

H. Vendors/Subcontractors

1. Provide all requested submittal data, including detailed startup procedures and specific responsibilities of the Owner to keep warranties in force.
2. Assist in equipment testing per agreements with subcontractors and/or contractor.
3. Include cost of all special tools and instruments (only available from vendor, specific to a piece of equipment) required for testing, operating, and maintaining equipment according to these contract documents in the base bid price to the contractor.
4. Analyze specified products and verify that the A/E has specified the newest, most current equipment reasonable for this project’s scope and budget.
5. Provide requested information regarding equipment sequence of operation and testing procedures.
6. Review construction checklists and test procedures for equipment installed by factory representatives.

1.9 EQUIPMENT/SYSTEMS TO BE COMMISSIONED

A. The following equipment/systems will be commissioned in this project:

1. Building Chiller (CH-1) Systems with associated pumps, and controls.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. All standard testing equipment required to perform startup and initial checkout and required performance testing shall be provided by the contractor for the equipment being tested. This includes, but is not limited to, two-way radios, meters, and data recorders. Data recorders may be provided by the CxA at the option of the CxA.

B. Special equipment, tools, and instruments required for testing equipment according to these contract documents shall be included in the contractor's base bid price and shall be turned over to the Owner at Project close-out.

C. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance within the tolerances specified in the specifications. If not otherwise noted, the following minimum requirements apply: Temperature sensors and digital thermometers shall have a certified calibration to NIST traceable standards within the past year to an accuracy of 0.5 degree F and a resolution of + or - 0.1 degree F. Pressure sensors shall have an accuracy of + or - 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year. All equipment shall be calibrated according to the manufacturer's recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates readily available.

PART 3 - EXECUTION

3.1 COMMISSIONING MEETINGS

A. Initial Meeting. The initial meeting will be scheduled as part of the preconstruction meeting.

B. Miscellaneous Meetings. Other meetings will be planned and conducted by the CxA as construction progresses. These meetings will cover coordination, deficiency resolution, and planning issues. These meetings will be held as part of the OAC meetings.

C. Post Occupancy / Warranty Meetings: Meeting will be held until all issues on issues log are resolved and after to discuss operation and warranty issues. These meetings may be weekly as necessary to resolve issues.

3.2 STARTUP, CONSTRUCTION CHECKLISTS, AND INITIAL CHECKOUT

A. The following procedures apply to all equipment/systems to be commissioned, according to Paragraph 1.9 Equipment/Systems to be commissioned.

B. General. Construction checklists are important to verify that the equipment and systems are fully connected and operational. It ensures that performance testing (in-depth system checkout) may proceed without unnecessary delays. The construction checklists for a given system must

be successfully completed and approved prior to startup and formal performance testing of equipment or subsystems of the given system.

C. Startup and Checkout Plan. The CxA will assist the project commissioning team members responsible for startup of any equipment. The primary role of the CxA in this process is to ensure that there is written documentation that each of the manufacturer-recommended procedures has been completed. The CxA shall provide construction checklists and startup shall be identified in the commissioning scoping meeting and on the checklist forms

1. The construction checklists indicate required procedures to be executed prior to startup and initial checkout of the systems.
2. The contractor shall determine which trade is responsible for executing and documenting each of the line item tasks and transmit the checklists to the responsible subcontractors. Each form may have more than one trade responsible for its execution.
3. The contractor/subcontractor with assistance from the CxA responsible for the purchase of the equipment shall develop the full startup plan by combining the manufacturer's detailed startup and checkout procedures and the construction checklists.
4. The contractor/subcontractor shall submit the full startup plan to the CxA for review and approval.
5. The CxA will review and recommend approval of the procedures and the documentation format for reporting. The CxA will return the procedures and the documentation format to the contractor, through the CM.
6. The contractor will transmit the full startup plan to the subcontractors for their review and use.

D. Sensor and Actuator Calibration. All field-installed temperature, relative humidity, CO, CO2, refrigerant, O2, and/or pressure sensors and gages, and all actuators (dampers and valves) on all equipment shall be calibrated. Verify that all locations are appropriate and away from causes of erratic operation. Submit to the CxA through the CM the calibration methods and results. All test instruments shall have had a certified calibration within the last 6 months to NIST traceable standards, and comply with all local, state and/or federal requirements/certifications, as required. Sensors installed in the unit at the factory with calibration certification provided need not be field calibrated. Provide bench testing as required at the direction of the CxA.

1. Sensor Calibration Methods

a. All Sensors-- Verify that all sensor locations are appropriate and away from causes of erratic operation. Verify that sensors with shielded cable, are grounded only at one end. For sensor pairs that are used to determine a temperature or pressure difference, make sure they are reading within 0.2°F of each other for temperature and within a tolerance equal to 2% of the reading, of each other, for pressure. Tolerances for critical applications may be tighter.
b. Sensors without Transmitters-- Standard Application. Make a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage or building automation system (BAS)) is within the tolerances in the table below of the instrument-measured value. If not, install offset in BAS, calibrate or replace sensor.
c. Sensors with Transmitters-- Standard Application. Disconnect sensor. Connect a signal generator in place of sensor. Connect ammeter in series between transmitter and BAS control panel. Using manufacturer's resistance-temperature data, simulate minimum desired temperature. Adjust transmitter potentiometer zero until 4 mA is read by the ammeter. Repeat for the maximum temperature matching 20 mA to the potentiometer span or maximum and verify at the BAS. Record all values and recalibrate controller as necessary to conform with specified control ramps, reset schedules, proportional relationship, reset relationship and P/I reaction. Reconnect sensor. Make a reading with a calibrated test instrument

within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage or building automation system (BAS) is within the tolerances in the table below of the instrument-measured value. If not, replace sensor and repeat. For pressure sensors, perform a similar process with a suitable signal generator.

2. Tolerances, Standard Applications

Sensor	Required Tolerance (±)
Cooling coil, chilled and condenser water temps	0.5F
AHU wet bulb or dew point	2.0F
Hot water coil and boiler water temp	1.5F
Outside air, space air, duct air temps	0.5F
Watt-hour, voltage & amperage	1% of design
Pressures, air, water and gas	3% of design
Flow rates, water	10% of design
Relative humidity	4% of design
Combustion flue temps	5.0F
Oxygen or CO_2 monitor	0.1 % pts
CO monitor	0.01 % pts
Natural gas and oil flow rate	1% of design
Barometric pressure	0.1 in. of Hg

3. Valve and Damper Stroke Setup and Check EMS Readout-- For all valve and damper actuator positions checked, verify the actual position against the BAS readout. Set pumps or fans to normal operating mode. Command valve or damper closed, visually verify that valve or damper is closed and adjust output zero signal as required. Command valve or damper open, verify position is full open and adjust output signal as required. Command valve or damper to a few intermediate positions. If actual valve or damper position doesn't reasonably correspond, replace actuator or add pilot positioner (for pneumatics).
4. Closure for cooling coil valves (NC)-- Set cooling setpoint 20°F above room temperature. Observe the valve close. Remove control air or power from the valve and verify that the valve stem and actuator position do not change. Restore to normal. Set cooling setpoint to 20°F below room temperature. Observe valve open. For pneumatics, by override in the EMS, increase pressure to valve by 3 psi (do not exceed actuator pressure rating) and verify valve stem and actuator position does not change. Restore to normal.

E. Execution of Construction Checklists and Startup.

1. Four weeks prior to the scheduled startup, the contractor shall coordinate startup and checkout with the CM, A/E, and CxA. The execution and approval of the construction checklists, startup, and checkout shall be directed and performed by the contractor, subcontractor or vendor. Signatures are required of the applicable subcontractors for verification of completion of their work.
2. The Owner/CM, and A/E as necessary, shall observe, at minimum, the procedures for each piece of primary equipment, unless there are multiple units, in which case a sampling strategy may be used. The CxA will observe all testing.
3. For lower-level components of equipment, (e.g., sensors, controllers), the CxA shall observe a sampling of the startup procedures.
4. The subcontractors and vendors shall execute startup and provide the CxA and A/E, through the Owner/CM, with a signed and dated copy of the completed startup and construction checklists.
5. Only individuals of the contractor (technicians, engineers, tradesmen, vendors, etc.) who have direct knowledge and witnessed that a line item task on the construction checklist

was actually performed shall check off that item. It is not acceptable for witnessing supervisors to fill out these forms.

F. Deficiencies, Non-Conformance, and Approval in Checklists and Startup(Master Issues Log).

1. The contractor shall ensure that the subcontractors clearly list any outstanding items of the initial startup and construction checklist procedures that were not completed successfully, on an attached sheet. The form and any outstanding deficiencies shall be provided, through the Owner/CM, to the CxA within two days of test completion.
2. The CxA will review the report and issue either a non-compliance report or an approval form, through the CM, to the contractor. The installing subcontractors or vendors shall correct all areas that are deficient or incomplete in the checklists and tests in a timely manner, shall notify the Owner/CM as soon as outstanding items have been corrected, and resubmit an updated startup report with a Statement of Correction on the original non-compliance report. When satisfactorily completed, the CxA will recommend approval of the execution of the checklists and startup of each system.
3. Items left incomplete, which later cause deficiencies or delays during performance may result in back-charges to the contractor. Refer to Paragraph 3.5, herein, for details.

3.3 SUBMITTALS

A. The CxA will provide appropriate contractors with a specific request for the type of submittal documentation the CxA requires facilitating the commissioning work. These requests will be integrated into the normal submittal process and protocol of the construction team. At minimum, the request will include the manufacturer and model number, the manufacturer's printed installation and detailed startup procedures, full sequences of operation, O&M data, performance data, any performance test procedures, control drawings and details of Owner contracted tests. In addition, the installation and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the commissioning authority. All documentation requested by the CxA will be included by the subcontractors in their O&M manual contributions.

B. The CxA will review and recommend approval of submittals related to the commissioned equipment for conformance to the contract documents as it relates to the commissioning process, to the performance of the equipment and adequacy for developing test procedures. This review is intended primarily to aid in the development of performance procedures and only secondarily to verify compliance with equipment specifications. The commissioning authority will notify the Owner/CM, PM or A/E as requested, of items missing or areas that are not in conformance with contract documents and which require resubmission.

C. The CxA may request additional design narrative from the A/E and controls contractor, depending on the completeness of the OPR documentation and sequences provided with the specifications.

D. These submittals to the CxA do not constitute compliance for O&M manual documentation. The O&M manuals are the responsibility of the contractor, though the CxA will review and recommend approval of them.

3.4 TEST, ADJUST, AND BALANCE (TAB) VERIFICATION

A. Contractor shall submit complete TAB report for CxA, Owner, and AE review. Report will be deemed incomplete if not balanced in compliance with contract documents or if incomplete because of contractor related issues. Once CxA, Owner, and AE verify report is complete, TAB verification will be scheduled.

B. TAB Report shall comply with NEBB or TAB standard reports and include drawings with inlets and outlets, and pump and fan curves with plotted test data.

C. TAB report shall have VFD pump differential water pressure setting recorded on drawings.

D. TAB report shall have data indicating calibration of airflow monitoring stations. Data shall include a minimum of traverse and corresponding airflow station reading at minimum OA and 100% economizers.

E. VAV AHU's with control algorithms maintaining minimum OA shall indicate OA traverse data when all VAV's are in heating and VFD is ramped down; traverse data at any steady state condition; and traverse data when VAV's in full cooling and VFD is ramped up.

F. Functional performance testing will not be started until all commissioning checklists and start up reports are submitted and approved by the CxA.

3.5 FUNCTIONAL PERFORMANCE TESTING

A. Requirements. The contractor directed functional performance testing shall demonstrate that each system is operating according to the documented design intent and contract documents. Performance testing facilitates bringing the systems from a state of individual substantial completion to full dynamic operation. Additionally, during the testing process, areas of deficient performance are identified and corrected, improving the operation and functioning of the systems.

B. Coordination and Scheduling. The contractor shall provide sufficient notice, regarding their completion schedule for the construction checklists and startup of all equipment and systems to allow the performance testing to be scheduled. The commissioning team shall oversee, witness, and document the performance of all equipment and systems. The CxA in association with the contractor/subcontractors and facility staff shall execute the tests. Performance testing shall be conducted after the construction checklists, and startup has been satisfactorily completed. The control system shall be sufficiently tested and recommend approval of by the CxA before it is used, to verify performance of other components or systems. The air balancing and water balancing shall be completed before performance testing of air or water-related equipment or systems. Testing proceeds from components to sub-systems to systems. When the proper performance of all interacting individual systems has been achieved, the interface or coordinated responses between systems shall be checked.

C. Development of Test Procedures. Before test procedures are finalized, the contractor shall provide to the A/E and the CxA all requested documentation and a current list of changes affecting equipment or systems, including an updated points list, program code, control sequences, and testing parameters. Using the testing parameters and requirements in the technical specifications, the CxA shall update/develop specific test procedures and forms to verify and document proper operation of each piece of equipment and system. Each contractor/subcontractor or vendor, as appropriate, shall provide assistance to the CxA in developing the final procedures. Prior to finalization, the A/E shall review and concur with the test procedure.

D. Test Methods.

1. Performance testing and verification may be achieved by manual testing or by monitoring the performance and analyzing the results using the control system's trend log capabilities or by stand-alone data loggers. The CxA may substitute specified methods or require an additional method to be executed other than what was specified, with the

approval of the A/E and Owner/CM. The CxA will determine which method is most appropriate for tests that do not have a specified method.

2. Simulated Conditions. Simulating conditions shall be allowed, though timing the testing to experience actual conditions is encouraged wherever practical.
3. Overridden Values. Overriding sensor values to simulate a condition, such as overriding the outside air temperature reading in a control system to be something other than it really is, is acceptable.
4. Simulated Signals. Using a signal generator which creates a simulated signal to test and calibrate transducers and DDC constants is generally recommended over using the sensor to act as the signal generator via simulated conditions or overridden values.
5. Altering Setpoints. Rather than overriding sensor values, and when simulating conditions is difficult, altering setpoints to test a sequence is acceptable.
6. Indirect Indicators. Relying on indirect indicators for responses or performance shall be allowed only after visually and directly verifying and documenting, over the range of the test parameters, that the indirect readings through the control system represent actual conditions and responses.
7. Setup. Each performance test shall be performed under conditions that simulate actual conditions as closely as is practically possible. The contractor/subcontractor(s) assisting the CxA in executing the test shall provide all necessary materials, system modifications, etc., to produce the necessary flows, pressures, temperatures, etc., necessary to execute the test according to the specified conditions. At completion of the test, the contractor/subcontractor(s) shall return all affected equipment and systems to their recommend and approved of operating settings.

E. Test Equipment. Refer to Part 2 for test equipment requirements.

F. Problem Solving. The burden of responsibility to solve, correct, and retest malfunctions/failures is with the contractor, with Owner approval as required.

3.6 DOCUMENTATION, NON-CONFORMANCE, AND APPROVAL OF TESTS

A. Documentation. The CxA shall witness and verify/pre-recommend approval of the documentation of the results of all performance tests. The CxA shall complete all documentation for performance testing.

B. Non-Conformance.

1. Corrections of minor deficiencies identified may be made during the tests at the discretion of the CxA. In such cases the deficiency and resolution will be documented on the procedure form or on an attached sheet.
2. As tests progress and a deficiency is identified, the CxA shall discuss the issue with the commissioning team, and the contractor.

    a. When there is no dispute on the deficiency and the contractor accepts responsibility to correct it:

        1) The CxA will document the deficiency and the contractor’s response and intentions. After the day’s work, the CxA will submit the non-compliance reports to the CM. The contractor corrects the deficiency, signs the statement of correction at the bottom of the non-compliance form certifying that the equipment is ready to be retested and sends it back to the CxA.
        2) The contractor shall reschedule the test; and the test repeated.

    b. If there is a dispute about a deficiency, regarding whether or not it is a deficiency:

1) The dispute shall be documented on the non-compliance form with the contractor's response.
2) Resolutions are made at the lowest management level possible. Other parties are brought into the discussions as needed. Final interpretive authority is with the A/E. Final acceptance authority is with the construction manager.
3) The CxA documents the resolution process.
4) Once the interpretation and resolution have been decided, the contractor corrects the deficiency, signs the statement of correction on the non-compliance form and provides it to the CxA, through the CM. The contractor shall reschedule the test and the test repeated until satisfactory performance is achieved.

3. Cost of retesting a performance test is the contractor's.
4. The contractor shall submit in writing to the CM at least as often as commissioning meetings are being scheduled, the status of each outstanding discrepancy identified during commissioning. Discussion shall cover explanations of any disagreement and proposals for their resolutions.

a. The CxA retains the original non-conformance forms until the end of the project.
b. Retesting shall not be considered a justified reason for a claim of delay or for a time extension by the contractor.

C. Failure Due to Manufacturer Defect. If 10% (or three, whichever is greater) of identical pieces of equipment fail to perform to the contract documents (mechanically or substantively) due to a manufacturing defect, not allowing it to meet its submitted performance specification, all identical units may be considered unacceptable by the A/E or CxA. In such case, the contractor shall provide the Owner with the following:

1. Within one week of notification from the Owner/CM, the contractor or manufacturer's representative shall examine all other identical units making a record of the findings. The findings shall be provided to the CM within two weeks of the original notice.
2. Within two weeks of the original notification, the contractor or manufacturer shall provide a signed and dated, written explanation of the problem, cause of failures, etc., and all proposed solutions. The proposed solutions shall not significantly exceed the specification requirements of the original installation.
3. The A/E will determine whether a replacement of all identical units or a repair is acceptable.
4. Two examples, where applicable, of the proposed solution shall be installed by the contractor and the A/E shall be allowed to test the installations for up to one week, upon which the A/E will decide whether to accept the solution.
5. Upon acceptance, the contractor and/or manufacturer shall replace or repair all identical items, at their expense. The replacement/repair work shall proceed with reasonable speed beginning within one week from when parts can be obtained.

D. Approval. The CxA notes each satisfactorily demonstrated function on the test form. Final approval of the performance test by the Owner is made after review by the CxA and CM, following recommendations by the A/E.

3.7 DEFERRED TESTING

A. Unforeseen Deferred Tests. If any check or test cannot be completed due to the project completion level, required occupancy condition or other deficiency, execution of checklists and performance testing may be delayed upon approval of the CxA and CM. These tests will be

conducted in the same manner as the seasonal tests as soon as possible. Services of necessary parties will be negotiated.

B. Seasonal Testing. During the warranty period, seasonal testing (tests delayed until weather conditions are closer to the system's design) shall be completed as part of this contract. The CxA shall coordinate this activity through the Owner/CM. Tests will be executed by the contractor, documented by the CxA and deficiencies should be corrected by the appropriate contractor/ subcontractors with the CxA witnessing. Any final adjustments to the O&M manuals and as-builts due to the testing shall be made by the contractor.

3.8 TRAINING OF OWNER PERSONNEL

A. The contractor shall provide training coordination, scheduling of subcontractors, and ensure that training is completed. All training shall be coordinated, through the CM, with the CxA.

B. The contractor shall ensure that each subcontractor and vendor (mechanical, plumbing, fire, electrical, specialty, etc.) shall have the following responsibilities:

1. Provide, to the CxA through the CM, a training plan sixty days before the planned training covering the following elements:

    a. Equipment
    b. Intended audience
    c. Location of training
    d. Objectives
    e. Subjects covered (description, duration of discussion, special methods, etc.)
    f. Duration of training on each subject
    g. Instructor for each subject
    h. Methods (classroom lecture, manufacturer's quality video, site walk-through, actual operational demonstrations, written handouts, etc.).

2. Provide designated Owner personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of equipment that makes up the system.
3. Training shall normally start with classroom sessions followed by hands-on demonstration/training on each piece of equipment.
4. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system shall be repaired or adjusted as necessary and the demonstration repeated at another scheduled time, if necessary.
5. The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment is required. More than one party may be required to execute the training.
6. The controls contractor shall attend sessions other than the controls training, as specified, to discuss the interaction of the controls system as it relates to the equipment being discussed.
7. The training sessions s
8. hall follow the outline in the table of contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.
9. Training shall include:

    a. Use of the printed installation, operation and maintenance instruction material included in the O&M manuals.

b. A review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include startup, operation in all modes possible, shutdown, seasonal changeover and any emergency procedures.
c. Discussion of relevant health and safety issues and concerns.
d. Discussion of warranties and guarantees.
e. Common troubleshooting problems and solutions.
f. Explanatory information included in the O&M manuals.
g. Discussion of any peculiarities of equipment installation or operation.
h. Classroom sessions shall include the use of overhead projections, slides, video/audio-taped material as might be appropriate.
i. Hands-on training shall include startup, operation in all modes possible, including manual, shut-down, alarms, power failure and any emergency procedures, and preventative maintenance for all pieces of equipment.

10. The contractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls not controlled by the central control system.

C. At the discretion of the CxA, training may occur before performance testing is complete if required by the facility operators to assist the CxA in the performance testing.

D. Videotaping of the training sessions will be provided by the contractor and added to the O&M manuals. In addition, factory training videos identifying key troubleshooting, repair, service and/or replacement techniques shall be provided and reviewed with the Owner.

E. The CxA at the beginning of each training session presents the overall system narrative and the design concept of each equipment section.

3.9 OPERATIONS AND MAINTENANCE MANUALS / DATA

A. The commissioning process requires detailed O&M documentation as identified in this section and technical specifications.

B. O&M documentation shall comply with 2021 IECC.

C. Contractor shall submit complete operating and maintenance manuals in electronic format (PDF) for CxTeam review within 60 calendar days after review of equipment submittals. Electronic manuals shall be identical in contents to a printed manual: with title/cover page, table of contents, tabbed/bookmarked sections, etc. Separate files for each piece of equipment will not be accepted.

D. Approved O&M's shall be installed linked to on the building operation system.

E. Contractor shall submit corrected final approved manuals prior to scheduling training sessions. Prior to final submittal, the CxA shall review the O&M manuals (in addition to the initial draft O&M manual), and documentation, with redline as-builts, for systems that were commissioned to verify compliance with the specifications. The CxA will communicate, through the CM, deficiencies in the manuals to the contractor or A/E, as requested. The CxA will also review each equipment warranty and verify that all requirements to keep the warranty valid are clearly stated. This work does not supersede the A/E's review of the O&M manuals according to the A/E's contract.

F. The contractor shall compile O&M manuals in accordance with all Specifications.

1. For equipment, subsystems, and systems to be commissioned, the contractor will include the following:

    a. Operation and Maintenance Instructions. These shall be the written manufacturer's data with the model and features of this installation clearly marked and edited to omit reference to products or data not applicable to this installation. This section shall include data on the following:

        1) Approved submittal, including model number, serial number and nameplate data for each piece of equipment and any subcomponent.
        2) Installation, startup and break-in instructions.
        3) All starting, normal shutdown, emergency shutdown, manual operation and normal and emergency operating procedures and data, including any special limitations.

            a) Step-by-step procedure for system startup, including a pre-start checklist. Refer to controls and indicators by nomenclature consistent with that used on panels and in control diagrams.
            b) Sequence of operation, with detailed instruction in proper sequence, for each mode of operation (i.e., day-night; staging of equipment).
            c) Emergency operation: If some functions of the equipment can be operated while other functions are disabled, give instructions for operations under these conditions. Include here only those alternate methods of operations (from normal) which the operator can follow when there is a partial failure or malfunctioning of components, or other unusual condition.
            d) Shutdown procedure: Include instructions for stopping and securing the equipment after operation. If a particular sequence is required, give step-by-step instructions in that order.

2. Building Operational Data:

    a. Provide a schedule for preventive maintenance in a printed format and an electronic format compatible with Owner's system. State, preferably in tabular form, the recommended frequency of performance for each preventive maintenance task, cleaning, inspection and scheduled overhauls. One comprehensive schedule indicating routine maintenance frequencies. Schedule shall indicate maintenance requirements for 2-calendar years starting from date of Owner acceptance. All required maintenance to maintain warranties shall be clearly listed.
    b. Filter Schedule: One comprehensive schedule indicating all equipment on the project with filters and their associated filter size, quantity, and MERV rating.
    c. Belt Schedule: One comprehensive schedule indicating all equipment on the project with belts and their associated belt size, type, and quantity.
    d. Lamp Schedule: One comprehensive schedule indicating lamps for all luminaires on the project and their types and quantities, manufacturers, and order codes.
    e. Warranty Schedule: One comprehensive schedule listing all equipment on project and their parts, labor, and extended warranties.
    f. Spare parts list: List shall include all spare parts that the contractor recommends the Owner to have for emergencies. List should include any items included in contract documents.

3. Safety Precautions: This subsection shall comprise a listing of safety precautions and instructions to be followed before, during and after making repairs, adjustments or routine maintenance.

4. Manufacturers' brochures (including controls): Manufacturers' descriptive literature covering devices and equipment used in the system, together with illustrations, exploded views and renewal parts lists. Manufacturers' standard brochures and parts list shall be corrected so that information applying to the actual installed equipment is clearly defined.
5. Supply any special tools required to service or maintain the equipment.
6. Performance data, ratings and curves.
7. Warranty and guarantee, which clearly lists conditions to be maintained to keep warranty in effect and conditions that would affect the validity of the warranty.
8. Any service contracts issued.
9. Supplemental Data. Prepare written text and/or special drawings to provide necessary information, where manufacturer's standard printed data is not available and information is necessary for a proper understanding and operation and maintenance of equipment or systems, or where it is necessary to provide additional information to supplement data included in the manual or project documents.
10. Control Diagrams/Drawings. Include the as-built control diagrams/drawings for the piece of equipment and its components, including full points list, full print out of all schedules and set points after testing and acceptance of the system, and copies of all checkout tests and calibrations performed by the contractor (not commissioning tests). Plans shall include location of all controllers, sensors, and BAS connections.
11. Record Drawings: Record drawings shall include all changes, RFI's, PR's, ASI's, substitutions, etc., in addition to field modifications.
12. TAB: this section shall include complete approve TAB report. TAB report airflows and water flows need to match submittals when they are approved different than design.
13. System Description. This section shall include the individual equipment portion of the overall system Design Basis Narrative.

3.10 Cx DOCUMENTS

A. The commissioning process generates a number of written work products described in various parts of the Specifications. The Commissioning Plan—Construction Phase, lists all the formal written work products, describes briefly their contents, who is responsible to create them, their due dates, who receives and approves them and the location of the specification to create them. In summary, the written products are:

Product	**Developed By**
1. Final commissioning plan	CxA
2. Cx meeting minutes	CxA
3. Commissioning schedules	CxA with GC and CM
4. Equipment documentation submittals	Subs
5. Sequence clarifications	Subs and A/E as needed
5. Pre-functional checklists	CxA
6. Startup plan	Subs and CxA
7. Startup and checklist forms filled out	Subs
8. Final TAB report	TAB
9. Issues log (deficiencies)	CxA
11. O&M manuals	Subs
12. Functional test forms	CxA
13. Completed /filled out functional tests	CxA
14. Overall training plan	CxA and CM
15. Specific training agendas	Subs
16. Final commissioning report	CxA

3.11 EXCLUSIONS

A. The Owner's representative and Owner's Commissioning Agent are not responsible for construction means, methods, job safety, or any management function related to commissioning on the job site.

END OF SECTION 01 91 00

SECTION 09 91 23 - PAINTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes surface preparation and the application of paint systems.

1.2 SCOPE

A. General
   1. Patch and paint walls and ceilings affected by demolition and new work. Painting shall consist of painting entire wall, ceiling, floor, surface, or plane affected.
   2. Paint color and sheen shall adjacent surfaces.

1.3 DEFINITIONS

A. Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.

B. Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.

C. Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.

B. Samples: For each type of paint system and in each color and gloss of topcoat.

C. Product List: For each product indicated. Include printout of current "MPI Approved Products List" for each product category specified in Part 2, with the proposed product highlighted.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

   1. Paint: 5 percent, but not less than 1 gal. of each material and color applied.

PART 2 - PRODUCTS

2.1 MANUFACTURER'S

A. Diamond Vogel

B. Sherwin Williams

2.2 PAINT, GENERAL

A. MPI Standards: Provide products that comply with MPI standards indicated and that are listed in its "MPI Approved Products List."

B. Material Compatibility:

1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

C. VOC Content: Products shall comply with VOC limits of authorities having jurisdiction and, for interior paints and coatings applied at Project site, the following VOC limits, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 150 g/L.
3. Dry-Fog Coatings: 400 g/L.
4. Primers, Sealers, and Undercoaters: 200 g/L.
5. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.
6. Zinc-Rich Industrial Maintenance Primers: 340 g/L.
7. Pretreatment Wash Primers: 420 g/L.
8. Floor Coatings: 100 g/L.
9. Shellacs, Clear: 730 g/L.
10. Shellacs, Pigmented: 550 g/L.

D. Color:
1. Match existing / adjacent surface for patched surfaces.

2.3 BLOCK FILLERS

A. Block Filler, Latex, Interior/Exterior: MPI #4.

2.4 PRIMERS/SEALERS

A. Primer Sealer, Interior, Institutional Low Odor/VOC: MPI #149.

2.5 METAL PRIMERS

A. Primer, Rust-Inhibitive, Water Based: MPI #107.

B. Primer, Alkyd, Anti-Corrosive, for Metal: MPI #79.

C. Primer, Alkyd, Quick Dry, for Metal: MPI #76.

D. Primer, Galvanized, Water Based: MPI #134.

2.6 WATER-BASED PAINTS

A. Latex, Interior, Institutional Low Odor/VOC, (Gloss Level 2): MPI #144.

B. Latex, Interior, Institutional Low Odor/VOC, (Gloss Level 3): MPI #145.

C. Latex, Interior, Institutional Low Odor/VOC, Semi-Gloss (Gloss Level 5): MPI #147.

2.7 SOLVENT-BASED PAINTS

A. Alkyd, Interior, Gloss (Gloss Level 6): MPI #48.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Concrete: 12 percent.
2. Masonry (Clay and CMU): 12 percent.
3. Wood: 15 percent.
4. Gypsum Board: 12 percent.
5. Plaster: 12 percent.

C. Provide moisture readings as part of close out documentation.

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

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

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Manual" applicable to substrates indicated.

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

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

C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

3.3 APPLICATION

A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual."

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

3.4 CLEANING AND PROTECTION

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

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

3.5 EXTERIOR PAINTING SCHEDULE

A. CMU Substrates:

1. Water-Based Light Industrial Coating System:

a. Prime Coat: Primer, alkyd, anti-corrosive for metal, MPI #79.
b. Intermediate Coat: Light industrial coating, exterior, water based, matching topcoat.
c. Topcoat: Light industrial coating, exterior, water based, match existing gloss and color.

END OF SECTION 09 91 23

SECTION 23 00 00 - MECHANICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This Section applies to all Division 23 (mechanical) work.

B. Related Documents: The general provisions of the Contract, including General and Supplementary Conditions and General Requirements applies to all Division 23 work.

1.2 COORDINATION BETWEEN SPECIFICATION SECTIONS

A. Each specification section within their respective division shall be coordinated with all other sections in that division for related work.

1.3 COORDINATION OF WORK

A. General:

1. Refer to the Division 1 sections for general coordination requirements applicable to the entire work. The contractor shall recognize that the contract documents are diagrammatic in showing certain physical relationships which must be established within the plumbing, mechanical and electrical work, and in its interface with other work including utilities and that such establishment is the exclusive responsibility of the Contractor. Because the drawings are diagrammatic and on a small scale, all rises, drops, offsets, etc., have not been shown. The Contractor shall agree to provide and install the necessary conduit, piping, fittings, valves, ducts, and other specialties to suit such conditions without additional cost to the Owner.
2. Piping and conduits, except electrical conduits run in floor construction, suspended ceiling space, or roof space shall be run parallel with lines of the building unless otherwise noted on drawings. Water supply pipes, where practicable, shall be placed at same elevation and hung on multiple hangers. Electric conduits shall not be hung on hangers with any other service, unless approved by the Engineer and shall be hung above all other service pipes. The different service pipes, valves, fittings, and similar items shall be so installed, that after the covering is applied; there will be not less than 1/2" clear space between the finished covering and other work and between the finished covering of parallel adjacent pipes. Hangers on different service lines running close to and parallel with each other shall be in line with each other and parallel to the lines of the building. Exact location of electric outlets, piping, ducts, and the like shall be coordinated to avoid interferences between lighting fixtures, piping, ducts, and similar items.
3. Locate operating and control equipment properly to provide easy access and arrange entire mechanical and electrical work with adequate access for operation and maintenance.
4. Give right-of-way to piping which must slope for drainage.
5. Advise other trades of openings required in their work for the subsequent move-in of large units of plumbing, mechanical and electrical work (equipment).
6. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Coordination Drawings:

1. For locations where several elements of mechanical (or combined plumbing, mechanical and electrical) work must be sequenced and positioned with precision in order to fit into the available space, prepare coordination drawings (shop drawings) showing the actual physical dimensions (at accurate scale) required for the installation. Prepare and submit coordination drawings prior to purchase-fabrication-installation of any of the elements involved in the coordination.
2. Install equipment and materials to provide required access for servicing and maintenance.

C. Contract Document Discrepancies:

1. If work is required in manner to make it impossible to produce first class work, or should discrepancies appear among contract documents, request interpretation before proceeding with work. If Contractor fails to make such request, no excuse will thereafter be entertained for failure to carry out work in satisfactory manner. Should conflict occur in or between drawings, and specifications, Contractor is deemed to have estimated on more expensive way of doing work unless he shall have asked for and obtained written decision before submission of proposal as to method or materials required.

1.4 FEES, PERMITS, LICENSES, UTILITY CONNECTION CHARGES, AND UTILITY COST.

A. The Contractor shall obtain and pay for all fees, permits, licenses, utility connection charges (water, sanitary sewer, storm sewer and gas) and utility cost for services to the building required.

B. The Contractor shall maintain all necessary signal lights, guard against danger and use all proper means for the safety of the public.

C. The Contractor shall pay for opening and repairing all pavement cuts.

D. The Contractor shall furnish to the Architect copies of all fees, permits and licenses required for all mechanical work herein specified before any mechanical work is started.

1.5 CONTRACTORS RESPONSIBILITY FOR CONSULTANTS ADDITIONAL SERVICES

A. The Consultant is entitled to compensation for additional services not included in their contract but provided on this project. Since our contract is with the Owner or Architect, the Owner or Architect has the responsibility to compensate us for these additional services. The Consultant will provide, without advance authorization from the Client, the Additional Services listed below. These services will be tracked in our office and billed to the Client upon completion of the project. The client will in turn deduct the sum of these additional services from the contractor's final payment. The following is a list of services that have been included in our contract with the client along with a description of services that will be charged against the contractor's final payment due to services brought about due to the contractor's actions:

1. Re-submittals: The consultant has included in their contract with our Client, one (1) review for each submittal item. The contractor is required to carefully review each submittal from their suppliers and subcontractors for compliance with the contract documents along with a written notice of deviations of any type prior to submitting them to the Engineer for review. The Contractor shall be responsible to the Client for all

reasonable costs charged by the Consultant to the Client for the Additional Services required for re-submittals.

2. Substitutions: The Consultant has included in their contract with our Client, incorporation of minor changes to the contract documents to develop record documents in electronic format. These changes are limited to unforeseen site conditions and clarifications to the contract documents. Review of substitutions for compliance with the contract documents, and services required to modify and coordinate changes required due to contractor substitutions or deviations from the contract documents are not included in our contract with the Client. The Contractor shall be responsible to the Client for all reasonable costs charged by the Consultant to the Client for the Additional Services required to modify and coordinate documents or provide field coordination due to contractor substitutions or deviations from the contract documents.
3. Requests For clarification or Interpretation (RFI): The Contractor may, after exercising due diligence to locate required information, request from the Consultant clarification or interpretation of the requirements of the Contract Documents. The Consultant shall, with reasonable promptness, respond to such Contractor's request for clarification or interpretation. However, if the information requested by the Contractor is apparent from field observations, is contained in the Contract Documents or is reasonably inferable from them, the Contractor shall be responsible to the Client for all reasonable costs charged by the Consultant to the Client for the Additional Services required to provide such information.
4. Construction Meetings & Site Observations: The consultant has included a predetermined number of construction meetings and site observations in their contract with the owner based on the anticipated construction period specified. However if additional construction meetings and site observations are required due to the contractors delay in completion of the project, the Contractor shall be responsible to the Client for all reasonable costs charged by the Consultant to the Client for the Additional Services required to attend additional construction meetings or provide additional site observations.
5. Re-inspections: The contractor is responsible to prepare a final punch list for the project and to correct all items prior to calling for a final inspection from the consultant. Upon being notified, the consultant will then visit the site and prepare a final punch list. The contractor is then required to correct all items on the consultant's final punch list and call for a re-inspection of the project. If all items have not been corrected, the final punch list will be updated and additional re-inspections will be required. However, if additional re-inspections are required, the Contractor shall be responsible to the Client for all reasonable costs charged by the Consultant to the Client for the Additional Services required for the additional re-inspections.

1.6 SINGULAR NUMBER

A. Where any device or part of equipment is herein referred to in the singular number (such as "the pump"), such reference shall be deemed to apply to as many such devices as are required to complete the installation as shown on the drawings.

1.7 CLEANING AND PROTECTION

A. General: During handling and installation of work at project site, each contractor shall clean and protect work in progress and adjoining work on a basis of perpetual maintenance. Apply suitable protective covering on newly installed work where reasonably required to ensure freedom from damage or deterioration at time of substantial completion; otherwise, clean and perform maintenance on newly installed work as frequently as necessary through remainder of

construction period. Adjust and lubricate operable components to ensure operability without damaging effects.

1.8 MAINTENANCE AND OPERATION MANUALS

A. Prepare and submit two (2) copies of maintenance and operation instructions for all Division 23 and Division 26 equipment furnished. Organize maintenance and operating manual information into suitable sets of manageable size and bind into individual binders properly identified and indexed (thumb-tabbed). Include emergency instructions, spare parts listing, copies of warranties, wiring diagrams, recommended "turn-around" cycles, inspection procedures, shop drawings, product data, preventative maintenance schedules, and similar application information. Bind each manual of each set in a heavy-duty 2", 3-ring vinyl-covered binder, and include pocket folders for folded sheet information. Mark identification on both front and spine of each binder.

1.9 PROJECT CLOSE OUT

A. General: Refer to the Division 1 sections for general closeout requirements. Maintain a daily log of operational data on mechanical equipment and systems through the closeout period; record hours of operation, assigned personnel, fuel consumption and similar information; submit copy to Owner.

B. Record Drawings: For Division 23 and Division 26 work, give special attention to the complete and accurate recording of underground conduit, piping and ductwork, other concealed and non-accessible work, branching arrangement and valve location for piping systems, locations of dampers and coils in duct systems, locations of control system sensors and other control devices, and work of change orders where not shown accurately by contract documents.

C. Closeout Equipment/Systems Operations: Sequence operations properly so that work of project will not be damaged or endangered. Coordinate with seasonal requirements. Operate each item of equipment and each system in a test run of appropriate duration with the Owner's operating personnel present, to demonstrate sustained, satisfactory performance. Adjust and correct operations as required for proper performance. Clean and lubricate each system, and replace dirty filters, excessively worn parts and similar expendable items of the work.

D. Operating Instructions: Conduct a full-day walk-through instruction seminar for the Owner's personnel to be involved in the continued operation and maintenance of mechanical equipment and systems. Explain the identification system, operational diagrams, emergency and alarm provisions, sequencing requirements, seasonal provisions, security, safety, efficiency and similar features of the systems.

E. Turn-Over of Operation: At the time of substantial completion, turn over the prime responsibility for operation of the mechanical equipment and systems to the Owner's operating personnel.

1.10 FINAL COMPLETION

A. The following special requirements shall be provided in addition to these specifications elsewhere in these specifications:

1. The Division 23 Contractors shall not call for a final completion check until the entire Mechanical and Electrical Equipment and Systems have been installed, adjusted,

balanced and in full and complete satisfactory operation and the following certifications of inspection from equipment suppliers have been completed and submitted to the Architect/Engineer. Certifications of Inspections for Division 23 Equipment are required on the following items of equipment:

a. Chillers (Factory Representative)
b. Pumps (Local Rep)
c. Glycol feeders (Local Rep)
d. Temperature control equipment (Manufacturer's rep)

B. The Certifications shall consist of letters signed by Factory Trained and Authorized Service Engineers stating the following:

1. They have inspected all of their equipment on the project.
2. They approve the condition of the equipment and its installation.
3. They have fully checked its operation and certify that it is operating properly.
4. They will note any problems, conditions or objections that could lead to future operating problems.
5. Log Sheets shall be provided on start-up of all chillers. Factory trained representative shall certify log sheets.
6. Units shall be inspected by all concerned and certify the installation and operation of the units and associated heating and cooling equipment. Certification to come from the local rep and the factory.

C. Exceptions may be permitted upon written request from the Contractor listing any minor items that are uncompleted and beyond his reasonable control. The full guarantee that they will be completed at a named later date and the guarantee extended as required to provide a full warranty.

1.11 FINAL PAYMENT

A. Final Payment will not be made until the Contractor has satisfactorily completed all final inspection items.

1.12 GUARANTEE

A. The one-year guarantee period shall not start until the project is fully completed and the Contractor has received the Final Payment and Certification of Completion.

B. All equipment and all work shall be fully guaranteed, parts, and labor, for one full year from the date of the Certificate of Completion. Repairs made during this period must be fully guaranteed for an additional one year period from the date of repairs.

C. The Division 23 Contractor has the full responsibility to guarantee all equipment and work and shall assume full responsibility to repair any equipment at his cost that the manufacturer refuses to guarantee.

D. The Owner has the right to order repairs to any equipment or work provided hereon and to charge the Contractor for same if repairs are not made by the Contractor within a reasonable period of time not to exceed 24 hours during an emergency or 72 hours on a non-critical item.

E. Where equipment is furnished by the owner and installed by the contractor, the contractor's responsibilities shall remain as indicated above except that the owner will assist in enforcing the stipulated manufacturer's warranty.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 23 00 00

SECTION 23 01 00 – MECHANICAL SUBMITTALS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 GENERAL

A. Shop drawing Submittals shall comply with the requirements of Division 1, Section 013300, and with the requirements of this Section. Shop Drawing Submittals shall include specially-prepared technical data for this project, including drawings, diagrams, performance curves, data sheets, schedules, templates, patterns, reports, calculations, instructions, measurements and similar information not in standard printed form for general application to a range of similar projects. Performance curves shall show the full operating range of the proposed equipment

B. Shop Drawing Submittals shall also include product data which includes standard printed information on materials, products and systems; not specially-prepared for this project, but with the designation of selections from among available choices for this project clearly identified.

1.3 SUBMITTAL REQUIREMENTS

A. Coordination and Sequencing: Coordinate preparation and processing of submittals with performance of the work so that work will not be delayed by submittals. Coordinate and sequence different categories of submittals for same work, and for interfacing units of work, so that one will not be delayed for coordination of Architect/Engineer's review with another.

B. Preparation of Submittals: Provide permanent marking on each submittal to identify project, date, contractor, subcontractor, submittal name and similar information to distinguish it from other submittals. Show Contractor's executed review and approval marking and provide space for Architect's/Engineer's "Action" marking. Package each submittal appropriately for transmittal and handling. Submittals which are received from sources other than through Contractor's office will be returned by Architect/Engineer "without action".

C. Provide Contractor's certification on form, ready for execution, stating that information submitted complies with requirements of contract documents. Failure to fully review submittals for compliance with contract documents may result in rejection by the Architect/Engineer requiring re-submittal by the contractor. Contractor shall pay the Architect/Engineer for review of all re-submittals in accordance with Section 013300.

1.4 SUBMITTAL LIST

A. Shop drawings shall be submitted for, but not limited to, the items listed in each section of the specifications. Submittals, in addition to those listed, may be required by the Architect/Engineer. The following is a summary list of submittals required for the project.

SECTION	ITEM	DATE RECEIVED BY A/E	TRANSMITTAL NO.	DATE RETURNED
23 00 00	Record Drawings			
23 00 00	Maintenance & Operations Manuals			
23 05 00	Concrete Work			
23 05 00	Joint Sealers			
23 05 53	Mechanical Identification			
23 05 29	Equipment Supports			
23 05 93	Testing, Adjusting & Balancing Certifications			
23 05 93	Testing, Adjusting & Balancing Plan			
23 05 93	Testing, Adjusting & Balancing Report			
23 07 00	Mechanical Insulation Materials			
23 08 00	Commissioning Equipment Checklists			
23 09 00	Temperature Control System Product Data			
23 09 00	Temperature Control System Shop Drawings			
23 09 00	Performance Verification Tests			
23 10 00	Variable Frequency Drives			
23 21 13	Hydronic Piping Product Data			
23 21 13	Hydronic Piping Layout Shop Drawings			
23 21 13	Maintenance & Operations Manuals			
23 21 13	Welders' Qualifications			
23 21 13	Test Reports			
23 21 13	Hydronic Piping (Layout Drawings)			
23 21 23	Pumps			
23 25 00	Water Treatment Systems			
23 64 23	Scroll Air Cooled Chillers			

END OF SECTION 23 01 00

SECTION 23 03 00 – ELECTRICAL PROVISIONS OF MECHANICAL WORK AND MECHANICAL PROVISIONS OF ELECTRICAL WORK

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Extent of electrical provisions to be provided as mechanical work and the requirements for piping and duct work connections to equipment furnished under Division 26 is indicated in other Division-23 sections, on drawings, and as further specified in this section.

B. Types of work, normally recognized as electrical but provided as mechanical, specified or partially specified in this section, include but are not necessarily limited to the following:

1. Motors for mechanical equipment.
2. Starters for motors of mechanical equipment, but only where specifically indicated to be furnished integrally with equipment and for all 2-speed motors.
3. Wiring from motors to disconnect switches or junction boxes for motors of mechanical equipment, but only where specifically indicated to be furnished integrally with equipment.
4. Furnish and install all electrical control circuit conduits and wiring and control devices required to perform the equipment control functions as specified in Division 23, including float control switches, flow control switches, and similar mechanical-electrical devices provided for mechanical systems.
5. Electrical heating coils and similar elements in mechanical equipment.
6. Furnish and install capacitors for power factor correction on all mechanical equipment as specified in other sections of this Division.
7. All electrical equipment provided and the wiring and installation of electrical equipment shall be in accordance with the requirements of this Section and Division 26.

C. Refer to Division-23 Controls sections for control system wiring.

D. Refer to other Division-23 sections for specific individual mechanical equipment electrical requirements.

E. Refer to Division-26 sections for motor starters and controls not furnished integrally with mechanical equipment.

F. Refer to Division-26 sections for junction boxes and disconnect switches required for motors and other electrical units of mechanical equipment.

1.2 QUALITY ASSURANCE

A. 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 is not otherwise specified.

B. Standards: For electrical equipment and products, comply with applicable NEMA standards, and refer to NEMA standards for definitions of terminology herein. Comply with National Electrical Code (NFPA 70) for workmanship and installation requirements.

C. Electrical components and materials shall be UL labeled.

1.3 SUBMITTALS

A. Listing, Motors of Mechanical Work:

1. Concurrently with submittal of mechanical products listing (Division 23 Section “Shop Drawings” and Division-1 requirements), submit separate listing showing rating, power characteristics, application (connected equipment), and general location of every motor to be provided with mechanical work.
2. Submit updated information promptly when and if initial data is revised.
3. Include in listing of motors, notation of whether motor starter is furnished or installed integrally with motor or equipment containing motor.
4. Submit thermal overload selection calculations including required selection parameters.

PART 2 - PRODUCTS

2.1 MOTORS

A. Manufacturer: Except where item of mechanical equipment (which otherwise complies with requirements) must be integrally equipped with motor produced by another manufacturer, provide motors for mechanical equipment manufactured by single one of the following:

1. ABB Industrial Systems
2. Baldor Electric Co.
3. General Electric Co.
4. Louis Allis Div.; Litton Industrial Products, Inc.
5. Marathon Electric Mfg. Corp.
6. Magne Tek Inc.
7. US Electric Motors.

B. Motor Characteristics: Except where more stringent requirements are indicated, comply with the following requirements for motors of mechanical work:

1. Torque characteristics shall be sufficient to satisfactorily accelerate the driven loads.
2. Service Factor:

a. Minimum 1.15 for polyphase motors and 1.35 for single-phase motors.
b. For installation altitudes greater than 3,300 feet the effective service factor shall be reduced to 1.0 on motors with nameplate service factors of 1.15 and greater.
c. Motors with nameplate Service Factors of 1.0 shall not be used for installation altitudes greater than 3,300 feet.

3. Irrespective of the schedule, installed motor sizes shall be large enough so that the driven load will not require the motor to operate in the service factor range, but not less than 75% of the nameplate; if a standard size does not fall within this range the next larger NEMA standard motor size shall be used.
4. Temperature Rating: Rated for 40 deg C environment with maximum 50 deg C temperature rise for continuous duty at full load (Class A Insulation). Provide Class B Insulation for motor ambient conditions in excess of 40 deg. C.

5. Starting Capability: Provide each motor capable of making starts as frequently as indicated by automatic control system, and not less than 5 evenly time spaced starts per hour for manually controlled motors.
6. Motors 1/2 horsepower and larger shall have bearings with pressure grease lubrication.
7. Motors connected to drive equipment by belt shall be furnished with adjustable slide rail bases except for fractional horsepower motors which shall have slotted bases. Motor leads shall be permanently identified and supplied with connectors.
8. Phases and Current Characteristics:

    a. Provide squirrel-cage induction polyphase motors for 1 hp and larger.
    b. Provide capacitor-start single-phase motors for 3/4 hp and smaller, except 1/6 hp and smaller may, at equipment manufacturer's option, be split-phase type.
    c. Coordinate current characteristics with power specified in Division-26 sections, and with individual equipment requirements specified in other Division-23 sections.
    d. For 2-speed motors provide 2 separate windings on polyphase motors and equipment starter with decelerating relay.
    e. Do not purchase motors until power characteristics available at locations of motors, ambient conditions, and altitude have been confirmed, and until rotation directions have been confirmed and the motor selected accordingly.

9. Motor Construction: Provide general purpose, continuous duty, premium efficiency motors, Design "B" except "C" where required for high starting torque.

    a. Bearings: Ball or roller bearings with inner and outer shaft seals, regreasable except permanently sealed where motor is normally inaccessible for regular maintenance. Where belt drives and other drives produce lateral or axial thrust in motor, provide bearings designed to resist thrust loading. Refer to individual sections of Division 23 for fractional-hp light-duty motors where sleeve-type bearings are permitted.
    b. Enclosure Type: Except as otherwise indicated, provide open drip-proof motors for indoor use where satisfactorily housed or remotely located during operation, and provide guarded drip-proof motors where exposed to contact by employees or building occupants. Provide weather- protected Type I for outdoor use, Type II where not housed. Refer to individual sections of Division 23 for other enclosure requirements. Provide motors with steel housings and bases for motors less than 5HP in size and cast iron housings and bases for motors larger than 5HP. Aluminum housings and bases will not be permitted.
    c. Overload Protection: Provide built-in thermal overload protection and, where indicated, provide internal sensing device suitable for signaling and stopping motor at starter.
    d. Each motor shall be free from magnetic hum, designed for quiet operation.

10. Efficiency:

    a. Provide motors with efficiency in accordance with IEEE Standard 112, test Method B.
    b. Minimum efficiencies and power factors shall not be less than listed in the table below for 460V, 3 phase, 1,800 rpm motors:

MOTOR SIZE (HP)	1,200 RPM PREMIUM EFFICIENCY		1,800 RPM PREMIUM EFFICIENCY	
	EFFICIENCY (%)	POWER FACTOR (%)	EFFICIENCY (%)	POWER FACTOR (%)
1	82.5	64	85.5	74.5
1.5	87.5	65.5	86.5	76.5

MOTOR SIZE (HP)	1,200 RPM PREMIUM EFFICIENCY		1,800 RPM PREMIUM EFFICIENCY	
	EFFICIENCY (%)	POWER FACTOR (%)	EFFICIENCY (%)	POWER FACTOR (%)
2	88.5	68.5	86.5	75.5
3	89.5	71	89.5	78.5
5	89.5	73	89.5	81.5
7.5	91	78	91	83.5
10	91	78.5	91.7	83.5
15	91.7	78	93	83
20	91.7	78.5	93	86
25	93	78.5	93.6	83
30	93	79	94.1	83.5
40	94.1	79	94.1	78
50	94.1	79	94.5	79
60	94.5	80.5	95	84
75	94.5	81.5	95	85.5
100	95	83	94.4	85.5
125	95	83.5	95.4	86.5
150	958	84	95.8	85.5
200	95.8	82	95.8	86.5

c. Minimum efficiencies and power factors for motors at other voltages and speeds for smaller than 1 HP in size shall be from the same “Energy Efficient” product line that conforms to the above table.

11. Variable Speed Motors: Variable speed motors used in conjunction with variable frequency drives shall be inverter duty type and rated for across the line starting. Variable speed motors 5HP and larger shall have shaft grounding kits. Variable speed motors serving direct driven fans and pumps shall be rated for a minimum of 120Hz operation (200% speed) by the manufacturer.

C. Name Plate: Provide metal nameplate on each motor, indicating full identification of manufacturer, ratings, characteristics, power factor, construction, special features and similar information.

2.2 STARTERS, ELECTRICAL DEVICES, AND WIRING

A. Motor Starter Characteristics:

1. 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.
2. Type and size of starter shall be as recommended by motor manufacturer and the driven equipment manufacturer for applicable protection and start-up condition.

B. Manual Switches:

1. Provide manual switch and pilot light for motors 1/3 hp and smaller, except where interlock or automatic operation is indicated.
2. Provide extra switch positions and pilot lights for multi-speed motors.
3. Overload Protection: Provide melting alloy type thermal overload relays.

C. Magnetic Starters: Provide magnetic starters for motors 1 hp and larger, and for smaller motors where interlock or automatic operation is indicted. Include the following:

1. Hand-Off-Auto selector switch and pilot lights, properly arranged for single-speed or multi-speed operation as indicated.
2. Trip-free thermal overload relays, each phase.
3. Interlocks, pneumatic switches and similar devices as required for coordination with control requirements of Division-23 Controls sections.
4. Built-in 120-volt control circuit transformer, fused from line side, where service exceeds 240 volts.
5. Externally operated manual reset.
6. Undervoltage release or protection.
7. Monitors for phase loss or reversal: Solid-state voltage and phase-angle sensing device which drives a SPDT electromechanical output relay.

D. Electrical Heating Elements: Where electric resistance coils and other heating elements are included in mechanical equipment or otherwise indicated as mechanical work, and except as otherwise indicated, provide 120-volt units where rating is less than 2 KW, higher-voltage single-phase units where rating is 2 KW but less than 5 KW, and higher-voltage 3-phase units where rating is 5 KW and greater.

E. Motor Connections: Provide flexible conduit, except where plug-in electrical cords are specifically indicated.

2.3 CAPACITORS

A. Capacitors shall be installed on all motors 1 horsepower and larger, that have an uncorrected power factor of less than 85 percent at rated load.

B. Features:

1. Individual unit cells.
2. All welded steel housing.
3. Each capacitor internally fused.
4. Non-flammable synthetic liquid impregnant.
5. Craft tissue insulation.
6. Aluminum foil electrodes.
7. KVAR size shall be as required to correct motor power factor to 90 percent or better.
8. Provide disconnect switches for each capacitor.

2.4 DISCONNECT SWITCHES

A. Fusible switches: fused, each phase; general duty; horsepower rated; non-teasible quick-make, quick-break mechanism; dead front line side shield; solderless lugs suitable for copper or aluminum conductors; spring reinforced fuse clips; electro silver plated current carrying parts; hinged doors; operating lever arranged for locking in the "OPEN" position; arc quenchers; capacity and characteristics as indicated.

B. Non-fusible switches: for equipment 2 horsepower and smaller, shall be horsepower rated; toggle switch type; quantity of poles and voltage rating as indicated. For equipment larger than 2 horsepower, switches shall be the same as fusible type.

C. Manual Starters: for equipment 1/3 horsepower and smaller, shall be horsepower rated; toggle switch type; quantity of poles and voltage rating as indicated equipped with thermal overloads.

2.5 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, gear 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.

2.6 CONTRACTOR COORDINATION

A. The following information is provided as an aid to interdisciplinary coordination. It is the general contractors responsibility to assure that full and complete coordination of the subcontractors is achieved to provide complete and fully operational systems.

B. Unless otherwise indicated, all motors, equipment, controls, etc. shall be furnished, set in place and wired in accordance with the following schedule.

ITEM	FURNISHED BY	SET BY	POWER WIRING BY	CONTROL WIRING BY
Equipment Motors	MC	MC	EC	--
Motor Control Centers	EC	EC	EC	MC*
Unit Mounted Motor Starters, Contactors, and Overload Heaters	MC	MC	EC	MC
Loose Motor Starters, Contactors and Overload Heaters	EC	EC	EC	MC
Fused and Unfused Disconnect Switches, Thermal Overload and Heaters	EC	EC	EC	--
Manual Operating Multi-speed Switches	MC	EC	EC	EC
Control Relays and Transformers	MC	MC	EC	MC
Thermostats and Time Switches	MC	MC	EC	MC
Temperature Control Panels	MC	MC	EC	MC
Variable Speed Drives	MC	EC	EC	MC
Electrically Operated Terminal Air Boxes	MC	MC	EC	MC
Electric actuators and Solenoid Valves, Damper Motors, PE and EP Switches	MC	MC	MC	MC
Combination Smoke and Fire Dampers	MC	MC	EC	EC
Duct Smoke Detectors	EC	MC	EC	EC
Refrigeration Equipment, Cooling Tower, and Controls	MC	MC	EC	MC
Pushbutton Stations	MC	MC	EC	EC
Temporary Heating Connections	MC	MC	EC	MC

ITEM	FURNISHED BY	SET BY	POWER WIRING BY	CONTROL WIRING BY
MC = Mechanical Contractor EC = Electrical Contractor * Temperature Control Wiring Only By Mechanical Contractor				

C. All starters shall be furnished by the Mechanical Contractor unless otherwise indicated on the preceding schedule. All starters shall be provided with three O.L. heaters, one normally-open and one normally-closed auxiliary contact and shall conform to NEC and NEMA requirements.

D. Immersion thermostats, remote bulb thermostats, motorized valves, controls, etc., which are an integral part of the mechanical equipment or directly attached to ducts, piping, equipment, etc., shall be set in place under mechanical contract. Motor driven units which are controlled from line voltage manual operating or start-stop switches or automatic controls such as line voltage thermostats, float switches or time switches which operate at line voltage shall be wired for both power and control circuit under the electrical contract. This description shall apply to equipment not covered by 23 09 00 (Electric Control System)

E. Factory prewired control panels and packaged HVAC units shall be provided with one power source connection point unless noted otherwise.

PART 3 - EXECUTION

3.1 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.

END OF SECTION 23 03 00

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SECTION 23 05 00 - BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Extent of basic mechanical materials and methods work required by this section is indicated on drawings and schedules, and/or specified in other Division-23 sections.

B. Types of basic mechanical materials and methods specified in this section include the following:

1. Mechanical equipment nameplate data.
2. Selective demolition including:
    a. Nondestructive removal of materials and equipment for reuse or salvage as indicated.
    b. Dismantling mechanical materials and equipment made obsolete by these installations.
3. Excavation for underground utilities and services, including underground piping (under the building and from building to utility connection), tanks, basins, and equipment.
4. Miscellaneous metals for support of mechanical materials and equipment.
5. Joint sealers for sealing around mechanical materials and equipment; and for sealing penetrations in fire and smoke barriers, floors, and foundation walls.
6. Access panels and doors in walls, ceilings, and floors for access to mechanical materials and equipment.
7. Mechanical Identification of mechanical materials and equipment.
8. Concrete for floor patching, equipment bases, etc.
9. Painting of mechanical materials and equipment.

1.2 DEFINITIONS

A. The following definitions apply to excavation operations:

1. Additional Excavation: Where excavation has reached required subgrade elevations, if unsuitable bearing materials are encountered, continue excavation until suitable bearing materials are reached. The Contract Sum may be adjusted by an appropriate Contract Modification.
2. Subbase: as used in this Section refers to the compacted soil layer used in pavement systems between the subgrade and the pavement base course material.
3. Subgrade: as used in this Section refers to the compacted soil immediately below the slab or pavement system.
4. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction from the Architect/Engineer.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract, Division 1 Specification Sections, and Section 23 01 00.

B. Product data for the following products:

1. Access panels and doors.
2. Joint sealers.

C. Shop drawings detailing fabrication and installation for metal fabrications, and wood supports and anchorage for mechanical materials and equipment.

D. Coordination drawings for access panel and door locations.

E. Samples of joint sealer, consisting of strips of actual products showing full range of colors available for each product.

F. Welder certificates, signed by Contractor, certifying that welders comply with requirements specified under "Quality Assurance" article of this Section.

G. Schedules indicating proposed methods and sequence of operations for selective demolition prior to commencement of Work. Include coordination for shut-off of utility services and details for dust and noise control.

1. Coordinate sequencing with construction phasing and Owner occupancy specified in Division 1 Section "Summary of Work."

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced Installer for the installation and application of joint sealers, access panels, and doors.

B. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel."

1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

C. Fire-Resistance Ratings: Where a fire-resistance classification is indicated, provide access door assembly with panel door, frame, hinge, and latch from manufacturer listed in the UL "Building Materials Directory" for rating shown.

1. Provide UL Label on each fire-rated access door.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver joint sealer materials in original unopened containers or bundles with labels informing about manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.

B. Store and handle joint sealer materials in compliance with the manufacturers' recommendations to prevent their deterioration and damage.

1.6 PROJECT CONDITIONS

A. Conditions Affecting Selective Demolition: The following project conditions apply:

1. Protect adjacent materials indicated to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.
2. Locate, identify, and protect mechanical services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.

B. Conditions Affecting Excavations: The following project conditions apply:

1. Maintain and protect existing building services which transit the area affected by selective demolition.
2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation operations.
3. Site Information: Subsurface conditions were investigated during the design of the Project. Reports of these investigations are available for information only; data in the reports are not intended as representations or warranties of accuracy or continuity of conditions. The owner will not be responsible for interpretations or conclusions drawn from this information.
4. Existing Utilities: Locate existing underground utilities in excavation areas in accordance with Colorado State Law. If utilities are indicated to remain, support and protect services during excavation operations.
5. Remove existing underground utilities indicated to be removed.

    a. Uncharted or Incorrectly Charted Utilities: Contact utility owner immediately for instructions.
    b. Provide temporary utility services to affected areas. Provide minimum of 48-hour notice to Engineer prior to utility interruption.

6. Use of explosives is not permitted.

C. Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits permitted by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

1.7 SEQUENCE AND SCHEDULING

A. Coordinate the shut-off and disconnection of utility services with the Owner and the utility company.

B. Notify the Architect/Engineer and Owner at least 5 days prior to commencing demolition operations.

C. Perform demolition in phases as indicated.

PART 2 - PRODUCTS

2.1 MECHANICAL EQUIPMENT NAMEPLATE DATA

A. Nameplate: For each piece of power operated mechanical equipment provide a permanent operational data nameplate 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.

2.2 SOIL MATERIALS

A. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, crushed slag, or natural or crushed sand.

B. Drainage Fill: Washed, evenly graded mixture of crushed stone, or crushed or uncrushed gravel, with 100 percent passing a 1-1/2 inch sieve, and not more than 5 percent passing a No. 4 sieve.

C. Backfill and Fill Materials: Materials complying with ASTM D2487 soil classification groups GW, GP, GM, SM, SW, and SP; free of clay, rock, or gravel larger than 2 inches in any dimension; debris; waste; frozen materials; and vegetable and other deleterious matter.

2.3 MISCELLANEOUS METALS

A. Steel plates, shapes, bars, and bar grating: ASTM A 36.

B. Cold-Formed Steel Tubing: ASTM A 500.

C. Hot-Rolled Steel Tubing: ASTM A 501.

D. Steel Pipe: ASTM A 53, Schedule 40, welded.

E. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout, recommended for interior and exterior applications.

F. Fasteners: Zinc-coated, type, grade, and class as required.

2.4 MISCELLANEOUS LUMBER

A. Framing Materials: Standard Grade, light-framing-size lumber of any species. Number 3 Common or Standard Grade boards complying with WCLIB or AWPA rules, or Number 3 boards complying with SPIB rules. Lumber shall be preservative treated in accordance with AWPB LP-2, and kiln dried to a moisture content of not more than 19 percent.

B. Construction Panels: Plywood panels; APA C-D PLUGGED INT, with exterior glue; thickness as indicated, or if not indicated, not less than 15/32 inches.

2.5 JOINT SEALERS

A. General: Joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.

B. Colors: As selected by the Architect from manufacturer's standard colors.

C. Elastomeric Joint Sealers: Provide the following types:

1. One-part, nonacid-curing, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for masonry, glass, aluminum, and other substrates recommended by the sealant manufacturer.
2. One-part, mildew-resistant, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for glass, aluminum, and nonporous joint substrates; formulated with fungicide; intended for sealing interior joints with nonporous substrates; and subject to in-service exposure to conditions of high humidity and temperature extremes.
3. Products: Subject to compliance with requirements, provide one of the following:

a. One-Part, Nonacid-Curing, Silicone Sealant:

1) "Chem-Calk N-Cure 2000," Bostic Construction Products Div.
2) "Dow Corning 790," Dow Corning Corp.
3) "Silglaze N SCS 2501," General Electric Co.
4) "Silpruf SCS 2000," General Electric Co.
5) "864," Pecora Corp.
6) "Rhodorsil 5C," Rhone-Poulenc, Inc.
7) "Spectrum 1," Tremco, Inc.
8) "Spectrum 2," Tremco, Inc.
9) "Dow Corning 795," Dow Corning Corp.
10) "Rhodorsil 6B," Rhone-Poulenc, Inc.
11) "Rhodorsil 70," Rhone-Poulenc, Inc.
12) "Omnisea," Sonneborn Building Products Div.
13) "Chem-Calk 100," Bostic Construction Products Div.
14) "Gesil N SCS 2600," General Electric Co.

b. One-Part, Mildew-Resistant, Silicone Sealant:

1) "Dow Corning 786," Dow Corning Corp.
2) "SCS 1702 Sanitary," General Electric Co.
3) "863 #345 White," Pecora Corp.
4) "Rhodorsil 6B," Rhone-Poulenc, Inc.
5) "Proglaze White," Tremco, Inc.
6) "OmniPlus," Sonneborn Building Products Div.

D. Acrylic-Emulsion Sealants: One-part, nonsag, mildew-resistant, paintable complying with ASTM C 834 recommended for exposed applications on interior and protected exterior locations involving joint movement of not more than plus or minus 5 percent.

1. Products: Subject to compliance with requirements, provide one of the following:

a. "Chem-Calk 600," Bostic Construction Products Div.
b. "AC-2-," Pecora Corp.
c. "Sonolac," Sonneborn Building Products Div.
d. "Tremco Acrylic Latex 834," Tremco, Inc.

2.6 FIRE BARRIER PENETRATIONS

A. General: All cracks, voids, or holes for the passing of mechanical and electrical items through fire rated floors, walls and ceilings and having a fire rating of 1 hour or more shall be sealed with a fire barrier caulk, putty, or sealant. Caulk, putty, and sealant systems shall be installed in

accordance with the manufacturers recommendations to maintain a fire rating of 3 hours minimum.

B. Fire-Resistant Joint Sealers: Two-part, foamed-in-place, silicone sealant formulated for use in through-penetration fire-stopping around cables, conduit, pipes, and duct penetrations through fire-rated walls and floors. Sealants and accessories shall have fire-resistant ratings indicated, as established by testing identical assemblies in accordance with ASTM E 814, by Underwriters' Laboratories, Inc., or other testing and inspection agency acceptable to authorities having jurisdiction.

C. Fire-Resistant Caulk:

1. Products: Subject to compliance with requirements, provide one of the following:

a. "Dow Corning Fire Stop Foam," Dow Corning Corp.
b. "Pensil 851," General Electric Co.
c. “3M” CP 25 Caulk or 303 Putty

2.7 ACCESS DOORS

A. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush with adjacent surfaces.

B. Frames: 16-gauge steel, with a 1-inch-wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling.

1. For installation in masonry, concrete, ceramic tile, or wood paneling: 1 inch-wide-exposed perimeter flange and adjustable metal masonry anchors.
2. For gypsum wallboard or plaster: perforated flanges with wallboard bead.
3. For full-bed plaster applications: galvanized expanded metal lath and exposed casing bead, welded to perimeter of frame.

C. Flush Panel Doors: 14-gage sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.

1. Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.

D. Locking Devices: Where indicated, provide 5-pin or 5-disc type cylinder locks, individually keyed; provide 2 keys.

E. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bar-Co., Inc.
2. J.L. Industries.
3. Karp Associates, Inc.
4. Milcor Div. Inryco, Inc.
5. Nystrom, Inc.

2.8 PAINTING, FINISHING

A. Painting of mechanical and electrical work exposed in occupied spaces, except mechanical and electrical machine rooms and maintenance/service space; and work exposed on the exterior is specified and performed under other divisions of these specifications.

B. Factory finishes, shop painting, and special protective coatings are specified in the individual equipment specification sections.

C. Where factory finishes are provided on equipment and no additional field painting is specified, all marred or damaged surfaces shall be touched up or refinished so as to leave a smooth, uniform finish at the time of final inspection.

D. Paint inside of ductwork black, where it can be seen from occupied spaces through diffusers, grilles or louvers (under any lighting condition).

2.9 CONCRETE AND REINFORCEMENT

A. Concrete mixes shall be designed by the Contractor to produce the classes of concrete specified below. Concrete shall be Class A for reinforced concrete and shall be designed for a maximum compressive strength of 3000 psi at 28 days. Concrete shall be class B for nonreinforced work unless otherwise shown or specified and shall be designed for a minimum compressive strength of 2500 psi at 28 days. Design mix computations and test data shall be submitted for approval. Maximum size aggregate shall be 3/4 inch. Exterior concrete shall have air entrainment of 5 to 7 percent. Concrete quality, mixing, placing, of reinforcement shall conform to American Concrete Institute Publications ACI 318 and 347. Maximum dimension of slab between construction joints shall be 25 feet. All exposed construction joints shall be sealed with approved joint sealant.

B. Reinforcement: Bars shall be deformed, grade 40 billet or axle steel, or grade 50 rail steel. Mesh shall be welded steel wire fabric with wires at right angles to each other.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting installation and application of joint sealers and access panels. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION FOR JOINT SEALERS

A. Surface Cleaning for Joint Sealers: Clean surfaces of joints immediately before applying joint sealers to comply with recommendations of joint sealer manufacturer.

B. Apply joint sealer primer to substrates as recommended by joint sealer manufacturer. Protect adjacent areas from spillage and migration of primers, using masking tape. Remove tape immediately after tooling without disturbing joint seal.

3.3 SELECTIVE DEMOLITION

A. General: Demolish, remove, demount, and disconnect abandoned mechanical materials and equipment indicated to be removed and not indicated to be salvaged or saved.

B. Materials and Equipment to be Salvaged: Remove, demount, and disconnect existing mechanical materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to the location designated for storage by Owner.

C. Disposal and Cleanup: Remove from the site and legally dispose of demolished materials and equipment not indicated to be salvaged.

D. Mechanical Materials and Equipment: Demolish, remove, demount, and disconnect the following items:

1. Inactive and obsolete piping, fittings and specialties, equipment, ductwork, controls, fixtures, and insulation.

    a. Piping and ducts embedded in floors, walls, and ceilings may remain if such materials do not interfere with new installations. Remove materials above accessible ceilings. Drain and cap piping and ducts allowed to remain.

2. Perform cutting and patching required for demolition in accordance with Division 1 Section "Cutting and Patching."

3.4 EXCAVATION

A. Slope sides of excavations to comply with OSHA, local codes and ordinances. Shore and brace as required for stability of excavation.

B. Shoring and Bracing: Establish requirements for trench shoring and bracing to comply with local codes and authorities. Maintain shoring and bracing in excavations regardless of time period excavations will be open.

1. Remove shoring and bracing when no longer required. Where sheeting is allowed to remain, cut top of sheeting at an elevation of 30 inches below finished grade elevation.

C. Install sediment and erosion control measures in accordance with local codes and ordinances.

D. Dewatering: Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.

1. Do not allow water to accumulate in excavations. Remove water to prevent softening of bearing materials. Provide and maintain dewatering system components necessary to convey water away from excavations.
2. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey surface water to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches.

E. Material Storage: Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade, and shape stockpiles for proper drainage.

1. Locate and retain soil materials away from edge of excavations. Do not store within drip-line of trees indicated to remain.
2. Remove and legally dispose of excess excavated materials and materials not acceptable for use as backfill or fill.

F. Excavation for Underground Tanks, Basins, and Mechanical Structures: Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 foot; plus a sufficient distance to permit placing and removal of concrete formwork, installation of services, other construction, and for inspection.

1. Excavate, by hand, areas within drip-line of large trees. Protect the root system from damage and dry-out. Maintain moist conditions for root system and cover exposed roots with burlap. Paint root cuts of 1 inch in diameter and larger with emulsified asphalt tree paint.
2. Take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed.

G. Trenching: Excavate trenches for mechanical installations as follows:

1. Excavate trenches to the uniform width, sufficiently wide to provide ample working room and a minimum of 6 to 9 inches clearance on both sides of pipe and equipment.
2. Excavate trenches to depth indicated or required for piping to establish indicated slope and invert elevations. Beyond building perimeter, excavate trenches to an elevation below frost line.
3. Limit the length of open trench to that in which pipe can be installed, tested, and the trench backfilled within the same day.
4. Where rock is encountered, carry excavation below required elevation and backfill with a layer of crushed stone or gravel prior to installation of pipe. Provide a minimum of 6 inches of stone or gravel cushion between rock bearing surface and pipe.
5. Excavate trenches for piping and equipment with bottoms of trench to accurate elevations for support of pipe and equipment on undisturbed soil.

    a. For pipes or equipment 6 inches or larger in nominal size, shape bottom of trench to fit bottom 1/4 of the circumference. Fill unevenness with tampered sand backfill. At each pipe joint over-excavate to relieve the bell or pipe joint of the pipe of loads, and to ensure continuous bearing of the pipe barrel on the bearing surface.

H. Cold Weather Protection: Protect excavation bottoms against freezing when atmospheric temperature is less than 35 degrees F (2 degrees C).

I. Backfilling and Filling: Place soil materials in layers to required subgrade elevations for each area classification listed below, using materials specified in Part 2 of this Section.

1. Under walks and pavements, use a combination of subbase materials and excavated or borrowed materials.
2. Under building slabs, use drainage fill materials.
3. Under piping and equipment, use subbase materials where required over rock bearing surface and for correction of unauthorized excavation.
4. For piping less than 30 inches below surface of roadways, provide 4-inch thick concrete base slab support. After installation and testing of piping, provide a 4-inch thick concrete encasement (sides and top) prior to backfilling and placement of roadway subbase.
5. Other areas, use excavated or borrowed materials.

J. Backfill excavation as promptly as work permits, but not until completion of the following:

1. Inspection, testing, approval, and locations of underground utilities have been recorded.
2. Removal of concrete formwork.
3. Removal of shoring and bracing, and backfilling of voids.
4. Removal of trash and debris.

K. Placement and Compaction: Place backfill and fill materials in layers of not more than 8 inches in loose depth for material compacted by heavy equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

L. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification specified below. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

M. Place backfill and fill materials evenly adjacent to structures, piping, and equipment to required elevations. prevent displacement of piping and equipment by carrying material uniformly around them to approximately same elevation in each lift.

N. Compaction: Control soil compaction during construction, providing minimum percentage of density specified for each area classification indicated below.

1. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density for soils which exhibit a well-defined moisture-density relationship (cohesive soils), determined in accordance with ASTM D 1557 and not less than the following percentages of relative density, determined in accordance with ASTM D 2049, for soils which will not exhibit a well-defined moisture-density relationship (cohesionless soils).

    a. Areas Under Structures, Building Slabs and Steps, Pavements: Compact top 12 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.
    b. Areas Under Walkways: Compact top 6 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.
    c. Other Areas: Compact top 6 inches of subgrade and each layer of backfill or fill material to 85 percent maximum density for cohesive soils, and 90 percent relative density for cohesionless soils.

2. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water. Apply water in minimum quantity necessary to achieve required moisture content and to prevent water appearing on surface during, or subsequent to, compaction operations.

O. Subsidence: Where subsidence occurs at mechanical installation excavations during the period 12 months after Substantial completion, remove surface treatment (i.e., pavement, lawn, or other finish), add backfill material, compact to specified conditions, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent areas.

3.5 ERECTION OF METAL SUPPORTS AND ANCHORAGE

A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

B. Field Welding: Comply with AWS "Structural Welding Code."

3.6 APPLICATION OF JOINT SEALERS

A. General: Comply with joint sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.

1. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.
2. Comply with recommendations of ASTM C 790 for use of acrylic-emulsion joint sealants.

B. Tooling: Immediately after sealant application and prior to time shinning or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

C. Installation of Fire-Stopping Sealant: Install sealant, including forming, packing, and other accessory materials, to fill openings around mechanical services penetrating floors and walls, to provide fire-stops with fire-resistance ratings indicated for floor or wall assembly in which penetration occurs. Comply with installation requirements established by testing and inspecting agency.

3.7 INSTALLATION OF ACCESS DOORS

A. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.

B. Adjust hardware and panels after installation for proper operation.

3.8 INSTALLATION OF CONCRETE AND REINFORCEMENT

A. Reinforcement: Reinforcement shall be supported off the floor or ground during placement of concrete. Exposed ends of bars shall be protected with plastic caps when not working immediately in or around the site if exposed to the public

B. Testing: The Contractor shall make for test purposes one set of three cylinders taken for each day's pour. The test cylinders shall be made and cured in accordance with ASTM Standard C 31. Two cylinders shall be tested by the Contractor in accordance with ASTM Standard C 39. The test result shall be the average of the strengths of the two cylinders. If the average strength of the cylinders falls below the minimum allowable strength, such changes may be required in the proportions of the concrete mix as will be necessary to obtain the required strength. One cylinder shall be stored by the Contractor for future testing for check tests.

C. Finishing: Finishes shall be as specified below. The dusting of surfaces with cement will not be permitted.

1. Monolithic Finish: Surfaces of interior floor slabs shall be finished by tamping the concrete with suitable tools to force coarse aggregate down from the surface, screeded with straightedges, and floated to the required finish level to within a tolerance of 1/8 inch in 10 feet. While the concrete is still green, but sufficiently hardened to bear a man's weight without imprint, the surface shall be steel troweled smooth and left free from tool

makers. Exposed finished floors shall be given a second steel troweling to produce a burnished appearance.

2. Rough Slab Finish: Slabs to receive fill and mortar setting beds shall be finished by screeding with straightedges to bring the surface to the required finish with no coarse aggregate visible. In addition, roof slabs and slabs to receive membrane waterproofing shall be floated to produce a reasonably true and uniform surface and shall be slightly steel troweled.
3. Broomed Finish: Exterior concrete slabs shall be screeded and floated to bring the surface to the required finish level with no coarse aggregate visible, steel-troweling to an even smooth surface, and brooming with a fiber-bristle brush in a direction transverse to that of the main traffic.

D. Curing: Immediately after placing or finishing, concrete surfaces not covered by forms shall be protected against moisture loss for not less than seven days. Curing shall be accomplished by moist curing, waterproof paper or polyethylene sheet curing or membrane curing. Membrane curing compound shall be applied as recommended by the manufacturer. Compound shall not be used on surfaces that are to receive any subsequent treatment that depends upon adhesion or bonding to the concrete.

END OF SECTION 23 05 00

SECTION 23 05 19 – METERS AND GAUGES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Extent of meters and gauges required by this section is indicated on drawings and/or specified in other Division-23 sections.

B. Types of meters and gauges specific in this section include the following:

1. Temperature Gauges and Fittings.

a. Glass Thermometers.
b. Remote Reading Dial Thermometers.
c. Dial Type Insertion Thermometers.
d. Thermometer Wells.
e. Temperature Gauge Connector Plugs.

2. Pressure Gauges and Fittings.

a. Pressure Gauges.
b. Pressure Gauge Cocks.
c. Pressure Gauge Connector Plugs.

3. Flow Measuring Gauges.

a. Calibrated Balance Valves.

C. 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. Manufacturers 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's: 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. 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 Section 23 00 00.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the following:

1. Glass Thermometers:

   a. Ernst Gage Co.
   b. Marshalltown Instruments, Inc.
   c. Trend Instruments, Inc.
   d. Trerice (H.O.) Co.
   e. Weiss Instruments, Inc.

2. Pressure Gauges:

   a. Ametek/U.S. Gauge
   b. Marsh Instrument Co., Unit of General Signal.
   c. Marshalltown Instruments, Inc.
   d. Trerice (H.O.) Co.
   e. Weiss Instruments, Inc.

3. Temperature and Pressure Gauge Connector Plugs:

   a. Peterson Engineering Co.

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" long.

C. Adjustable Joint: Die cast aluminum, finished to match case, 180 degree adjustment in vertical plane, 360 degree adjustment in horizontal plane, with locking device.

D. Tube and Capillary: Organic liquid filled, magnifying lens, 1% 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.

G. Range: Conform to the following:

1. Chilled Water: 30°F - 130°F with 1°F scale divisions.

2.3 THERMOMETER WELLS

A. General: Provide thermometer wells constructed of brass or stainless steel, pressure rated to match piping system design pressure. Provide 2" extension for insulated piping. Provide cap nut with chain fastened permanently to thermometer well.

B. Manufacturer: Same as thermometers.

2.4 TEMPERATURE GAUGE CONNECTOR PLUGS

A. General: Provide temperature gauge connector plugs pressure rated for 500 psi and 200°F. Construct of brass and finish in nickel-plate, equip with 1/2" NPT fitting, with self-sealing valve core type neoprene gasketed orifice suitable for inserting 1/8" 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.

2.5 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% accuracy, ANSI B 40.1 grade A, phospher bronze bourdon type, bottom connection.

C. Case: 4-1/2” diameter black glass reinforced thermo plastic (PBTP), solid front construction, blowout back safety design, weatherproof.

D. Connector: Brass with 1/4" 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" Hg - 15 PSI.
2. Water: 0 - 100 PSI.

2.6 PRESSURE GAUGE ISOLATION VALVES

A. General: Provide ball valves on low pressure systems and barstock or forged steel valves on high temperature water systems. Refer to Division 23 Sections “General Duty Valves” and “Industrial Valves”.

B. Syphon: 1/4" straight coil constructed of brass tubing with 1/4" male NPT on each end.

C. Snubber: 1/4" brass bushing with corrosion resistant porous metal disc, through which pressure fluid is filtered. Select disc material for fluid served and pressure rating.

D. Manufacturer: Same as for pressure gauges.

2.7 PRESSURE GAUGE CONNECTOR PLUGS

A. General: Provide pressure gauge connector plugs pressure rated for 500 psi and 200°F. Construct of brass and finish in nickel-plate, equip with 1/2" NPT fitting, with self-sealing valve core type neoprene gasketed orifice suitable for inserting 1/8" O.D. probe assembly from dial type insertion pressure gauge. Equip orifice with gasketed screw cap and chain. Provide extension, length equal to insulation thickness, for insulated piping.

2.8 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 valve with integral EPT check valve designed to minimize system fluid loss during monitoring process. Provide calibrated nameplate to indicated degree of closure of precision machined orifice. Construct balancing valve with internal EPT o-ring seals to prevent leakage around rotating element. Provide balance valves with preformed polyurethane insulation suitable for use on heating and cooling systems, and to protect balance valves during shipment.

B. Manufacturer: Subject to compliance with requirements, provide calibrated balance valves of one of the following:

1. Bell & Gossett ITT; Fluid Handling Div.
2. Flow Design Inc.
3. Thrush Products, Inc.

PART 3 - EXECUTION

3.1 EXAMINATION

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 TEMPERATURE GAUGES

A. General: Install temperature gauges in vertical upright position and tilted so as to be easily read by observer standing on floor.

B. Locations: As applicable to this project, install in the following locations, and elsewhere as indicated:

1. At inlet and outlet of each hydronic zone.
2. At inlet and outlet of each hydronic boiler and chiller.
3. At inlet and outlet of each hydronic coil in air handling units, and built-up central systems.
4. At inlet and outlet of each thermal storage tank.

C. Thermometer Wells: Install in piping tee where indicated, in vertical upright position. Fill well with oil or graphite, secure cap.

D. Temperature Gauge Connector Plugs: Install in piping tee where indicated, located on pipe at most readable position. Secure cap.

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 hydronic pump.
2. At discharge of each pressure reducing valve.
3. At water service outlet.
4. At inlet and outlet of water cooled condensers and refrigerant cooled chillers.

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.

3.4 INSTALLATION OF FLOW MEASURING GAUGES

A. General: Install flow measuring gauges 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 inlet of each hydronic coil in built-up central systems.

C. Calibrated 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 21 – PIPING SPECIALTIES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Extent of piping specialties work required by this section is indicated on drawings and schedules and by requirements of this section.

B. Types of piping specialties specified in this section include the following:

1. Pipe Escutcheons.
2. Pipeline Strainers.
3. Mechanical Sleeve Seals.
4. Drip Pans.
5. Pipe Sleeves.
6. Sleeve Seals.

C. 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. Manufacturers 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".

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 Section 23 00 00.

PART 2 - PRODUCTS

2.1 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.

2.2 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.

D. Manufacturer: Subject to compliance with requirements, provide pipe escutcheons of one of the following:

1. Chicago Specialty Mfg. Co.
2. Producers Specialty & Mfg. Corp.
3. Sanitary-Dash Mfg. Co.

2.3 LOW PRESSURE Y-TYPE 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 screens, with 3/64" perforations @ 233 per sq. in.

B. Threaded Ends, 2" and Smaller: Cast-iron body, screwed screen retainer with centered blowdown fitted with pipe plug.

C. Threaded Ends, 2-1/2" and Larger: Cast-iron body, bolted screen retainer with off-center blowdown fitted with pipe plug.

D. Flanged Ends, 2-1/2" and Larger: Cast-iron body, bolted screen retainer with off-center blowdown fitted with pipe plug.

E. Butt Welded Ends, 2-1/2" and Larger: Schedule 40 cast carbon steel body, bolted screen retainer with off-center blowdown fitted with pipe plug.

F. Manufacturer: Subject to compliance with requirements, provide low pressure Y-type strainers of one of the following:

1. Armstrong Machine Works.

2. Hoffman Specialty ITT; Fluid Handling Div.
3. Metraflex Co.
4. R-Pve; Div. White Consolidated Industries, Inc.
5. Spirax Sarco.
6. Victaulic Co. of America.
7. Watts Regulator Co.

2.4 MECHANICAL SLEEVE SEALS

A. General: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

B. Manufacturer: Subject to compliance with requirements, provide mechanical sleeve seals of one of the following:

1. Thunderline Corp.

2.5 WATER HAMMER ARRESTERS

A. General: Provide bellows type water hammer arresters, stainless steel casing and bellows, pressure rated for 250 PSI, tested and certified in accordance with PDI Standard WH-201.

B. Provide water hammer arresters at the following locations:

1. Upstream of quick closing make-up water valves such as solenoid valves for cooling towers.

C. Manufacturer: Subject to compliance with requirements, provide water hammer arresters of one of the following:

1. Amtrol, Inc.
2. Smith (Jay R.) Mfg. Co.
3. Tyler Pipe; Sub. of Tyler Corp.
4. Zurn Industries, Inc.; Hydromechanics Div.

2.6 FABRICATED PIPING SPECIALTIES

A. Drip Pans: Provide drip pans fabricated from corrosion-resistant sheet metal with watertight joints, and with edges turned up 2-1/2". Reinforce top, either by structural angles or by rolling top over 1/4" steel rod. Provide hole, gasket, and flange at low point for watertight joint and 1" drain line connection.

B. Pipe Sleeves: Provide pipe sleeves of one of the following:

1. Sheet-Metal: Fabricate from galvanized sheet metal; round tube closing with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate from the following gages: 3" and smaller, 20 gage; 4" to 6", 16 gage; over 6", 14 gage.
2. Steel-Pipe: Fabricate from Schedule 40 galvanized steel pipe; remove burrs.
3. Iron-Pipe: Fabricate from cast-iron or ductile-iron pipe; remove burrs.

4. PVC Plastic-Pipe: Fabricate from Schedule 80 PVC plastic pipe; remove burrs.
5. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

C. Sleeve Seals: Provide sleeve seals for sleeves located in foundation walls below grade, or in exterior walls, of one of the following:

1. Mechanical Sleeve Seals: Installed between sleeve and pipe.

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. Y-Type Strainers: Install Y-type strainers full size of pipeline, in accordance with manufacturer's installation instructions. Install pipe nipple and shutoff valve in strainer blow down connection, full size of connection, except for strainers 2" and smaller installed ahead of control valves feeding individual terminals. Where indicated, provide drain line from shutoff valve to plumbing drain, full size of blow down connection.

1. Locate Y-type strainers in supply line ahead of the following equipment, and elsewhere as indicated, if integral strainer is not included in equipment:

a. Pumps.
b. Temperature control valves.
c. Pressure reducing valves.
d. Temperature or pressure regulating valves.

C. Mechanical Sleeve Seals: Loosely assemble rubber links around pipe with bolts and pressure plates located under each bolt head and nut. Push into sleeve and center. Tighten bolts until links have expanded to form watertight seal.

D. Fire Barrier Penetration Seals: Where pipes pass through fire rated walls, floors, or ceilings, fill all cracks, voids, or holes with fire rated joint sealer. Refer to Division 23 Section “Basic Mechanical Materials and Methods”.

E. Water Hammer Arresters: Install in upright position, in locations and of sizes in accordance with PDI Standard WH-201, and elsewhere as indicated.

3.2 INSTALLATION OF FABRICATED PIPING SPECIALTIES

A. Drip Pans: Locate drip pans under piping passing over or within 3' horizontally of electrical equipment, and elsewhere as indicated. Hang from structure with rods and building attachments, weld rods to sides of drip pan. Brace to prevent sagging or swaying. Connect 1" drain line to drain connection and run to nearest plumbing drain or elsewhere as indicated.

B. Pipe Sleeves: Install pipe sleeves of types indicated where piping passes through walls, floors, ceilings, and roofs. Do not install sleeves through structural members of work, except as detailed on drawings, or as reviewed by Architect/Engineer. Install sleeves accurately centered on pipe runs. Size sleeves so that piping and insulation (if any) will have free movement in sleeve, including allowance for thermal expansion; but not less than 2 pipe sizes larger than piping run. Where insulation includes vapor-barrier jacket, provide sleeve with sufficient clearance for installation. Install length of sleeve equal to thickness of construction penetrated, and finish flush to surface, except floor sleeves. Extend floor sleeves 1/4" above level floor finish, and 3/4" above floor finish sloped to drain. Provide temporary support of sleeves during placement of concrete and other work around sleeves and provide temporary closure to prevent concrete and other materials from entering sleeves.

1. Install sheet metal sleeves at interior partitions and ceilings other than suspended ceilings.
2. Install steel-pipe or plastic-pipe sleeves except as otherwise indicated.
3. Install iron-pipe sleeves at exterior penetrations, both above and below grade.
4. Install PVC pipe sleeves at exterior penetrations below grade.
5. Install Reusable Molded PE sleeves at exterior penetrations below grade. Set in cast-in-place concrete and remove with formwork.

END OF SECTION 23 05 21

SECTION 23 05 23 – GENERAL DUTY VALVES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This Section includes general duty valves common to most mechanical piping systems.

B. Types of valves specified in this section include the following:

1. Ball
2. Butterfly
3. Check

C. Special purpose valves are specified in individual piping system specifications.

D. Valves tags and charts are specified in Division-23 Section "[Mechanical Identification] [Basic Mechanical Materials and Methods]."

1.2 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract, Division 1 Specifications Sections and Section 23 01 00.

B. 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. American Society of Mechanical Engineers (ASME) Compliances: Comply with ASME B31.9 for building services piping and ASME B31.1 for power piping.

B. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS) Compliance: Comply with the various MSS Standard Practices referenced.

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 rust and corrosion.
2. Protect valve ends against damage to threads, flange faces, and weld-end preps.
3. Set valves in best position for handling. Set globe and gate valves closed to prevent rattling; set ball and plug valves open to minimize exposure of functional surfaces; set butterfly valves closed or slightly open; and block swing check valves in either closed or open position.

B. Storage: Use the following precautions during storage:

1. Do not remove valve end protectors unless necessary for inspection; then reinstall for storage.
2. Protect valves from weather. Store valves indoor. Maintain valve temperature higher than the ambient dew point temperature. If outdoor storage is necessary, support valve off the ground or pavement in watertight enclosures.

C. Handling: Use a sling to handle valves whose size requires handling by crane or lift. Rig valves to avoid damage to exposed valve parts. Do not use handwheels and stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer: Subject to the compliance with requirements, provide valves from one of the manufacturers listed in valve schedule.

2.2 VALVE FEATURES, GENERAL

A. Valve Design: Rising steam or rising outside screw and yoke stems.

1. Non-rising stem valves may be used where headroom prevents full extension of rising stems.

B. Pressure and Temperature Ratings: As scheduled and required to suit system pressures and temperatures.

C. Sizes: Same size as upstream pipe, unless otherwise indicated.

D. Operators: Provide the following special operator features:

1. Handwheels, fastened to valve stem, for valves other than quarter turn.
2. Lever Handles, on quarter-turn valves 6 inches and smaller, except for plug valves. Provide plug valves with square heads; provide one wrench for every 10 plug valves.
3. Chain-wheel operators for valves 2-1/2 inches and larger, installed 72 inches or higher above finished floor elevation. Extend chains to an elevation of 5'-0" above finished floor elevation.
4. Gear drive operators on quarter-turn valves 8 inches and larger.

E. Extended Stems: Where insulation is indicated or specified, provide extended stem arranged to receive insulation.

F. Bypass and Drain Connections: Comply with MSS SP-45 bypass and drain connections.

G. End Connections: As indicated in the valve specifications.

1. Threads: Comply with ANSI B1.20.1.
2. Flanges: Comply with ANSI B16.1 for cast iron, ANSI B16.5 for steel, and ANSI B16.24 for bronze valves.
3. Solder-Joint: Comply with ANSI B16.18.

a. Caution: Where soldered end connections are used, use solder having a melting point below 840°F for gate, globe, and check valves; below 421°F for ball valves.

2.3 BALL VALVES

A. Ball valves - 1 Inch and Smaller: Rated for 150 psi saturated steam pressure, 400 psi WOG pressure; two-piece construction; with bronze body conforming to ASTM B 62, standard (or regular) port, chrome-plated brass ball, replaceable "Teflon" or "TFE" seats and seals, blowout proof steam, and vinyl-covered steel handle. Provide solder ends for condenser water, chilled water, and domestic hot and cold water service; threaded ends for heating hot water and low pressure steam.

B. Ball Valves - 1-1/4 Inch to 2 Inch: Rated for 150 psi saturated steam pressure, 400 psi WOG pressure; 3-piece construction; with bronze body conforming to ASTM B 62, conventional port, chrome-plated brass ball, replaceable "Teflon" or "TFE" seats and seals, blowout proof stem, and vinyl-covered steel handle. Provide solder ends for condenser water, chilled water, and domestic hot and cold water service; threaded ends for heating hot water and low pressure steam.

2.4 BUTTERFLY VALVES

A. Butterfly Valves - 2-1/2 Inches and Larger: MSS SP-67; rated at 250 psi, cast iron body conforming to ASTM A 126, Class B. Provide valves with aluminum bronze disc, stainless steel stem, and EPDM O-ring stem seals. Provide lever operators with adjustable index plate for sizes 2 through 6 inches and gear operators with position indicator for sizes 8 through 24 inches. Provide lug type valves, wafer type valves will not be permitted. Drill and tap valves on dead-end service or requiring additional body strength.

2.5 CHECK VALVES

A. Swing Check Valves - 2 Inches and Smaller: MSS SP-80; Class 125, cast bronze body and cap conforming to ASTM B 62, with horizontal swing, Y-pattern, and bronze disc; and having threaded or solder ends. Provide valves capable of being reground while the valve remains in the line. Provide Class 150 valves meeting the above specifications, with threaded end connections, where system pressure requires or Class 125 valves are not available.

B. Silent Check Valves: Class 125, cast iron body; wafer style with replaceable bronze seat, and non-slam design lapped and balanced twin bronze flappers and stainless steel trim and torsion spring. Provide valves designed to open and close at approximately one foot differential pressure.

C. Lift Check Valves 2 Inches and Smaller: Class 125, cast-bronze body and cap conforming to ASTM B 62, horizontal or angle pattern, lift-type valve, with stainless steel spring, bronze disc holder with renewable "Teflon" disc, and threaded ends. Provide valves capable of being refitted and ground while the valve remains in the line.

PART 3 - EXECUTION

3.1 EXAMINATION

A. 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.

B. Actuate valve through an open-close and close-open cycle. Examine functionally significant features, such as guides and seats made accessible by such action. Following examination, return the valve closure member to the shipping position.

C. Examine threads on both the valve and the mating pipe for form (i.e., out-of-round or local indentation) and cleanliness.

D. Examine mating flange faces for conditions which might cause leakage. Check bolting for proper size, length, and material. Check gasket material for proper size, material composition suitable for service, and for freedom from defects and damage.

E. Prior to valve installation, examine the piping for cleanliness, freedom from foreign materials, and proper alignment.

F. Replace defective valves with new valves.

3.2 VALVE SELECTION

A. Select valves with the following ends or types of pipe/tube connections:

1. Copper Tube Size 2 Inches and Smaller: Solder ends, except provide threaded ends for heating hot water.
2. Steel Pipe Sizes 2 Inches and Smaller: Threaded.
3. Steel Pipe Sizes 2-1/2 Inches and Larger: flanged.

3.3 VALVE INSTALLATIONS

A. General Application: Use ball, and butterfly valves for shut-off duty;, ball and butterfly for throttling duty. Refer to piping system specification sections for specific valve applications and arrangements.

B. Provide memory stops for all valves used for throttling service.

C. Locate valves for easy access and provide separate support where necessary.

D. Install valves and unions for each fixture and item of equipment arranged to allow equipment removal without system shut-down. Unions are not required on flanged devices.

E. Install three-valve bypass around each pressure reducing valve using throttling type valves.

F. Install valves in horizontal piping with stem at or above the center of the pipe.

G. Install valves in a position to allow full stem movement.

H. Check valves at pump discharge shall be non-slam silent check valves.

I. Installation of Check Valves: Install for proper direction of flow as follows:

1. Swing Check Valves: Horizontal or vertical position with hinge pin level.
2. Silent Check Valves: Horizontal or vertical position, between flanges.
3. Life Check Valve: With stem upright and plumb.

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 or tube.

D. Open gate and globe valves to fully open position.

E. Remove the cap and disc holder of swing check valves having 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 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.

3.6 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.

C. For dead end service, butterfly valves required flanges both upstream and downstream for proper shutoff and retention.

3.7 FIELD QUALITY CONTROL

A. Tests: After piping system have been tested and put into service, but before final adjusting and balancing, inspect valve for leaks. Adjust or replace packing to stop leaks; replace valve if leak persists.

3.8 ADJUSTING AND CLEANING

A. Cleaning: Clean mill scale, grease, and protective coatings from exterior of valves and prepare to receive finish painting or insulation.

3.9 VALVE PRESSURE/TEMPERATURE CLASSIFICATION SCHEDULES

VALVES - 2 INCHES AND SMALLER		
SERVICE	BALL	CHECK
Chilled Water	150	125
Domestic Hot and Cold Water	150	125

VALVES - 2-1/2 INCHES AND LARGER		
SERVICE	BALL	CHECK
Chilled Water	200	125
Domestic Hot and Cold Water	200	125

3.10 VALVE SCHEDULE

A.

BALL VALVES - 1 INCH AND SMALLER		
MANUFACTURER	THREADED ENDS	SOLDER ENDS
Conbraco (Apollo)	77-100	77-200
Jomar	T-100N	S-100N
Nibco	T-585-70-66	S-585-70-66
Watts	B-6080	B-6081
REMARKS: X – Means not available.		

B.

BALL VALVES – 1-1/4 INCH AND LARGER		
MANUFACTURER	THREADED ENDS	SOLDER ENDS
Conbraco (Apollo)	82-100	82-200
Jomar	T-600-4B	S-600-4B
Nibco	T-590-Y	S-590-Y
Watts	B-6800	B-6801
REMARKS: X – Means not available. For grooved end connections, use Victaulic Style 721.		

C.

BUTTERFLY VALVES – 2-1/2 INCH AND LARGER			
MANUFACTURER	DISC. MATERIAL	LEVER	GEAR

Centerline	Aluminum Bronze	Series 225	Series 225
Grinnell	Aluminum Bronze	Or Equal	Or Equal
Keystone	Aluminum Bronze	222	222
Nibco	Aluminum Bronze	Or Equal	Or Equal

REMARKS:
X – Means not available.
For grooved connections use Victaulic Series 300A,700A, and 703A for Aluminum Bronze Disc.

SWING CHECK VALVES - 2 INCH AND SMALLER				
	CLASS 125		CLASS 150	
MANUFACTURER	THREADED	SOLDER	THREADED	SOLDER
Crane	37	1342	137	X
Grinnell	3300	3300SJ	3320	X
Hammond	IB940	IB941	IB946	X
Jenkins	92-A	1222	92-A	X
Lunkenheimer	2144	2145	230-70	X
Milwaukee	509	1509	510	X
Nibco	T-413	S-413	T-433	X
Powell	578	1825	596	X
Stockham	B-319	B-309	B-321	X

REMARKS:
X – Means not available.
For grooved connections, use Victaulic Series 712.

SILENT CHECK VALVES – 2-1/2 INCH AND LARGER				
	WAFER STYLE		GLOBE STYLE	
MANUFACTURER	CLASS 125	CLASS 250	CLASS 125	CLASS 250
Metraflex	#900			
Milwaukee	1800			
Mueller	101MAP	103MAP	105MAP	107MAP
Nibco	W-910	W-960	F-910	F-960

REMARKS:
X – Means not available.

LIFT CHECK VALVES – 2 INCH AND SMALLER		
MANUFACTURER	HORIZONTAL	ANGLE
Hammond	X	IB954
Jenkins	655-A	X
Lunkenheimer	233	X

REMARKS:
X – Means not available.

Plug Valves - 2 Inch and Smaller: Lunkenheimer: 454.
Plug Valves - 2-1/2 Inch and Larger: Powell: 2201.

END OF SECTION 23 05 23

SECTION 23 05 29 – HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Extent of supports and anchors required by this section is indicated on drawings and/or specified in other Division-23 sections.

B. Types of supports and anchors specified in this section include the following:

1. Horizontal-Piping Hangers and Supports.
2. Vertical-Piping Clamps.
3. Hanger-Rod Attachments.
4. Building Attachments.
5. Pipe Covering Protection Saddles and Shields.
6. Spring Hangers and Supports.
7. Pipe Anchors.
8. Pipe Alignment Guides
9. Miscellaneous Materials.
10. Equipment Supports.
11. Roof Equipment Supports.

C. Supports and anchors furnished as part of factory-fabricated equipment, are specified as part of the equipment assembly in other Division-23 sections.

1.2 QUALITY ASSURANCE

A. Manufacturers 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. Code Compliance: Comply with 2012 IPC Section 308.5 and other applicable codes pertaining to product materials and installation of supports and anchors.
2. ANSI/ASME B31.1 – Power Piping.
3. UL and FM Compliance: Provide products which are UL-listed and FM approved.
4. MSS Standard Compliance:

a. Provide pipe hangers and supports of which materials, design, and manufacture comply with MSS SP-58.
b. Select and apply pipe hangers and supports, complying with MSS SP-69.
c. Fabricate and install pipe hangers and supports, complying with MSS SP-89.
d. Terminology used in this section is defined in MSS SP-90.

1.3 SUBMITTALS

A. 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 Section 23 00 00.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Pipe Hangers and Supports

   a. Anvil.
   b. B-Line Systems, Inc.
   c. Carpenter and Patterson, Inc.
   d. Corner & Lada Co., Inc.
   e. Elcen Metal Products Co.
   f. Fee & Mason Mfg. Co., Div. Figgie International.
   g. PHD Manufacturing, Inc.
   h. Piping Technology & Products, Inc.
   i. Unistrut.

2. Pipe Covering Protection Saddles and Shields

   a. Anvil.
   b. Elcen Metal Products Co.
   c. PHD Manufacturing, Inc.
   d. Pipe Shields, Inc.
   e. Piping Technology & Products, Inc.

3. Pipe Alignment Guides

   a. Adsco.
   b. Anvil.
   c. Heppan Precision Products, Inc.
   d. Metraflex (The) Co.
   e. PHD Manufacturing, Inc.
   f. Piping Technology and Products.

4. Roof Equipment Supports

   a. Custom Curb, Inc.
   b. Pate Co.
   c. Thycurb Div.; Thycurb Corp.

2.2 HORIZONTAL-PIPING HANGERS AND SUPPORTS

A. General: Except as otherwise indicated, provide factory- fabricated horizontal-piping hangers and supports complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit horizontal-piping systems, in accordance with MSS SP-69 and manufacturer's

published product information. Use only one type by one manufacturer for each piping service. Select size of hangers and supports to exactly fit pipe size for bare piping, and to exactly fit around piping insulation with saddle or shield for insulated piping. Provide copper-plated hangers and supports for copper-piping systems. Provide hot dipped galvanized steel hangers and supports in tunnels, shallow concrete trenches, and valve vaults.

B. Adjustable Steel Clevis Hangers: MSS Type 1.

C. Yoke Type Alloy Steel Pipe Clamps: MSS Type 2.

D. Steel Double Bolt Pipe Clamps: MSS Type 3.

E. Steel Pipe Clamps: MSS Type 4.

F. Pipe Hangers: MSS Type 5.

G. Adjustable Swivel Pipe Rings: MSS Type 6.

H. Adjustable Steel Band Hangers: MSS Type 7.

I. Adjustable Band Hangers: MSS Type 9.

J. Adjustable Swivel Rings, Band Type: MSS Type 10.

K. Split Pipe Rings: MSS Type 11.

L. Extension Split Pipe Clamps: MSS Type 12.

M. U-Bolt: MSS Type 24.

N. Clips: MSS Type 26.

O. Pipe Slides and Slide Plates: MSS Type 35, Structural tee slide assembly with PTFE slide bearings, including one of the following plate types:

1. Plate: Unguided type.
2. Plate: Guided type.
3. Plate: Hold-down clamp type.

P. Pipe Saddle Supports: MSS Type 36, including steel pipe base- support and cast-iron floor flange.

Q. Pipe Stanchion Saddles: MSS Type 37, including steel pipe base support and cast-iron floor flange.

R. Adjustable Pipe Saddle Supports: MSS Type 38, including steel pipe base support and cast-iron floor flange.

2.3 VERTICAL-PIPING CLAMPS

A. General: Except as otherwise indicated, provide factory- fabricated vertical-piping clamps complying with MSS SP-58, of one of the following types listed, selected by Installer to suit vertical piping systems, in accordance with MSS SP-69 and manufacturer's published product

information. Select size of vertical piping clamps to exactly fit pipe size of bare pipe. Provide copper-plated clamps for copper piping systems. Provide hot dipped galvanized steel clamps in tunnels, shallow concrete trenches, and valve vaults.

B. Two-Bolt Riser Clamps: MSS Type 8.

C. Four-Bolt Riser Clamps: MSS Type 42.

2.4 HANGER-ROD ATTACHMENTS

A. General: Except as otherwise indicated, provide factory- fabricated hanger-rod attachments complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit horizontal-piping hangers and building attachments, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hanger-rod attachments to suit hanger rods. Provide copper-plated hanger-rod attachments for copper-piping systems. Provide hot dipped galvanized steel hanger rod attachments in tunnels, shallow concrete trenches, and valve vaults.

B. Steel Turnbuckles: MSS Type 13.

C. Steel Clevises: MSS Type 14.

D. Swivel Turnbuckles: MSS Type 15.

E. Malleable Iron Sockets: MSS Type 16.

F. Steel Weldless Eye Nuts: MSS Type 17.

2.5 BUILDING ATTACHMENTS

A. General: Except as otherwise indicated, provide factory- fabricated building attachments complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit building substrate conditions, in accordance with MSS SP-69 and manufacturer's published product information. Select size of building attachments to suit hanger rods. Provide copper-plated building attachments for copper piping systems. Provide hot dipped galvanized steel building attachments in tunnels, shallow concrete trenches, and valve vaults.

B. Concrete Inserts: MSS Type 18.

C. Top Beam C-Clamps: MSS Type 19.

D. Side Beam or Channel Clamps: MSS Type 20.

E. Center Beam Clamps: MSS Type 21.

F. Welded Beam Attachments: MSS Type 22.

G. C-Clamps: MSS Type 23.

H. Side Beam Clamps: MSS Type 25.

I. Adjustable Beam Clamps: MSS Type 27.

J. Steel Beam Clamps W/Eye Nut: MSS Type 28.

K. Linked Steel Clamps W/Eye Nut: MSS Type 29.

L. Malleable Beam Clamps: MSS Type 30.

M. Steel Brackets: One of the following for indicated loading:

1. Light Duty: MSS Type 31.
2. Medium Duty: MSS Type 32.
3. Heavy Duty: MSS Type 33.

N. Side Beam Brackets: MSS Type 34.

O. Plate Lugs: MSS Type 57.

P. Horizontal Travelers: MSS Type 58.

2.6 PIPE COVERING PROTECTION SADDLES AND SHIELDS

A. General: Except as otherwise indicated, provide pipe covering protection saddles or shields under piping hangers and supports, factory-fabricated, for all insulated piping. Size pipe covering protection saddles and shields for exact fit to mate with pipe insulation.

B. Pipe Covering Protection Saddles: MSS Type 39; steel saddle welded to pipe, fill interior voids with segments of insulation matching adjoining insulation.

C. Protection Shields: MSS Type 40; of length recommended by manufacturer to prevent crushing of insulation.

D. Thermal Hanger Shields: Constructed of 360 degree insert of high density, 100 PSI, water-proofed calcium silicate, encased in 360 degree sheet metal shield. Provide assembly of same thickness as adjoining insulation.

2.7 SPRING HANGERS AND SUPPORTS

A. General: Except as otherwise indicated, provide factory- fabricated spring hangers and supports complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type of one manufacturer for each piping service. Select spring hangers and supports to suit pipe size and loading.

B. Restraint Control Devices: MSS Type 47.

C. Spring Cushion Hangers: MSS Type 48.

D. Spring Cushion Roll Hangers: MSS Type 49.

E. Spring Sway Braces: MSS Type 50.

F. Variable Spring Hangers: MSS Type 51; preset to indicated load and limit variability factor to 25%.

G. Variable Spring Base Supports: MSS Type 52; preset to indicated load and limit variability factor to 25%; include load flange.

H. Variable Spring Trapeze Hangers: MSS Type 53; present to indicated load and limit variability factor to 25%.

I. Constant Supports: Provide one of the following types, selected to suit piping system. Include auxiliary stops for erection and hydrostatic test, and field load-adjustment capability.

1. Horizontal Type: MSS Type 54.
2. Vertical Type: MSS Type 55.
3. Trapeze Type: MSS Type 56.

2.8 PIPE ALIGNMENT GUIDES

A. Spider Guides: Provide factory-fabricated guides, of heavy fabricated steel, consisting of a bolted two- section outer cylinder and base with a two-section guiding 4-finger 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. Provide hot dipped galvanized steel pipe alignment guides in tunnels, shallow concrete trenches, and valve vaults.

B. Pipe Slide and Slide Plate Guides: MSS Type 35, structural tee slide assembly, PTFE slide bearing, and guided hold-down type plate. Order structural tee for specified insulation thickness or cut vertical leg in field as required due to space constraints.

C. Pipe Roller Guides: MSS Type 41, pipe rollers above and below pipe with MSS type 39 pipe covering protection saddles welded to pipe.

2.9 MISCELLANEOUS MATERIALS

A. General: Provide hot dipped galvanized steel materials in tunnels, shallow concrete trenches, and valve vaults.

B. Structural Steel: ASTM A 36/A36M, steel Plates, Shapes and Bars, black and galvanized.

C. Bolts and Nuts: ASME B18.10 or ASTM A183, steel, hex-head, track bolts and nuts.

D. Washers: ASTM F844, steel, plain, flat washers.

E. Grout: ASTM C1107, Grade B, non-shrink, nonmetallic.

1. Characteristics include post-hardening, volume-adjusting, drying, hydraulic-cement-type grout that is non-staining, non-corrosive, nongaseous and is recommended for both interior and exterior applications.
2. Design Mix: 5,000-psi (34.5Mpa), 28-day compressive strength.
3. Water: Potable.
4. Packaging: Premixed and factory-packaged.

F. Powder-Actuated Drive-Pin Fasteners: Powder-actuated-type, drive-pin attachments with pull-out and sheer capacities appropriate for supported loads and construction materials where used. Fasteners for fire protection systems include UL listing and FM approval.

G. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used. Fasteners for fire protection systems include UL listing and FM approval.

2.10 ROOF EQUIPMENT SUPPORTS

A. General: Construct roof equipment supports using minimum 18-ga galvanized steel with fully mitered and welded corners, 3" cant, internal bulkhead reinforcing, integral base plates, pressure treated wood nailer, and 18-ga galvanized steel counter flashing.

B. Configuration: Construct to sizes as indicated, compensate for slope in roof so top of support is dead level.

PART 3 - EXECUTION

3.1 EXAMINATION

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.

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.

3.3 INSTALLATION OF BUILDING ATTACHMENTS

A. Install building attachments at required locations within concrete or on structural steel for proper piping support. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional building attachments where support is required for additional 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 securely to forms. Install reinforcing bars through openings at top of inserts.

B. Install powder-actuated drive-pin fasteners in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners

according to powder-actuated tool manufacturer's operating manual. Do not use in lightweight concrete slabs or in concrete slabs less than 4 inches (100mm) thick.

C. Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install according to fastener manufacturer's written instructions. Do not use in lightweight concrete slabs or in concrete slabs less than 4 inches (100mm) thick.

3.4 INSTALLATION OF HANGERS AND SUPPORTS

A. General: Comply with MSS SP-69 and SP-89. Install hangers, supports, clamps and attachments to support piping properly from building structure. Arrange for grouping of parallel runs of horizontal piping to be supported together on field-fabricated, heavy-duty trapeze type hangers where possible. Install supports with maximum interval spacing complying with both MSS SP-69 and 2012 IPC Table 308.5 Hanger Spacing. Where piping of various sizes is to be 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. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.

C. Heavy-Duty Steel Trapezes: Field-fabricate from ASTM A 36 steel shapes selected for loads being supported. Weld steel according to AWS D-1.1.

D. Support fire protection systems piping independently of other piping.

E. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated, or by other recognized industry methods.

F. Install hangers and supports to allow controlled movement of piping systems, permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.

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

H. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ASME B31.1 are not exceeded.

I. 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 ASME B31.1.
2. Saddles: Install protection saddles MSS Type 39 where insulation without vapor barrier is indicated.
3. Shields: Install MSS Type 40, protective shields on cold piping with vapor barrier. Shields span an arc of 180 degrees and have dimensions in inches not less than the following:

NPS (Inches	LENGTH (Inches)	THICKNESS (Inches)
1/4 to 3-1/2	12	0.048
4	12	0.060

5 and 6	18	0.060
8 to 14	24	0.075
16 to 24	24	0.105

4. Pipes 8 Inches (200mm) and Larger: Include wood inserts.
5. Insert Material: Length at least as long as the protective shield.
6. Thermal-Hanger Shields: Install with insulation of same thickness as piping.

3.5 INSTALLATION OF ALIGNMENT GUIDES

A. Install guides in locations as recommended by the expansion joint manufacturer but in no case shall the first guide be located less than 10 pipe diameters from the end of the expansion joint.

B. Install guides at locations indicated and at intervals required to maintain alignment of the pipe as indicated below:

PIPE SIZE	**MAXIMUM GUIDE SPACING (FT)**
1-1/2”	10’
2”	12’
2-1/2”	15’
3”	20’
4”	25’
5”	30’
6”	35’
8”	45’
10”	60’

3.6 INSTALLATION OF ANCHORS

A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ASME B31.1, 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 ASME B31.1 and with AWS standards.

C. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions, to limit movement of piping and forces to maximums recommended by manufacturer for each unit.

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.

3.7 EQUIPMENT SUPPORTS

A. Provide concrete housekeeping bases for all floors mounted equipment furnished as part of the work of Division-23. Size bases to extend minimum of 4" beyond equipment base in any direction; and 3-1/2" above finished floor elevation. Construct of reinforced concrete, roughen floor slab beneath base for bond, and provide steel rod anchors between floor and base. Locate anchor bolts using equipment manufacturer's templates. Chamfer top and edge corners.

B. Provide structural steel stands to support equipment not floor mounted or hung from structure. Construct of structural steel members or steel pipe and fittings. Provide factory-fabricated tank saddles for tanks mounted on steel stands.

C. Furnish roof equipment supports to Contractor for installation as part of work of Division 7.

3.8 ADJUSTING AND CLEANING

A. Hanger Adjustment: Adjust hangers so as to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Support Adjustment: Provide grout under supports so as to bring piping and equipment to proper level and elevations.

3.9 PAINTING

A. Touching Up: Clean field welds and abraded areas of shop paint and paint exposed areas immediately after erection of hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).

B. Touching Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal is specified in Division 9 Section “Painting.”

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanized-repair paint to comply with ASTM A 780.

END OF SECTION 23 05 29

SECTION 23 05 48 – MECHANICAL VIBRATION AND SEISMIC CONTROLS

PART 1 - GENERAL

1.1 WORK INCLUDED

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. Vibration Isolation Springs.
4. Pad-Type Isolators.
5. Plate-Type Isolators.
6. Double-Plate-Type Isolators.
7. Threaded Double-Plate-Type Isolators.
8. All Directional Anchors.
9. Neoprene Mountings.
10. Spring Isolators, Housed.
11. Spring Isolators, Vertically-Restrained.
12. Equipment Rails.
13. Fabricated Equipment Bases.
14. Inertia Base Frames.
15. Isolation Hangers.
16. Riser Isolators.
17. 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, and other work related to vibration control work.

E. Refer to other Division-23 sections for requirements of electrical connections to equipment isolated on vibration control products.

F. Refer to other Division-23 sections for 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.

B. Except as otherwise indicated, obtain vibration control products from single manufacturer.

C. Engage manufacturer to provide technical supervision of installation of vibration control products.

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.

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.

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 Section 23 00 00.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide vibration control products of one of the following:

1. Amber/Booth Co.
2. Korfund Dynamics Corp.
3. Mason Industries, Inc.
4. Peabody Noise Control, Inc.
5. Vibration Eliminator Co., Inc.
6. Vibration Mountings and Controls, 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.

C. Vibration Isolation Springs: Wound-steel compression springs, of high-strength spring alloy steel; with spring diameter not less than 0.8 of compressed height of spring at rated loads. Provide minimum additional travel to solid, equal to 50% of rated deflection. Provide spring wire with elastic limit stress exceeding stress at solid deflection.

D. Pad-Type Isolators: Except as otherwise indicated, provide manufacturer's standard pad-type isolation unit, fiberglass pads or shapes, or neoprene pads.

E. Plate-Type Isolators: Laminate pad-type isolator to steel plate.

F. Double-Plate-Type Isolators: Cement pad-type isolator to either side of 16-ga shim and cement assembly to load distribution steel plate.

1. Where required for anchorage of equipment, include threaded anchor bolt secured to plate and extending through unit, distance sufficient for anchorage of equipment as indicated.
2. Include 2 holes in plate for bolting unit to substrate.

G. Threaded Double-Plate-Type Isolators: Provide double-plate-type isolator, with threaded connection centered in one plate and oversized hole in other plate.

1. Except as otherwise indicated, included threaded insert extending through entire thickness of unit.
2. Include 2 bolts in plate opposite threaded plate, for bolting unit to substrate.

H. All-Directional Anchors: Provide all-directional acoustical pipe anchor consisting of telescopic arrangement of 2 sizes of steel tubing separated by minimum 1/2" thickness of heavy-duty neoprene and duck, or neoprene isolation material. Provide vertical restrains by similar material arranged to prevent vertical travel in either direction. Design for maximum 500 PSI load on isolation materials and provide for equal resistance in any direction. Equip anchor with threaded hole on top and 2 holes in base plate for bolting down; or provide welding provisions top and bottom, if indicated.

I. 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". Provide threaded hole in upper plate and 2 holes in base plate for securing to equipment and to substrate.

J. Spring Isolators, Housed: Except as otherwise indicated, provide vibration isolation spring between telescoping steel housings with top and bottom loading plates, and with pad-type isolator bonded to bottom of loading plate. Include resilient inserts to separate and guide telescoping housings.

1. Equip top loading plate with equipment anchorages as indicated or as required for support and attachment.
2. Include pad-type isolator bonded to top of top loading plate, except on units with leveling bolts.
3. Include holes in bottom plate for bolting unit to substrate.

K. Spring Isolators, Vertically-Restrained: Provide spring isolators in housing that includes vertical limit stops. Design housing to act as blocking during erection, and with installed height and operating height being equal. maintain 1/2" minimum clearance around restraining bolts, and between housing and springs. Design so limit stops are out of contact during normal operation.

L. Equipment Rails: Where rails or beams are indicated for use with isolator units to support equipment, provide steel beams complying with ASTM A36, with minimum depth of 6" or 0.10 x span of beam between isolators (whichever is greater). Provide welded bracket at each end of beams, and anchor each end to spring isolator unit. Provide bolt holes in beams matching anchor bolt holes in equipment. provide beams of section modules indicated or, if not indicated, selected for normal-weight equipment loading to limit static load stress to 16,000 PSI.

M. Fabricated Equipment Bases: Where supplementary bases are indicated for use with isolator units to support equipment (base not integral with equipment), provide welded rectangular unit, fabricated of structural steel shapes, plates and bars complying with ASTM A36, as shown. provide welded support brackets at points indicated, and anchor base to spring isolator units. Except as otherwise indicated arrange brackets to result in lowest possible mounting height for

equipment, but provide minimum of 1". Provide bolt holes in base matching anchor bolt holes in equipment.

1. Where indicated, provide for auxiliary motor slide base under motor or motor slide rails for adjusting belt tension. Design primary base for bolting of rails or slide base in position.
2. Where sizes of base framing members are not indicated, fabricate base with depth of structure not less than 0.10 x longest span of base, rigidly braced to support equipment without deflections or distortions which would be detrimental to equipment or equipment performance.

N. Inertia Base Frames: Where inertia bases are indicated for use with isolation units to support equipment, provide rectangular structural beam channel, or complete sheet metal box concrete forms for floating foundations, with materials complying with ASTM A36. Frame unit as shown or, if not shown, with minimum depth of 0.08 x longest dimension of base, but not less than 6" deep. Size frame as shown or, if not shown, so that weight of frame plus concrete fill will be greater than operating weight of equipment supported. Provide steel reinforcing both ways with both ends of reinforcing butt welded to base framing.

1. Provide welded support brackets at points indicated, and anchor base frame to spring isolator units.
2. Provide anchor bolts, located as required for equipment anchorage and supported for casting of concrete. Locate bolts as indicated.
3. Provide adjustable bolts in pipe sleeves; for minimum of 1/2" adjustment around anchor bolts.

O. Isolation Hangers: Hanger units formed with brackets and including manufacturers' standard compression isolators of type indicated. Design brackets for 3 times rated loading of units. Fabricate units to accept misalignment of 15° off center in any direction before contacting hanger box, and for use with either rod or strap type members, and including acoustical washers to prevent metal-to-metal contacts.

1. Provide vibration isolation spring with cap in lower part of hanger and rubber hanger element in top, securely retained in unit.
2. Provide neoprene element, with minimum deflection of 0.35", securely retained in hanger box.
3. Provide fiberglass pad or shape, securely retained in unit, with threaded metal top plate.
4. Provide hangers, pre-compressed to rated load to limit deflection during installation. Design so hanger may be released after full load is applied.

P. Riser Isolators: Suspend risers from, or support risers by, spring hangers or spring isolators. Wherever possible, anchor risers at central point with resilient anchors. Provide hanger or mounting deflection of 0.75" except in those expansion locations where additional deflection is required to limit deflection or load changes to $\pm$25% of initial deflection. Provide sliding guides held in position by resilient anchors, located between anchor points and end of piping, spaced as indicated.

Q. 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. For ferrous piping, provide stainless steel hose covered with stainless steel wire braid for NPT steel nipples or 150 PSI ANSI flanges, welded to hose.

R. Flexible Pipe Connectors: Provide neoprene or EDPM construction consisting of multiple plies of nylon tire cord fabric and elastomer molded and cured in hydraulic rubber presses. Provide straight or elbow connector as indicated, rated at 125 PSI at 220°F.

PART 3 - EXECUTION

3.1 EXAMINATION

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 Installer.

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.

3.3 APPLICATIONS

A. General: Except as otherwise indicated, select vibration control products in accordance with ASHRAE Handbook, 1980 Systems Volume, Chapter 35 "Sound and Vibration Control", Table 27. Where more than one type of product is offered, selection is Installer's option.

B. Piping: For piping connected to equipment mounted on vibration control products, install isolation hangers as indicated, and for first 3 points of support for pipe sizes 4" and less, for first 4 points of support for pipe sizes 5" through 8", and for first 6 points of support for pipe sizes 10" and over.

3.4 INSTALLATION

A. General: Except as otherwise indicated, comply with manufacturer's instructions for installation and load application to vibration control materials and units. Adjust to ensure that units have equal deflection, do not bottom out under loading, and are not short-circuited by other contracts or bearing points. Remove space blocks and similar devices intended for temporary support during installation.

B. Install units between substrate and equipment as required for secure operation and to prevent displacement by normal forces, and as indicated.

C. Adjust leveling devices as required to distribute loading uniformly onto isolators. Shim units as required where substrate is not level.

D. Install inertia base frames on isolator units as indicated, so that minimum of 1" clearance below base will result when frame is filled with concrete and supported equipment has been installed and loaded for operation.

E. Locate isolation hangers as near overhead support structure as possible.

F. Weld riser isolator units in place as required to prevent displacement from loading and operations.

G. Flexible Pipe Connectors: Install on equipment side of shutoff valves, horizontally and parallel to equipment shafts wherever possible.

3.5 ADJUSTING AND CLEANING

A. Upon completion of vibration control work, prepare report showing measured equipment deflections for each major item of equipment as indicated.

B. 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.

END OF SECTION 23 05 48

SECTION 23 05 53 – MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Extent of mechanical identification work required by this section is indicated on drawings and/or specified in other Division-23 sections.

B. Types of identification devices specified in this section include the following:

1. Painted Identification Materials.
2. Plastic Pipe Markers.
3. Plastic Tape.
4. Underground-Type Plastic Line Marker.
5. Plastic Duct Markers.
6. Valve Tags.
7. Valve Schedule Frames.
8. Engraved Plastic-Laminate Signs.
9. Plastic Equipment Markers.
10. Plasticized Tags.

C. Mechanical identification furnished as part of factory-fabricated equipment, is specified as part of the equipment assembly in other Division-23 sections.

D. Refer to other Division-23 sections for identification requirements at central-station mechanical control center; not work of this section.

1.2 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.

1.3 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), and variations for identification (if any). Mark valves which are intended for emergency shut-off and similar special uses, by special "flags", in margin

of schedule. In addition to mounted copies, furnish extra copies for Maintenance Manuals as specified in Section 23 00 00.

C. Maintenance Data: Include product data and schedules in maintenance manuals; in accordance with requirements of Section 23 00 00.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide mechanical identification materials of one of the following:

1. Allen Systems, Inc.
2. Brady (W.H.) Co.; Signmark Div.
3. Industrial Safety Supply Co., Inc.
4. Seton Name Plate Corp.

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 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. Pressure-Sensitive Type: Provide manufacturer's standard pre- printed, permanent adhesive, color-coded, pressure-sensitive vinyl pipe markers, complying with ANSI A13.1.

C. Insulation: Furnish 1" thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125^{o}F or greater. Cut length to extend 2" beyond each end of plastic pipe marker.

D. Small Pipes: For external diameters less than 6" (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. Adhesive lap joint in pipe marker overlap.
3. Laminated or bonded application of pipe marker to pipe (or insulation).
4. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 3/4" wide; full circle at both ends of pipe marker, tape lapped 1-1/2".

E. Large Pipes: For external diameters of 6" 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. Laminated or bonded application of pipe marker to pipe (or insulation).
2. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 1-1/2" wide, full circle at both ends of pipe marker, tape lapped 3".
3. Strapped-to-pipe (or insulation) application of semi-rigid type, with manufacturer's standard stainless steel bands.

F. Lettering: Comply with piping system nomenclature as specified, scheduled or shown, and abbreviate only as necessary for each application length.

1. 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.

2.4 PLASTIC DUCT MARKERS

A. General: Provide manufacturer's standard laminated plastic, color coded duct markers. Conform to the following color code:

1. Green: Cold air.
2. Yellow: Hot air.
3. Yellow/Green: Supply air.
4. Blue: Exhaust, outside, return, and mixed air.
5. For hazardous exhausts, use colors and designs recommended by ANSI A13.1.

B. Nomenclature: Include the following:

1. Direction of air flow.
2. Duct service (supply, return, exhaust, etc.).
3. Duct origin (from).
4. Duct destination (to).
5. Design cfm.

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" wide tape markers on pipes with outside diameters (including insulation, if any) of less than 6", 2- 1/2" 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" high letters and sequenced valve numbers 1/2" high, and with 5/32" hole for fastener.
1. Provide size and shape as specified or scheduled for each piping system.
2. Fill tag engraving with black enamel.

B. Valve Tag Fasteners: Manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.

C. Access Panel Markers: Provide manufacturer's standard 1/16" thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve. Include 1/8" center hole to allow attachment.

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 SSB-grade 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" for units up to 20 sq. in. or 8" length; 1/8" for larger units.

C. Fasteners: Self-tapping stainless steel screws, except contact- type permanent adhesive where screws cannot or should not penetrate the substrate.

2.9 PLASTIC EQUIPMENT MARKERS

A. General: Provide manufacturer's standard laminated plastic, color coded equipment markers. Conform to the following color code:

1. Green: Cooling equipment and components.
2. Yellow: Heating equipment and components.
3. Yellow/Green: Combination cooling and heating equipment and components.
4. Brown: Energy reclamation equipment and components.
5. Blue: Equipment and components that do not meet any of the above criteria.
6. For hazardous equipment, use colors and designs recommended by ANSI A13.1.

B. Nomenclature: Include the following, matching terminology on schedules as closely as possible.

1. Name and plan number.
2. Equipment service.
3. Design capacity.
4. Other design parameters such as pressure drop, entering and leaving conditions, rpm, etc.

C. Size: Provide approximate 2-1/2" x 4" markers for control devices, dampers, and valves; and 4-1/2" x 6" for equipment.

2.10 PLASTICIZED TAGS

A. General: Manufacturer's standard pre-printed or partially pre- printed accident-prevent tags, of plasticized card stock with matt finish suitable for writing, approximately 3-1/4" x 5-5/8", with brass grommets and wire fasteners, and with approximate pre- printed wording including large-size primary wording (as examples; DANGER, CAUTION, DO NOT OPERATE).

2.11 LETTERING AND GRAPHICS

A. General: Coordinate names, abbreviations and other designations used in mechanical identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of mechanical systems and equipment.

1. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples; Boiler No. 3, Air Supply No. 1H, Standpipe F12).

PART 3 - EXECUTION

3.1 APPLICATION AND INSTALLATION

A. General Installation Requirements:

1. 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 one of the following types on each system indicated to receive identification, and include arrows to show normal direction of flow:

1. 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.
2. Stenciled markers, black or white for best contrast, wherever continuous color-coded painting of piping is provided.

B. 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.

1. Near each valve and control device.
2. 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.
3. Near locations where pipes pass through walls or floors/ ceilings, or enter non-accessible enclosures.

4. At access doors, manholes and similar access points which permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced intermediately at maximum spacing of 50' along each piping run, except reduce spacing to 25' in congested areas of piping and equipment.
7. On piping above removable acoustical ceilings, except omit intermediately spaced markers.

3.3 VALVE IDENTIFICATION

A. General: Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory-fabricated equipment units, plumbing fixture faucets, convenience and lawn-watering hose bibs, and shut-off valves at plumbing fixtures, HVAC terminal devices and similar rough-in connections of end-use fixtures and units. List each tagged valve in valve schedule for each piping system.

1. Tagging Schedule: Comply with requirements of "Valve Tagging Schedule" at end of this section.

B. Mount valve schedule frames and schedules in machine rooms where indicated or, if not otherwise indicated, where directed by Architect/Engineer.

1. Where more than one major machine room is shown for project, install mounted valve schedule in each major machine room, and repeat only main valves which are to be operated in conjunction with operations of more than single machine room.

3.4 MECHANICAL EQUIPMENT IDENTIFICATION

A. General: Install engraved plastic laminate sign or plastic equipment marker on or near each major item of mechanical equipment and each operational device, as specified herein if not otherwise specified for each item or device. Provide signs for the following general categories of equipment and operational devices.

1. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
2. Meters, gages, thermometers and similar units.
3. Fuel-burning units including boilers, furnaces, heaters, stills and absorption units.
4. Pumps, compressors, chillers, condensers and similar motor- driven units.
5. Heat exchangers, coils, evaporators, cooling towers, heat recovery units and similar equipment.
6. Fans, blowers, primary balancing dampers and mixing boxes.
7. Packaged HVAC central-station and zone-type units.
8. Tanks and pressure vessels.
9. Strainers, filters, humidifiers, water treatment systems and similar equipment.

B. Optional Sign Types: Where lettering larger than 1" height is needed for proper identification, because of distance from normal location of required identification, stenciled signs may be provided in lieu of engraved plastic, at Installer's option.

C. Lettering Size: Minimum 1/4" high lettering for name of unit where viewing distance is less than 1'-0", 1/2" high for distances up to 6'-0", and proportionately larger lettering for greater distances. Provide secondary lettering of 2/3 to 3/4 the size of principal lettering.

D. Text of Signs: In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

E. Optional Use of Plasticized Tags: At Installer's option, where equipment to be identified is concealed above acoustical ceiling or similar concealment, plasticized tags may be installed within concealed space to reduce amount of text in exposed sign (outside concealment).

1. Operational valves and similar minor equipment items located in non-occupied spaces (including machine rooms) may, at Installer's option, be identified by installation of plasticized tags in lieu of engraved plastic signs.

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.

3.6 EXTRA STOCK

A. Furnish minimum of 5% extra stock of each mechanical identification material required, including additional numbered valve tags (not less than 3) for each piping system, additional piping system identification markers, and additional plastic laminate engraving blanks of assorted sizes.

1. Where stenciled markers are provided, clean and retain stencils after completion of stenciling and include used stencils in extra stock, along with required stock of stenciling paints and applicators.

END OF SECTION 23 05 53

SECTION 23 05 93 – TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Extent of testing, adjusting, and balancing work required by this section is indicated on drawings and schedules, and by requirements of this section; and is defined to include, but is not necessarily limited to, air distribution systems, hydronic distribution systems, and associated equipment and apparatus of mechanical work. The work consists of setting speed and volume (flow) adjusting facilities provided for systems, recording data, conducting tests, preparing and submitting reports, and recommending modifications to work as required by contract documents.

B. Component types of testing, adjusting, and balancing specified in this section includes the following as applied to mechanical equipment:

1. Pumps.
2. Chillers.

C. Refer to Division-23 sections for installation and start-up of equipment to be tested, adjusted, and balanced.

D. Refer to Division-23 sections for pressure testing of piping and/or ductwork systems.

E. Refer to Division-26 sections for electrical hook-up and wiring of equipment to be tested, adjusted, and balanced.

F. Refer to Division-23 and Division-01 for TAB contractor responsibilities in relation to commissioning requirements.

1.2 QUALITY ASSURANCE

A. Tester's Qualifications: Firm with at least 3 years of successful testing, adjusting, and balancing experience on projects with testing and balancing requirements similar to those required for this project, who is not Installer of system to be tested, and is otherwise independent of project.

B. Tester's Qualifications: Firm certified by National Environmental Balancing Bureau (NEBB) in those testing and balancing disciplines similar to those required for this project, who is not Installer of system to be tested and is otherwise independent of project.

C. Tester's Qualifications: Firm certified by Associated Air Balance council (AABC) in those testing and balancing disciplines similar to those required for this project.

D. Codes and Standards:

1. NEBB Compliance: Comply with NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" as applicable to mechanical air hydronic distribution systems, and associated equipment and apparatus.

2. AABC Compliance: Comply with AABC's Manual MN-1 "AABC National Standards", as applicable to mechanical air and hydronic distribution systems, and associated equipment and apparatus.
3. Industry Standards: Comply with ASHRAE recommendations pertaining to measurements, instruments, and testing, adjusting, and balancing, except as otherwise indicated.

1.3 SUBMITTALS

A. Submit certified test reports signed by Test and Balance Supervisor who performed TAB work. In addition, have report certified by Professional Engineer who is familiar with TAB work and also with project, and who is registered in jurisdiction where testing is being conducted.

B. Include identification and types of instruments used, and their most recent calibration date with submission of final test report.

C. Submit biographical data on Engineer who is to directly supervise testing, adjusting, and balancing work.

D. Maintenance Data: Include in maintenance manuals, copies of certified test reports, and identification of instruments; in accordance with requirements of Division 1.

1.4 JOB CONDITIONS

A. Do not proceed with testing, adjusting, and balancing work until work has been completed and is operable. **Ensure that there is not latent residual work still to be completed.**

B. Do not proceed until work scheduled for testing, adjusting, and balancing is clean and free from debris, dirt and discarded building materials.

PART 2 - PRODUCTS

2.1 PATCHING MATERIALS

A. Except as otherwise indicated, use same products as used by original Installer for patching holes in insulation, ductwork and housings which have been cut or drilled for test purposes, including access for test instruments, attaching jigs, and similar purposes.

1. At Tester's option, plastic plugs with retainers may be used to patch drilled holes in ductwork and housings.

2.2 TEST INSTRUMENTS

A. Utilize test instruments and equipment for TAB work required, of type, precision, and capacity as recommended in the following TAB standards:

1. NEBB's Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.
2. AABC's Manual MN-1 "AABC National Standards".

PART 3 - EXECUTION

3.1 INSPECTION

A. At time of bid take-off, review drawings for completeness in regards to balancing operations. Notify prospective contractors of discrepancies such as missing balancing dampers, balancing valves, etc. upon submittal of proposal to insure that these items are covered in his bid.

B. Examine installed work and conditions under which testing is to be done to ensure that work has been completed, cleaned and is operable. Before any air balance work is done, the system shall be checked for:

1. Excessive duct leakage.
2. Filters are installed (and changed if they are dirty).
3. Correct motor rotation.
4. Equipment lubrication and vibration.
5. Proper operation of automatic control dampers and valves.
6. Coil fins are cleaned and combed where needed.
7. Steam, condensate, and hydronic systems have been flushed and cleaned.

C. Do not proceed with TAB work until unsatisfactory conditions have been corrected in manner acceptable to Tester.

3.2 TOLERANCES

A. Adjust hydronic systems to the following tolerances:

1. Cooling System:

a. Supply water temperature above 55°F: 0% to +10% of design value.
b. Supply water temperature 45°F to 55°F: -5% to +10% of design value.
c. Supply water temperature below 45°F: -5% to +10% of design value.

3.3 WATER SYSTEM TESTING, ADJUSTING AND BALANCING

A. Test, adjust and balance environmental systems and components, as indicated, in accordance with procedures outlined in applicable standards, with the following minimum requirements.

B. Preliminary checks, settings and adjustments shall be as follows:

1. Open valves to full open position. Close coil bypass stop valves. Set mixing valve to full coil flow.
2. Remove and clean strainers.
3. Examine the water in the system and determine if water has been treated and cleaned.
4. Check pump rotation.
5. Check expansion tanks to determine that they are not air bound and the system is completely full of water.
6. Check air vents at high points of water systems and determine that all are installed and operating freely.
7. Set temperature controls so coils are calling for full flow.
8. Check operation of automatic bypass valves.

9. Check and set operating temperatures of heat exchangers, boilers and chillers to design requirements.

C. Phase I - Water systems testing and balancing procedures shall be as follows:

1. Set chilled water water pumps to the proper gallon per minute delivery.
2. Adjust water flows through chillers to design requirements.
3. Check leaving water temperatures and return water temperatures through chillers. Reset to correct design temperature.
4. Mark settings on valves and record data upon the completion of flow readings and adjustments at coils.

D. Phase II - Water systems testing and balancing procedures shall be as follows:

1. Recheck settings at the pumps, heat exchangers, boilers and chillers and re-adjust, if required, after adjustments are made to coils.
2. Install pressure gauges on coils, and read pressure drop through coil at set flow rate on demand for full cooling and full heating. Set pressure drop across bypass valve to match coil full flow pressure drop.
3. Check and record the following items at each cooling and heating element:

    a. Inlet water temperatures.
    b. Leaving water temperatures.
    c. Pressure drop of each chiller.
    d. GPM at each pump and chiller.
    e. Pump operating suction and discharge pressure and final total dynamic head.
    f. List mechanical specifications of pumps.
    g. Rated and actual running amperage of pump motor.
    h. Check control valves for operation from full open to full closed, and record pressures.

4. Constant volume hydronic systems with flow measuring devices: Systems/ devices shall be balanced proportionally using the flow measuring devices. On completion of the balance, the following information shall be recorded in the report: Flow meter size and brand, measuring device orifice size, required flow rate and pressure drop, valve settings on balancing valves with a readable scale, flow rate in both full coil flow and full bypass modes.
5. When all hydronic balancing is done, all balancing valve positions shall be marked and the locking devices set. Control valve bypass loops (where used) shall be set with the balancing valve to provide equal flow in either mode. Confirm in report.

3.4 SEASONAL CONSIDERATIONS

A. Test, adjust and balance system during summer season for air conditioning systems and during winter season for heating systems, including at least period of operation at outside conditions within 5°F wet bulb temperature of maximum summer design condition, and within 10°F dry bulb temperature of minimum winter design condition. When seasonal operation does not permit measuring final temperatures, then take final temperature readings when seasonal operation does permit.

3.5 CLOSEOUT PROCEDURES

A. Prepare report of test results, including instrumentation calibration reports, in format recommended by applicable standards.

B. Patch holes in insulation, ductwork and housings, which have been cut or drilled for test purposes, in manner recommended by original Installer.

C. Mark equipment settings, including damper control positions, valve indicators, and similar controls and devices, to show final settings at completion of TAB work. Provide markings with paint or other suitable permanent identification materials.

D. Prepare a report of recommendations for correcting unsatisfactory mechanical performances when system cannot be successfully balanced; including, where necessary, modifications which exceed requirements of contract documents for mechanical work.

E. Retest, adjust and balance systems subsequent to significant system modifications, and resubmit test results.

END OF SECTION 23 05 93

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SECTION 23 07 00 - MECHANICAL INSULATION

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Extent of mechanical insulation required by this section is indicated on drawings and schedules, and by requirements of this section.

B. This section includes pipe, duct, and equipment insulation.

1.2 DEFINITIONS

A. Hot Surfaces: Normal operating temperatures of 100 degree F or higher.

B. Dual-Temperature Surfaces: Normal operating temperatures that vary from hot to cold.

C. Cold Surfaces: Normal operating temperatures less than 75 degree F.

D. Thermal Resistivity: "r-values" represent the reciprocal of thermal conductivity (k-value). Thermal conductivity is the rate of heat flow through a homogenous material exactly 1 inch thick. Thermal resistivities are expressed by the temperature difference in degrees F between two exposed faces required to cause one Btu to flow through one square foot of material, in one hour, at a given mean temperature.

E. Density: Is expressed in lb/sq.ft.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation.

B. Submit schedule showing manufacturer's product number, k-value, thickness, and furnished accessories for each mechanical system requiring insulation.

1.4 QUALITY ASSURANCE

A. Fire Performance Characteristics: Conform to the following characteristics for insulation including facings, cements, and adhesives, when tested according to ASTM E 84, by UL or other testing or inspecting organization acceptable to the authority having jurisdiction. Label insulation with appropriate markings of testing laboratory.

1. Interior Insulation: Flame spread rating of 25 or less and a smoke developed rating of 50 or less.
2. Exterior Insulation: Flame spread rating of 75 or less and a smoke developed rating of 150 or less.

1.5 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.

1.6 SEQUENCING AND SCHEDULING

A. Schedule insulation application after testing of piping and duct systems.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Glass Fiber:

a. CertainTeed Corporation.
b. Knauf Fiberglass GmbH.
c. Manville.
d. Owens-Corning Fiberglas Corporation.
e. USG Interiors, Inc. - Thermafiber Division.

2.2 GLASS FIBER

A. Material: Inorganic glass fibers, bonded with a thermosetting resin.

B. Jacket: All-purpose, factory-applied, laminated glass-fiber- reinforced, flame-retardant kraft paper and aluminum foil having self-sealing lap.

C. Board: ASTM C 612, Class 2, semi-rigid jacketed board.

1. Thermal Conductivity: 0.23 average maximum, at 75 degree F mean temperature.
2. Density: 12 pcf average maximum.
3. Maximum Temperature Use: 400^{o}F.

D. Blanket: ASTM C 553, Type II, Class F-1, jacketed flexible blankets.

1. Thermal Conductivity: 0.24 average maximum, at 75 degree F mean temperature.
2. Maximum Temperature Use: 400^{o}F.

E. Preformed Pipe Insulation: ASTM C 547, Class 1, rigid pipe insulation, jacketed.

1. Thermal Conductivity: 0.23 average maximum at 75 degree F mean temperature.
2. Density: 10 average maximum.

F. Adhesive: Produced under the UL Classification and Follow-up service.

1. Type: Non-flammable, solvent-based.
2. Service Temperature Range: Minus 20 to 180 degree F.

G. Vapor Barrier Coating: Waterproof coating recommended by insulation manufacturer for outside service.

2.3 INSULATING CEMENTS

A. Mineral Fiber: ASTM C 195.

1. Thermal Conductivity: 1.0 average maximum at 500 degree F mean temperature.
2. Compressive Strength: 10 psi at 5 percent deformation.
3. Temperature Use Range: 100°F to 1600°F.

B. Expanded or Exfoliated Vermiculite: ASTM C 196.

1. Thermal Conductivity: 1.10 average maximum at 500 degree F mean temperature.
2. Compressive Strength: 5 psi at 5 percent deformation.
3. Temperature Use Range: 100°F to 1800°F.

C. Mineral Fiber, Hydraulic-Setting Insulating and Finishing Cement: ASTM C 449.

1. Thermal Conductivity: 1.2 average maximum at 400 degree F mean temperature.
2. Compressive Strength: 100 psi at 5 percent deformation.
3. Temperature Use Range: 100°F to 1200°F.

2.4 ADHESIVES

A. Flexible Elastomeric Cellular Insulation Adhesive: Solvent-based, contact adhesive recommended by insulation manufacturer.

B. Lagging Adhesive: MIL-A-3316C, non-flammable adhesive in the following Classes and Grades:

1. Class 1, Grade A for bonding glass cloth and tape to unfaced glass fiber insulation, sealing edges of glass fiber insulation, and bonding lagging cloth to unfaced glass fiber insulation.
2. Class 2, Grade A for bonding glass fiber insulation to metal surfaces.

2.5 FIELD APPLIED JACKETS

A. General: ASTM C 921, Type 1, except as otherwise indicated for field applied jackets.

B. Foil and Paper Jacket: Laminated glass-fiber-reinforced, flame-retardant kraft paper and aluminum foil.

1. Water Vapor Permeance: 0.02 perm maximum, when tested according to ASTM E 96.
2. Puncture Resistance: 50 beach units minimum, when tested according to ASTM D 781.

C. PVC Jacketing: High-impact, ultra-violet-resistant PVC, 20-mils thick, roll stock ready for shop or field cutting and forming to indicated sizes.

1. Adhesive: As recommended by insulation manufacturer.

D. PVC Fitting Covers: Factory-fabricated fitting covers manufactured from 20-mil-thick, high-impact, ultra-violet-resistant PVC.

1. Adhesive: As recommended by insulation manufacturer.

E. Aluminum Jacket: ASTM B 209, 3003 Alloy, H-14 temper, factory cut and rolled to indicated sizes.

F. Aluminum Jacket: ASTM B 209, 3003 Alloy, H-14 temper, roll stock ready for shop or field cutting and forming to indicated sizes.

1. Finish and Thickness: Stucco embossed finish, 0.016 inch thick.
2. Moisture Barrier: 1-mil, heat-bonded polyethylene and kraft paper.
3. Elbows: Preformed 45-degree and 90-degree, short- and long-radius elbows, same material, finish, and thickness as jacket.

G. Shrink Wrap Polyurethane: 20 mil polyurethane tube.

2.6 ACCESSORIES AND ATTACHMENTS

A. Glass Cloth and Tape: Woven glass fiber fabrics, plain weave, presized a minimum of 8 ounces per sq. yd.

1. Tape Width: 4 inches.
2. Cloth Standard: MIL-C-20079H, Type I.
3. Tape Standard: MIL-C-20079H, Type II.

B. Bands: 3/4-inch wide, in one of the following materials compatible with jacket:

1. Stainless Steel: Type 304, 0.020 inch thick.
2. Galvanized Steel: 0.005 inch thick.
3. Aluminum: 0.007 inch thick.
4. Brass: 0.01 inch thick.
5. Nickel-Copper Alloy: 0.005 inch thick.

C. Wire: 14-gage nickel copper alloy, 16-gage, soft-annealed stainless steel, or 16-gage, soft-annealed galvanized steel.

D. Corner Angles: 28-gage, 1-inch by 1-inch aluminum, adhered to 2-inch by 2-inch kraft paper.

E. Anchor Pins: Capable of supporting 20 pounds each. Provide anchor pins and speed washers of sizes and diameters as recommended by the manufacturer for insulation type and thickness.

2.7 REMOVABLE INSULATION COVERING

A. General: Provide factory fabricated flexible field applied insulation covering at expansion joints, pressure reducing valves, valves, and condensate pumps. Insulation covering shall be as follows:

1. Design: Provide custom designed reusable insulation covers to conform to the shape of the equipment, fitting, or device to be insulated. Covers that encapsulate the equipment, fitting or device and conceal its type are not acceptable.
2. Identification: Each cover shall have a permanently attached stainless steel tag secured to the outer surface of the cover for the purpose of identifying the manufacturer and source to reorder.
3. Construction: Insulation covers shall be sewn with two parallel rows of lock stitching (approximately 10 to 14 stitches per inch) approximately 1/4 to 1/2 inches apart. "Hog Ringed" seams are not acceptable. Insulation covers 2 inches thick and above shall be gusseted to insure full insulation thickness throughout.
4. Thermal Requirements: Insulation thickness shall be sufficient to provide a cold face temperature at or below 140ºF regardless of the thickness of the adjacent pipe insulation.
5. Jacketing: Jacketing shall be silicone impregnated fiberglass fabric minimum 16 ounces per square yard containing a minimum of 25 percent silicone by weight. Fabric shall be suitable for use with steam to 500ºF. Insulation shall be asbestos-free constructed of glass fiber insulating material composed of 100 percent Type E fiberglass, density of 11.5 pounds per cubic foot, alkalinity shall be 0.15 percent or less, conductivity "k" value no more than .38 at a mean temperature of 400ºF when measured in accordance with ASTM C177.
6. Sewing Thread: Kevlar or Teflon coated fiberglass suitable for the purpose intended.
7. Accessories: Type 304 stainless steel quilting and lacing pins shall be used to secure the insulation with the jacket. Drawcord shall be suitable for 600F service minimum diameter of 0.125 inch. Tie wire for securing covers shall be minimum No. 16 B&S (0.051 inch diameter) gauge soft annealed Type 302 or 304 stainless steel.

2.8 SEALING COMPOUNDS

A. Vapor Barrier Compound: Water-based, fire-resistive composition.

1. Water Vapor Permeance: 0.08 perm maximum.
2. Temperature Range: Minus 20 to 180 degree F.

B. Weatherproof Sealant: Flexible-elastomer-based, vapor-barrier sealant designed to seal metal joints.

1. Water Vapor Permeance: 0.02 perm maximum.
2. Temperature Range: Minus 50 to 250 degree F.
3. Color: Aluminum.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Preparation: Clean, dry, and remove foreign materials such as rust, scale, and dirt.

B. Mix insulating cements with clean potable water. Mix insulating cements contacting stainless-steel surfaces with demineralized water.

1. Follow cement manufacturer's printed instructions for mixing and portions.

3.2 INSTALLATION, GENERAL

A. Refer to schedules on the drawings for materials, forms, jackets, and thicknesses required for each mechanical system.

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

C. Install vapor barriers on insulated pipes, ducts, and equipment having surface operating temperatures below 60 degree F.

D. Apply insulation material, accessories, and finishes according to the manufacturer's printed instructions.

E. Install insulation with smooth, straight, and even surfaces.

F. Seal joints and seams to maintain vapor barrier on insulation requiring a vapor barrier.

G. Seal penetrations for hangers, supports, anchors, and other projections in insulation requiring a vapor barrier.

H. Seal Ends: Except for flexible elastomeric insulation, taper ends at 45 degree angle and seal with lagging adhesive. Cut ends of flexible elastomeric cellular insulation square and seal with adhesive.

I. Apply adhesives and coatings at manufacturer's recommended coverage-per-gallon rate.

J. Keep insulation materials dry during application and finishing.

K. Items Not Insulated: Unless otherwise indicated do not apply insulation to the following systems, materials, and equipment:

1. Fibrous glass ducts.
2. Metal ducts with duct liner.
3. Factory-insulated flexible ducts.
4. Factory-insulated plenums, casings, terminal boxes, and filter boxes and sections.
5. Flexible connectors for ducts and pipes.
6. Vibration control devices.
7. Testing laboratory labels and stamps.
8. Nameplates and data plates.
9. Access panels and doors in air distribution systems.
10. Below grade piping.
11. Piping specialties including air chambers, unions, strainers, check valves, plug valves, and flow regulators.

3.3 PIPE INSULATION INSTALLATION, GENERAL

A. Tightly butt longitudinal seams and end joints. Bond with adhesive.

B. Stagger joints on double layers of insulation.

C. Apply insulation continuously over fittings, valves, and specialties, except as otherwise indicated.

D. Apply insulation with a minimum number of joints.

E. Apply insulation with integral jackets as follows:

1. Pull jacket tight and smooth.
2. Cover circumferential joints with butt strips, at least 3-inches wide, and of same material as insulation jacket. Secure with adhesive and outward clinching staples along both edges of butt strip and space 4 inches on center.
3. Longitudinal Seams: Overlap seams at least 1-1/2 inches. Apply insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches on center.

    a. Exception: Do not staple longitudinal laps on insulation applied to piping systems with surface temperatures at or below 35 degree F.

4. Vapor Barrier Coatings: Where vapor barriers are indicated, apply on seams and joints, over staples, and at ends butt to flanges, unions, valves, and fittings.
5. At penetrations in jackets for thermometers and pressure gages, fill and seal voids with vapor barrier coating.
6. Repair damaged insulation jackets, except metal jackets, by applying jacket material around damaged jacket. Adhere, staple, and seal. Extend patch at least 2 inches in both directions beyond damaged insulation jacket and around the entire circumference of the pipe.

F. Roof Penetrations: Apply insulation for interior applications to a point even with the top of the roof flashing. Seal with vapor barrier coating. Apply insulation for exterior applications butted tightly to interior insulation ends. Extend metal jacket for exterior insulation outside roof flashing at least 2 inches below top of roof flashing. Seal metal jacket to roof flashing with vapor barrier coating.

G. Exterior Wall Penetrations: For penetrations of below grade exterior walls, terminate insulation flush with mechanical sleeve seal. Seal terminations with vapor barrier coating.

H. Interior Walls and Partitions Penetrations: Apply insulation continuously through walls and partitions, except fire-rated walls and partitions. Apply an aluminum jacket with factory-applied moisture barrier over insulation. Extend 2 inches from both surfaces of wall or partition. Secure aluminum jacket with metal bands at both ends. Seal ends of jacket with vapor barrier coating. Seal around penetration with joint sealer. Refer to Division 23 Section “Basic Mechanical Materials and Methods”.

I. Fire-Rated Walls and Partitions Penetrations: Terminate insulation at penetrations through fire-rated walls and partitions. Seal insulation ends with vapor barrier coating. Seal around penetration with firestopping or fire-resistant joint sealer. Refer to Division 23 Section “Basic Mechanical Materials and Methods for firestopping and fire-resistant joint sealers.

J. Floor Penetrations: Terminate insulation underside of floor assembly and at floor support at top of floor.

K. Flanges, Fittings, and Valves - Interior Exposed and Concealed: Coat pipe insulation ends with vapor barrier coating. Apply premolded, precut, or field-fabricated segments of insulation around flanges, unions, valves, and fittings. Make joints tight. Bond with adhesive.

1. Use same material and thickness as adjacent pipe insulation.
2. Overlap nesting insulation by 2 inches or 1-pipe diameter, which ever is greater.
3. Apply materials with adhesive, fill voids with mineral fiber insulating cement. Secure with wire or tape.
4. Insulate elbows and tees smaller than 3-inches pipe size with premolded insulation.
5. Insulate elbows and tees 3 inches and larger with premolded insulation or insulation material segments. Use at least 3 segments for each elbow.
6. Cover insulation, except for metal jacketed insulation, with PVC fitting covers and seal circumferential joints with butt strips.

L. Hangers and Anchors: Apply insulation continuously through hangers and around anchor attachments. Install saddles, shields, and inserts as specified in Division 23 Section "Hangers and Supports." For cold surface piping, extend insulation on anchor legs a minimum of 12 inches and taper and seal insulation ends.

1. Inserts and Shields: Cover hanger inserts and shields with jacket material matching adjacent pipe insulation.

3.4 GLASS FIBER AND MINERAL WOOL PIPE INSULATION INSTALLATION

A. Bond insulation to pipe with lagging adhesive.

B. Seal exposed ends with lagging adhesive.

C. Seal seams and joints with vapor barrier compound.

3.5 EQUIPMENT INSULATION INSTALLATION, GENERAL

A. Install board and block materials with a minimum dimension of 12 inches and a maximum dimension of 48 inches.

B. Groove and score insulation materials as required to fit as closely as possible to the equipment and to fit contours of equipment. Stagger end joints.

C. Insulation Thicknesses Greater than 2 Inches: Install insulation in multiple layers with staggered joints.

D. Bevel insulation edges for cylindrical surfaces for tight joint.

E. Secure sections of insulation in place with wire or bands spaced at 9-inch centers, except for flexible elastomeric cellular insulation.

F. Protect exposed corners with corner angles under wires and bands.

G. Manholes, Handholes, and Information Plates: Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.

H. Removable Insulation: Install insulation on components that require periodic inspecting, cleaning, and repairing for easy removal and replacement without damage to adjacent insulation.

I. Finishing: Except for flexible elastomeric cellular insulation, apply 2 coats of vapor barrier compound to a minimum thickness of 1/16 inch. Install a layer of glass cloth embedded between layers.

3.6 GLASS FIBER AND MINERAL WOOL EQUIPMENT INSULATION INSTALLATION

A. Secure insulation with anchor pins and speed washers.

B. Space anchors at maximum intervals of 12 inches in both directions and not more than [3 inches from edges and joints.

C. Apply a smoothing coat of insulating and finishing cement to finished insulation.

3.7 FIELD APPLIED JACKETS

A. Foil and Paper Jackets (FP): Install jackets drawn tight. Install lap or butt strips at joints with material same as jacket. Secure with adhesive. Install jackets with 1-1/2-inch laps at longitudinal joints and 3-inch-wide butt strips at end joints.

1. Seal openings, punctures, and breaks in vapor barrier jackets and exposed insulation with vapor barrier compound.

B. Interior Exposed Insulation: Install continuous PVC jackets.

C. Exterior Exposed Insulation: Install continuous aluminum jackets and seal all joints and seams with waterproof sealant.

D. Install metal jacket with 2-inch overlap at longitudinal and butt joints. Overlap longitudinal joints to shed water. Seal butt joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel draw bands 12 inches on center and at butt joints.

E. Install the PVC jacket with 1-inch overlap at longitudinal and butt joints and seal with adhesive.

F. Install glass cloth jacket directly over insulation. On insulation with a factory applied jacket, install the glass cloth jacket over the factory applied jacket. Install jacket drawn smooth and tight with a 2-inch overlap at joints. Embed glass cloth between (2) 1/16-inch-thick coats of lagging adhesive. Completely encapsulate the insulation with the jacket, leaving no exposed raw insulation.

3.8 FINISHES

A. Paint finished insulation as specified in Division 9 Section "Painting."

3.9 APPLICATIONS

A. General: Materials and thicknesses are specified in schedules on the drawings.

B. Interior, Exposed Piping Systems: Unless otherwise indicated, insulate the following piping systems:

1. Hydronic piping (35 to 99°F).

C. Interior, Concealed Piping Systems: Unless otherwise indicated, insulate the following piping systems:

1. Hydronic piping (35 to 99°F).

D. Exterior, Exposed Piping Systems: Unless otherwise indicated, insulate the following piping systems:

1. Hydronic piping (35 to 99°F).

E. Exterior, Concealed Piping Systems: Unless otherwise indicated, insulate the following piping systems:

1. Hydronic piping (35 to 99°F).

3.10 PIPE INSULATION SCHEDULES

A. General: Abbreviations used in the following schedules include:

1. Field-Applied Jackets: P - PVC, K - Foil and Paper, A - Aluminum, S - Stainless Steel, C - Canvas, SWP - Shrink Wrap Polyurethane.
2. Pipe Sizes: NPS - Nominal Pipe Size.

3.11 EXISTING INSULATION REPAIR

A. Repair damaged sections of existing mechanical insulation, where damaged or removed for new connections. Use insulation of same thickness as existing insulation, install new jacket lapping and sealed over existing.

3.12 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

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SECTION 23 08 00 - MECHANICAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General Commissioning Requirements 01 91 00
B. All applicable provisions of the divisions 23, and 26 also apply to this section.

1.2 SUMMARY

A. This section includes general requirements that apply to the implementation of the commissioning process in addition to section 01 91 00.

1.3 EQUIPMENT/SYSTEMS TO BE COMMISSIONED

A. The following equipment/systems will be commissioned in this project:

1. Chiller CH-1 and pumps.
2. Glycol Feeders.
3. Building Automated Control System (BAS)

1.4 RESPONSIBILITIES

A. The general responsibilities of various parties in the commissioning process are provided in section 01 91 00. The specific responsibilities may also be identified in the Technical Specifications.

B. Mechanical Contractor, their subcontractors, and vendors shall assign representatives with expertise and authority to act on their behalf and schedule them to participate in and perform commissioning process activities including, but not limited to, the following:

1. Provide detailed startup procedures
2. Include the cost of commissioning in the total contract price.
3. Ensure that all subcontractors and vendors execute their commissioning responsibilities according to the contract documents.
4. Attend and participate in commissioning team meetings. No later than 60 days prior to startup of the first piece of major equipment, meet with the CxA, CM, A/E, and PM and Owner to finalize the detailed commissioning procedures and schedule.
5. Review and accept construction checklists provided by the commissioning authority.
6. Complete construction checklists as work is completed and provide to CxA.
7. Accomplish commissioning process test procedures.
8. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.
9. Cooperate with the CxA for resolution of issues recorded in the “Issues Log”.
10. Prepare O&M manuals, according to the contract documents, including clarifying and updating the original sequences of operation to as-built/as-tested conditions.
11. Provide the training of Owner personnel.
12. Ensure that subcontractors and vendors provide assistance for seasonal or deferred performance testing, performed by the CxA, according to the specifications.
13. Ensure that subcontractors correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.
14. Perform all warranty work for materials furnished under the contract for the time specified in the contract, including all warranties and curing all latent defects within the time period provided in the contract.

C. TAB Contractor Responsibilities:

1. Contract Documents Review: With the CxA, review the Contract Documents before developing TAB procedures. Identify possible balancing device accessibility, effectiveness, and discontinuities in the Contract Documents (this TAB Subcontractor review of the Contract Documents may satisfy requirements specified in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC" item 3.1.A).
2. In conjunction with CxA, TAB Contractor shall verify the following:
    a. Accessibility of equipment and components required for TAB Work.
    b. c. Adequate number and placement of balancing valves to allow proper balancing and recording of water flow.
    d. Adequate number and placement of test ports and test instrumentation to allow reading and compilation of system and equipment performance data needed to conduct both TAB and commissioning testing.
    e. Air and water flow rates have been specified and compared to rated equipment output capacities.
3. TAB contractor shall participate in 5% waterside verification with CxA and Cx Team (this may satisfy requirements specified in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC" Inspections item 3.23). TAB contractor shall provide final report for review to CxA prior TAB Verification.
4. TAB Contractor shall participate in tests as typically specified in sections "HVAC Instrumentation and Controls" and "Sequence of Operation."

D. HVAC Instrumentation and Control Contractor Responsibilities:

1. Assist CxA with review control designs for design compliance, controllability with respect to actual equipment to be installed, and recommend adjustments to control designs and sequence of operation descriptions.
2. Assist CxA in preparation of BAS control tests.
3. Perform BAS control tests and complete prepared test forms for CxA review prior to CxA testing.
5. Attend TAB verification testing.
6. Contractor shall assist CxA to obtain trends of the system operating parameters to evaluate acceptable system functionality. The requirements of trending shall be specified with FPT procedures. Contractor shall establish these trends, ensure they are being stored properly, provide CxA web-based remote access, and forward the data in electronic format to the CxA.
7. Contractor shall assign adequate personnel and tools for FPT tests, and as required for scheduled retests.

E. Vendors

1. Provide all requested submittal data, including detailed startup procedures and specific responsibilities of the Owner to keep warranties in force.
2. Assist in equipment testing per agreements with subcontractors and/or contractor.
3. Include cost of all special tools and instruments (only available from vendor, specific to a piece of equipment) required for testing, operating, and maintaining equipment according to these contract documents in the base bid price to the contractor.
4. Analyze specified products and verify that the A/E has specified the newest, most current equipment reasonable for this project’s scope and budget.
5. Provide requested information regarding equipment sequence of operation and testing procedures.
6. Review construction checklists and test procedures for equipment installed by factory representatives.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. Refer to General Commissioning Requirements 01 91 00.

PART 3 - EXECUTION

3.1 COMMISSIONING MEETINGS

A. Refer to General Commissioning Requirements 01 91 00.

3.2 STARTUP, CONSTRUCTION CHECKLISTS, AND INITIAL CHECKOUT

A. Refer to General Commissioning Requirements 01 91 00.

3.3 OPERATIONS AND MAINTENANCE MANUALS / DATA

A. Refer to General Commissioning Requirements 01 91 00.

3.4 FUNCTIONAL PERFORMANCE TESTING

A. Refer to General Commissioning Requirements 01 91 00.

3.5 TRAINING OF OWNER PERSONNEL

A. Refer to General Commissioning Requirements 01 91 00.

3.6 DEFERRED TESTING

A. Refer to General Commissioning Requirements 01 91 00.

3.7 COMMISSIONING DOCUMENTS

A. Refer to General Commissioning Requirements 01 91 00.

END OF SECTION 23 08 00

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SECTION 23 09 00 – ELECTRIC CONTROL SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The General provisions of the Contract, including General, Supplementary and Special Conditions, the Owner's policy concerning the Executive Order Compliance and Division 1 - General Requirements, apply to work specified in this section. Subcontractor must familiarize himself with the terms of the above documents.

1.2 QUALITY ASSURANCE

A. Refer to paragraph "Acceptable Manufacturers" for acceptable pre-qualified temperature control sub-contractors for the work specified in this section.

B. Installers Qualifications: Firms specializing and experienced in electric control system installations for not less than 5 years.

C. Codes and Standards:

1. Electrical Standards: Provide electrical products (line voltage) which have been tested, listed and labeled by UL and comply with NEMA standards.
2. NEMA Compliance: Comply with NEMA standards pertaining to components and devices for electric control systems.
3. NFPA Compliance: Comply with NFPA 90A “Standard for the Installation of Air Conditioning and Ventilating Systems” where applicable to controls and control sequences.
4. NEMA EMC1 - Energy Management Systems Definitions.
5. ASME MC85.1 - Terminology for Automatic Control.
6. NEMA ICS1 - Industrial Control and Systems.
7. UL Compliance: Provide control system listed under UL 916 for Control of Mechanical Systems and Temperature Regulating Systems.
8. NFPA Compliance: Comply with NFPA 70 “National Electrical Code.

1.3 DESCRIPTION OF WORK

A. Provide all controls and instrumentation work necessary for the construction of the project as indicated on the Drawings and specified herein. Such work includes, but is not limited to the following:

1. The system of electronic temperature controls utilizing microprocessor-based digital controllers shall include all controlled equipment as shown on drawings, herein specified, and as shown on point list.
2. Provide control and interface panels and all necessary transducers, EPU's, relays, switches and other devices for the complete control system as specified herein.

B. The work included under this section of the specifications and drawings includes providing controls for new equipment and integrating the new equipment with the existing building control system. The new equipment will also require new thermostats, CO2 sensors, and humidistats.

C. Provide updated controls graphics for each new system and provide an updated floorplan for room temperature, CO2, and humidity.

D. The point list identifies those points that are to be addressed by the digital controller and incorporated into the new electronic temperature control system.

E. The system of automatic temperature control shall be furnished and installed as required for proper control of the HVAC equipment and shall include the furnishing and installation of all equipment materials and labor necessary for or reasonably incidental to the complete control system, and if shown but not specified or if specified but not shown shall be provided as though delineated in both specifications and drawings.

F. The contractor is to furnish and install a complete temperature control system including all necessary hardware and all operating and applications software necessary to perform the control sequences of operation as called for in this specification.

G. The contractor is to obtain and pay for all necessary construction permits and licenses.

H. The Drawings and Specifications are not intended to show all details. The Contractor is to secure satisfactory information before submitting the proposal and include in the proposal a sum sufficient to cover all items of labor and material required for the complete installation of the devices and systems described.

I. All work performed under this Section of the Specification shall comply with all codes, laws and governing bodies. If the Drawings and/or Specifications are in conflict with governing codes, the Contractor shall submit a proposal with appropriate modifications to the project to meet code restrictions. If this Specification and associated drawings exceeds governing code requirements, this Specification shall govern.

J. The Contractor shall execute his work in such a manner as to minimize down time and prevent delays in the scheduled completion date.

1.4 COORDINATED WORK

A. This Contractor shall cooperate with other contractors performing work on this project as necessary to achieve a complete neatly fitted installation for each condition. To that end, each contractor shall consult the drawings and specifications for all trades to determine nature and extent of others' work.

B. It shall be the duty of the Contractor to work in cooperation with the owner and other contractors and so arranging his work that the entire project will be delivered complete in the best possible condition by the scheduled completion date.

1.5 CLEAN-UP

A. This Contractor shall maintain the premises in an orderly fashion at all times during the construction period. He shall remove all cartons, containers, crates, etc., as soon as their contents have been removed and he shall also remove all debris, caused by his work daily. All

cartons, debris, etc., shall be removed from the site and premises at the sole expense of the Contractor.

B. At the completion of the work, the Contractor shall clean all of his work, equipment, etc., free from dust, etc., and leave the work in good housekeeping fashion in a manner acceptable to the Owner.

1.6 SUBMITTALS

A. Shop Drawings: Provide shop drawings for both the hardware and applications software to be utilized in the temperature control system. The following is a minimum submittal requirement:

1. Hardware:

a. Include a complete bill of material of equipment used indicating quantity, manufacturer and model number and other relevant technical data.
b. Include manufacturer's description and technical data, such as, performance curves, product specification sheets and installation/maintenance instructions for the items listed and other items relevant but not listed below:

1) Digital Controller
2) D/A and A/D Converters
3) Modem
4) Power Supply
5) Sensors
6) Batteries
7) Relays/Switches
8) Operator Interface Equipment
9) Control Panels
10) Flow Switches
11) PC Printer and CRT

c. Provide complete coded interconnection wiring diagrams for each electrically operated piece of equipment. Show all termination and wiring numbers.
d. Provide schematic wiring diagrams for each control panel. Show all terminations and wiring numbers.
e. Provide schematic wiring diagrams for all field sensors and controllers.

2. Software:

a. Provide a complete description of the applications programming language and instructions on how to program and reprogram any portion of the system.
b. Provide programming flow diagrams of the applications software.
c. Include a complete description of the operation of the temperature control system including sequences of operation.
d. Provide line-by-line applications software utilized to accomplish the control strategies called for in this specification.
e. Provide the control loop algorithms/calculations proposed.
f. Provide a digital controller point list including both inputs and outputs indicating I/O point number, the controlled device associated with the I/O point and the location of the I/O device.
g. Provide other documentation not listed above if deemed necessary by the Owner or Engineer to enable understanding of the applications software and algorithms proposed for proper functioning of the control system.

3. General:

   a. No construction may begin until shop drawings are approved by the Engineer for conformity with the plan and specification design intent.
   b. Quantities of items submitted will not be reviewed by the Engineer, and is the responsibility of the Contractor.
   c. When manufacturers cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project will be highlighted or clearly indicated by other means.
   d. Provide to the Engineer any additional information or data which the Engineer deems necessary to determine compliance with these specifications or which he deems valuable to the Owner in documenting the system to be installed.

B. Construction Record Documents: At the completion of the work, the Contractor shall submit three (3) revised signed and certified sets of documents as construction record documents. Construction record documents should include significant departures from the Contractor's originally approved documents or the Engineer's documents.

1. Construction record documents to be submitted are those listed under shop drawings pertaining to both hardware and software.
2. Construction record documents for software also requires that the Contractor supply to the Owner the project software in storage on written/paper form and on compact disc.

C. Operating and Maintenance (O&M) Manuals: Three (3) O&M manuals shall be submitted for approval and shall include the following, at a minimum, bound in three (3) ring hardback binders after system acceptance.

1. Names, addresses and telephone numbers of Contractors installing equipment and systems and the service representative for the system.
2. Shop drawing hardware and software submittals as well as construction record documentation if not duplication of shop drawing submittals.
3. Complete descriptions on the maintenance of all system components including sensors, controllers, actuators, etc. The descriptions shall include inspection, periodic preventative maintenance suggestions, system/component failure and diagnosis and the procedure for repair or replacement of defective components.
4. Definitions of terms utilized where applicable and necessary for complete Owner understanding of the installed system.

1.7 START-UP/TESTING

A. Prior to testing and verifying proper system operation, the Contractor shall furnish the Owner and Engineer, for acceptance, two (2) copies each of the start-up/testing procedure proposed. The Owner and Engineer must approve the check-out procedure prior to start-up/testing.

B. Submittal of the start-up/testing procedure must be submitted one (1) calendar month prior to the projected construction completion date.

C. After the procedure is approved and after installation is complete and systems are ready to be placed in regular service, the Contractor shall notify the Owner of this fact in writing.

D. On the start-up date, the Contractor will have on-site qualified field technicians to place the system in operation, making such tests, adjustments and changes as may be found necessary to insure successful operation of the equipment and systems.

E. The Contractor is to test and verify proper operation for each control loop.

F. Each control loop check will verify that the digital controller, watch dog circuit, automatic/manual switch, fail-safe control and electric interlocks are operating as intended to accomplish the control strategy.

G. Sensor calibrating/operation will be tested to verify that they are operating and within the performance parameters established in this specification.

H. Each input and output shall be checked to verify that correct terminations/designations of I/O are in place.

I. Communications to the digital controller shall be tested and verified that it is in working order.

1. On-site communications to the digital controller will be tested as well as on-site communications to the controller.
2. Off-site ommunications by the digital controller shall be tested to verify that the digital controller is able to initiate and establish communications with a designated terminal off-site for exception reporting/alarms.

J. Proper operation of all on-site operator interface hardware shall be tested to verify proper operation.

K. Downloading of applications programs will be tested both from on-site and off-site locations to verify proper operation of downloading procedure.

L. Reports/trend logs will be retrieved to verify proper operation/format.

M. All tests will be documented by the Contractor and certified verifying that the tests have been performed and that all deficiencies have been corrected.

1. All testing must be performed and all deficiencies corrected to the Owners satisfaction.

N. At the end of the start-up/testing, if equipment and systems are operating satisfactory to the Owner and Engineer, the Owner shall sign certificate certifying that the systems operation has been tested and accepted in accordance with the terms of this specification. The date of Owner's acceptance shall be the start of guaranty.

1.8 GUARANTY

A. The control systems specified shall be guaranteed free from defects, workmanship and material under conditions for a period of fifteen (15) months after acceptance by the Owner. Any equipment herein described proven to be defective in workmanship or material during guarantee period shall be adjusted, repaired or replaced at no charge to the Owner.

B. During the guarantee period, software updates/digital controller improvements, i.e., microprocessor chip changes, shall be provided to the Owner at no charge. Written authorization by the Owner must, however, be granted prior to the software or digital controller hardware updates.

C. The Contractor shall submit an alternate price for an extended service agreement after the end of the one-year warranty. Contract shall include parts, labor, and software. An escalation percentage shall be included for an additional four years.

1.9 TRAINING

A. Within one (1) week after the temperature control systems has been accepted by the Owner, the Contractor will provide a minimum of sixteen (16) hours of training at the site of the Installation for Owner designated personnel on the operation and maintenance of the system installed. Training sessions shall be limited to four hours per day and two days per week.

B. The Instructor(s) shall be competent and have full knowledge of the system installed and will provide training specifically oriented to the Owner's installed system.

C. The training shall utilize the operating and maintenance manual provided for the system as the reference manual and the training will include, at a minimum, the following:

1. Description of the overall control system configuration and physical layout indicating location of all sensors and controlled devices.
2. Description of the control strategies being utilized at the installation.
3. Description of all the key hardware components utilized in the system.
4. Instructions on how to communicate with (command and monitor) the systems digital controller.
5. Description of the programming instructions required to use the system.
6. Description of the requirements to retrieve alarm and trend log formats and how to react to alarm conditions.
7. Description of diagnostic trouble-shooting techniques for the entire system.

D. One (1) month after the initial training program is conducted, a second training session shall be held at the site of the installation. This session shall be a minimum of eight (8) hours in length, and will be held to refresh the Owner's designated operating personnel in the items listed under paragraph C above. This session will also provide the Owner designated operating personnel an opportunity to question the instructor after some experience with the system has been gained.

E. Prior to final turnover of the system to Owner, the Contractor shall provide a minimum of eight (8) hours training on the actual installation for the Owner's personnel. Specifically, detailed description of the system shall be given to the building's operating personnel, etc.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide electric control system of one of the following:

1. Existing Controls contractor

B. The function of this section is to establish a minimum quality of hardware to be provided, a minimum quality of installation and to establish equipment or equipment configurations to be utilized for standardization.

C. All work installed by the temperature control contractor shall be done in a neat and workmanlike manner as determined by the Owner, and acceptable standards for this type of work.

D. The temperature control contractor will provide hardware as specified to meet all system performance requirements. Should hardware be required to meet the specified system performance which is not specified herein, the contractor shall follow procedures established in the General Conditions.

E. Where two (2) or more units of the same class of equipment are required, these units shall be products of a single manufacturer; however, the component parts of the system need not be the products of a single manufacturer.

F. The digital controller system materials and installation will be addressed in three sections:

1. System Controller.
2. Operator Interface.
3. Field Equipment.
4. Wiring.

2.2 ARCHITECTURE

A. Diagram shown on the drawings shows the major hardware components which will form the digital control system. This diagram is included for clarification purposes only and is not intended to dictate a specific control system configuration.

B. The following terms, when used in this section, will be as defined here.

1. Digital Controller: A microprocessor-based controller supplied by an approved manufacturer. The term digital controller will be used to designate a package of equipment as supplied by the manufacturer.
2. System Controller: A digital controller plus associated equipment. The term system controller will be used to designate a specific group of equipment which will be supplied either as part of the digital controller package or supplied independently to meet the system controller specification.
3. Field Equipment: Equipment through which the system controller will interface with the facilities environmental, mechanical, and electrical systems.
4. Operator Interface: Equipment through which operator personnel will be able to access the digital controller.

2.3 SYSTEM CONTROLLER

A. General:

1. The temperature control contractor will supply a system controller which is capable of meeting or exceeding the performance requirements as specified under this section.
2. The temperature control contractor will supply a sufficient number of system controllers to meet the input/output capacity requirements and shall supply a sufficient number of system controllers such that none is overloaded from a control standpoint.

a. Overloaded is defined as a condition where the system controller cannot update all input values, calculate control outputs and execute all control within five (5) seconds.

3. Supply a dedicated 120 volt/1 phase, 20 amp circuit to power the system controller. Provide a service disconnect at the system controller. Provide surge protection for the power circuit.
4. The system controller shall be enclosed in a rigid enclosure, with baked enamel finish, hinged access door and keyed latch. Digital controllers meeting this criteria may be directly mounted.
5. When the digital controller qualifies for direct mounting, remaining components to complete the system controller shall be mounted in the field interface panel.
6. When the digital controller is to be mounted in a contractor supplied enclosure, all components classified under system controller shall be mounted in a common enclosure.
7. The system controller shall be labeled using one inch plastic engraved tags. Every component forming the system controller shall be labeled using 1/2 inch plastic embossed tags. Every termination within the system controller shall be labeled with mechanically fabricated or mechanically printed letters, numbers, etc., which exactly corresponds to as-built drawings.

B. Enclosure:

1. The contractor supplied enclosure shall be of rigid construction with baked enamel finish, NEMA Type 1, have a hinged door with keyed lock. The enclosure shall be sized for twenty (20) percent spare mounting space. The lock shall be keyed consistent with the field interface panels.

C. Digital Controller:

1. The digital controller shall be supplied by a pre-approved manufacturer and shall be of the designation, model or type listed.
2. These units shall be the latest version available including the most updated software and hardware offered by the manufacturers and shall include:

    a. Application Specific Controllers (ASC) - all VAV terminal units, air handling units, hot water system, chilled water system, etc..
    b. IBM PS/2 software:

        1) Standard machine third party interface
        2) Graphic programming language

    c. Network monitoring terminal.

3. Application Specific Controller: An Application Specific Controller shall be a 16 bit microprocessor based standalone DDC controller capable of monitoring and controlling all input and output points of a specific system. An ASC shall be capable of performing its specified control responsibilities independently of other controllers in the network. Each ASC shall have sufficient memory to support its own operating system and data base and shall directly interface to a portable service terminal. All programming including application programs, defined functions, and point database shall be protected from loss due to power failure with non-volatile memory. Multiple ASC's shall not be used to control a single system unless they communicate through a true Peer-Peer communications protocal in which loss of communication between them and the Network/Global controller does not cause loss of communication between ASC's. The minimum communication rate shall comply with BACNet standards

4. Input/Output Electrical Protection:

a. All analog inputs/outputs and digital inputs and outputs shall be protected at minimum to withstand 120 volts AC continuously without damage to the digital controller.
b. This includes any input/output supplied whether or not it will be utilized in meeting this specification.

5. Field Input/Output:

a. Provide, at minimum, digital input, digital output, analog input, and analog output point capacity as follows:

1) Basic requirements: Per input/output summary.
2) Spare capacity: 1 from each block of eight.

6. Memory:

a. The microprocessor-based digital controllers shall contain both random access memory (RAM) and read only memory (ROM). All the operating programs (systems' monitor) for the digital controller shall be ROM or PROM, i.e., memory resident operating system. Application software programs and strategies to accomplish the desired sequence of operation and other requirements shall be random access memory (RAM) resident. Bulk storage devices such as disks, tapes, etc., shall not be allowed/used in an interactive "on-line" mode.

7. Provide a sufficient memory capacity for all applications programs specified in this Section plus 100 percent future growth.
8. Communications Section:

a. Network/Global controllers shall communicate with each other and the network monitoring terminal through a Local Area Network.

D. Digital Controller Power Supply:

1. When this power supply may create problem heat for the digital controller, it may be mounted in the field interface panel or separately in it's own enclosure.

E. Battery Backup:

1. Provide battery backup to the memory and real time clock such that a loss of house service power of up to 24 hours will not cause any program loss or loss of the time. The battery shall be rechargeable and automatically be recharged after a power outage.
2. Provide circuitry to eliminate erratic operation due to low battery charge, sensing battery performance to execute an orderly shutdown before the electronic minimum operating point is reached.
3. Upon restoration of power, the system controller will automatically resume its operating functions.

F. System Integrity Checks:

1. The digital controller will have circuitry to continuously check for system integrity. This will include such items as hardware/software checks and watch dog timers. Should the digital controller fail any of these integrity checks, all controller outputs will go to a failsafe value.

2.4 FIELD EQUIPMENT

A. General:

1. All field interface devices, where practical, will be mounted in the field interface panel. All other field interface devices will be mounted at the point of field interface in a separate enclosure suitable for the location. When the manufacturer provides an enclosure/packaging of the device or sensor which protects the device from dust, moisture, conceals integral wiring and moving parts, this enclosure will be acceptable.
2. Every field interface device and every field termination will be labeled using words, letters or numbers with permanent mechanically fabricated or printed tags exactly corresponding to as-built drawings.

B. Field Interface Panel:

1. General:

a. Mounted within the field interface panel will be power supplies for sensors, interfacing relays and contactors, output point logic override for safety pneumatic to electric and electric to pneumatic transducers, output status indication, etc.
b. Where shown on the plans, the field interface panel will be firmly attached to a permanent wall or it shall be freestanding.

2. Enclosure:

a. Supply an enclosure of all steel construction with baked enamel finish, NEMA, Type 1 rated with a hinged type door and keyed lock or equivalent rigid construction. The enclosure shall be sized for twenty (20) percent spare mounting space.

3. Terminations:

a. All wiring to and from the field interface panel will be to screw type terminals. Analog or communications wiring may use the field interface panel as a raceway without terminating.
b. All wiring within the field interface panel will be run in plastic wiring duct to give a neat and workmanlike appearance.

4. Output Status:

a. Every output shall have a visual indication of it's status. Binary outputs will use a light emitting diode (LED). Electrical analog outputs will use either a voltmeter or ammeter. Pneumatic analog outputs will use an air gauge.
b. All output status indication will be amounted in a common location within the field interface panel on a sub-panel. Provide sufficient room for all used and all spare outputs. Each output will be properly labeled.

5. Pulse Width Modulation to Continuous Analog Output:

a. Where called for, provide equipment to convert a binary output from pulse width modulation to a continuous analog signal. Binary to electric will be through the use of a stepping motor potentiometer arrangement. Binary to pneumatic will be through the use of a pulsed feed and bleed solenoids.

C. Analog Inputs:

1. The temperature control contractor shall provide equipment for analog sensing as indicated in the point list. This will include the sensor, signal conditioning equipment and wiring.
2. Sensors and signal conditioning equipment provided shall be of the type which are universally accepted in the industry, can easily be second sourced and could be utilized with the majority of Digital Controller manufacturer's equipment.
3. Transducers may be supplied as an integral unit with the field sensor, mounted separately from the sensor, in a field interface panel or be packaged as part of the Digital Controller providing specified sensing accuracy is achieved. All transducers shall be calibratable.
4. Transduced analog signals shall be of one of the following forms: 4-20 MA, 0-5V, or 0-10V. Frequency modulated signals will not be allowed.

    a. Exception: Direct thermistor input to the Digital Controller for A to D conversion and software linearization will be acceptable.

5. Sensor and transducer selection shall be appropriate for the duty and mounting location including but not limited to the following items:

    a. The sensor/transducer will be appropriately packaged for the location.

        1) Architectural housing for space wall mounting.
        2) Weatherproof/sunshield housing for outside mounting.
        3) Thermal well housing for water applications.
        4) Dust and physical protective housing for duct mounting.

    b. The sensor/transducer will be appropriately selected to withstand ambient conditions.

        1) Moisture or condensation where it is a factor.
        2) Vibration from ductwork, equipment, etc.
        3) Reasonably expected transient conditions such as temperatures, pressures, humidities, etc., outside the normal sensing range.

    c. The sensor/transducer will be appropriately selected to most closely match the expected sensing range.
    d. The system shall maintain the specified end-to-end accuracy throughout the warranty period from sensor to Digital Controller read-out.
    e. Temperature Sensors: Temperature sensors will be by the use of thermistors or RTD's. Thermocouples or solid state temperature sensors will not be allowed.
    f. Space temperature applications with a range of 50 to 120°F. within plus or minus 0.5°F. Sensor shall have built in built-in setpoint potentiometer.
    g. Duct temperature applications with a range of 25 to 130°F within plus or minus 0.5°F. Averaging type temperature sensors shall utilize a resistance sensing element incorporated in a copper capillary of 20 feet.
    h. Outside air temperature applications with a range of minus 20 to plus 100°F within plus or minus 1.0°F. Sensor shall be available for outdoor or duct mounting.
    i. Water temperature applications with a range of 30 to 100F. within plus or minus 0.5°F; the range of 100 to 250°F within plus or minus 1.0°F; and applications for the purpose of performing BTU calculations using differential temperatures to within plus or minus 0.15°F.
    j. Humidity Sensors:

1) Space humidity applications within a range of 20 to 80 percent plus or minus 2 percent.
2) Duct humidity applications within a range of 20 to 80 percent plus or minus 2 percent.
3) Duct humidity applications for high limit control within a range of 0 to 100 percent plus or minus 5 percent.
4) Dew point with a range of 50-70°F. plus or minus 2 degrees F.

k. Pressure Sensors: Differential pressure sensor shall vary the output voltage with a change in differential pressure. The sensor shall be connected to the remote controller by means of a three-wire unshielded cable.

1) Space Static Pressure: Pressure sensor shall have a range of .1 inches WC with an accuracy of plus or minus .5 percent of range.
2) Duct Static Pressure: Pressure sensor shall have a range suitable for the specific application with an accuracy of plus or minus 1 percent of range. Differential pressure sensors used in laboratory exhaust applications shall be constructed of type 316L stainless steel and shall be UL listed under UL 913 Class 1, Division 1 standards.
3) Flow: Air flow applications with a range for the specific application and an accuracy within plus or minus 1.0 percent of maximum design flow. Steam flow applications with a range for the specific applications with an accuracy within plus or minus 1.0 percent of maximum design flow.

l. Space Sensors: Space sensors shall be EZNS-T100 combination temperature, CO2 and occupancy. Space sensors shall have humidity sensing for systems with evaporative cooling.
m. Airflow monitoring: Airflow monitoring shall be provided by the rooftop unit manufacturer and shall be EBTRON gold or engineer approved equal.

D. Analog Outputs:

1. The temperature control contractor shall provide equipment for analog outputs as indicated in the point list. This will include digital to analog conversion and wiring or pneumatic tubing to the controlled device. When required, the analog output signal must be fed back as an analog input. When hardware feedback is not required, the output will be software estimated.
2. All controlled devices which are to be modulated are to receive analog signals of one of the following forms: 4-20 MA, 0-5V, 0-10 volt or 0-20 psi.
3. Digital to analog converters shall be packaged as part of the digital controller and have a minimum resolution of 8 bits plus sign for 256 levels of control.
4. Alternate Method #1: The following method of conversion of a pulsed digital output to an analog signal may be employed.

a. 0-20 psi: Pulsed solenoids rate for a minimum 5 million operations and have a response time of less than .1 second.
b. Electric: Pulsed motor/potentiometer rated for a minimum of 5 million operations and be able to respond to input impulses of less than .2 second duration.

5. Alternate Method #2: The following method of conversion of a pulsed digital output to an analog signal may be employed.

a. Electric: The actuated device may be directly controlled from the digital controller provided that the digital controller in conjunction with the controlled device can give a minimum of 50 levels of control.

1) This method of control cannot be used when analog feedback is required.

E. Digital Inputs:

1. The temperature control contractor shall provide equipment for digital inputs as indicated in the point list.
2. All digital inputs will be electrically isolated from the digital controller either by optical isolation or relays.

   a. When relays are used, transient suppression shall be placed across the relay contacts.

3. All digital inputs will be provided by dry contacts single pole double throw. The contacts will be wired normally open or normally closed as required.
4. Pulse Accumulation: For pulse accumulation, provide a buffed input port which will totalize pulses between interrogations. The pulse accumulator shall accept rates up to ten (10) pulses per second.
5. Flow Switches:

   a. Thermal dispersion type switches (gas or liquid service) shall be two (2) piece design, UL Listed, SPDT snap-acting contacts, adjustable sensitivity with NEMA 4 enclosure. Two (2) piece design shall include the following:

      1) Probe: Sensor probe constructed of type 316 stainless steel, 7" long, sized for the application pipe size for temperatures to 240°F.
      2) Evaluation Control Monitor: Panel mounted electronic module with DIN rail mounting for 90-240VAC power input applications. Units shall incorporate flow, wire break and temperature monitoring function relays with power on time delay. Function relays shall have normally open and normally closed contacts rated for 4A. Flow and temperature setpoints shall be adjustable through potentiometers by use of a screwdriver. Units shall be jumper selectable for gas or liquid applications. For water flow applications, units shall have a setting range of 5-590FPM velocity. Units shall have the following LED indicators:

         a) 11 LED flow velocity indication.
         b) Red LED for wire break indication.
         c) Red LED for high temperature indication.

      3) Accessories: Provide with pipe adapter and cables with straight or angled quick disconnect socket connectors.
      4) Manufacturer: IFM Effector 300 or equal.

6. Pressure Switches: Pressure switches shall have a repetitive accuracy of plus or minus one (1) percent of their operating range and shall withstand up to 150 percent of rated pressure. Sensors shall be diaphragm or bourdon tube. Switch actuation shall be adjustable over the operating pressure range. Switch shall have a snap-action SPDT contact rated for the application. Switch contacts shall be wiping contacts and shall have adjustable differential setting. Differential pressure switches shall be Dwyer 1630 Series with Operating ranges between 0.05 to 12 inches, W.C.
7. Control Relays: Control relay contacts shall be rated for the application, with SPDT contacts, enclosed in a dustproof enclosure. Relays shall have silver cadmium contact with a minimum life span rating of one million operations. All control relays shall have a LED status indicator light.

F. Digital Outputs:

1. The temperature control contractor shall provide equipment for digital outputs as indicated in the point list.
2. All digital outputs will be electrically isolated from the digital controller either by optical isolation or relays.

    a. When relays are used, transient suppression shall be placed across the coils.

3. All digital outputs will be provided by dry contacts single pole double throw. The contacts will be wired normally open or normally closed as required.
4. Equipment Start/Stop: Equipment on/off control shall use either momentary relays or magnetic latching relays as appropriate for the equipment control starter.

G. Controlled Devices:

1. Control Valves: Provide factory-fabricated electrical control valves of type, body material and pressure class indicated. Where type or body material is not indicated, provide selection as determined by manufacturer for installation requirements and pressure class, based on maximum pressure and temperature rating of piping system. Except as otherwise indicated, provide valves which mate and match material of connecting piping. Equip control valves with control valve motors, and with proper shutoff ratings for each individual application.

    a. Water Service Valves: Equal percentage characteristics with range of 50 to 1, and maximum full flow pressure drop of 5 PSIG.
    b. Valve Trim and Stems: Polished stainless steel.
    c. Packing: Spring-loaded Teflon, self-adjusting.
    d. Terminal Unit Control Valves: Provide control valves for control of terminal units including, but not necessarily limited to, convectors, finned tube radiation, and fancoil units that are of integral motor type. Provide modulating type valves.

2. Dampers: Provide automatic control dampers as indicated, with damper frames not less than formed 13 ga galvanized steel. Maximum damper section size shall be 48"x72" with larger damper installed in sections with appropriate jack shafting. Provide mounting holes for enclosed duct mounting. Provide damper blades not less than formed 16 ga galvanized steel, with maximum blade width of 8". Equip dampers with motors, with proper rating for each application.

    a. Secure blades to 1/2" diameter zinc-plated axles using zinc- plated hardware. Seal off against spring stainless steel blade bearings. Provide blade bearings of nylon and provide thrust bearings at each end of every blade. Construct blade linkage hardware of zinc-plated steel and brass. Submit leakage and flow characteristic, plus size schedule for controlled dampers.
    b. Operating Temperature Range: From -20°F to 200°F.
    c. For standard applications, provide parallel or opposed blade design. For proportional or modulating control applications, provide opposed blade design. For mixing applications, provide parallel blade design. Dampers shall be designed to operate in systems having velocities up to 3,000 FPM and shall have stainless steel seals along top, bottom and sides of frame and butyl rubber seals along each blade. Dampers shall be rated for leakage at less than 10 cfm/sq. ft. of damper area, at differential pressure of 4" w.g. when damper is being held by a torque of 5.0 inch-pounds.

3. Dampers and Valve Motors: Size each motor to operate dampers or valves with sufficient reserve power to provide smooth modulating action or 2-position action as specified.

   a. Provide permanent split-capacitor or shaded pole type motors with gear trains completely oil-immersed and sealed. Equip spring-return motors, where indicated on drawings or in operational sequence, with integral spiralspring mechanism. Furnish entire spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
   b. Motors for outdoor locations shall be completely weatherproof, and capable of normal operation at -20°F.
   c. Actuators may be of the push-pull or rotating type for either modulating or two-positioning control. Actuators shall stroke by a rotating motion of an overload-proof synchronous motor. Control voltage shall be either 24V AC or 0-20V DC as required by the application.

H. Smoke Detectors:

1. Duct Mounted Smoke Detectors: Duct Mounted Smoke Detectors are provided as work of Division 26.

I. Contactors, Relays, and Switches:

1. Electric Contactors: Provide contactors for operating or limit- control of electric heating loads which are UL-listed for 100,000 cycles of resistive loads. Equip with replaceable molded coils and replaceable silver cadmium oxide contacts. Coat core laminations with heat-resistant inorganic firm to reduce core losses. Provide line and load terminals on contactors with higher-than-35-amp rating, or provide one-piece formed-and-welded pressure type. Provide screw-type contactors for 35-amp-or-lower rating. Equip field-mounted contactors with suitable steel enclosures; and provide open-type mounting for those installed in factory- fabricated panels.

2.5 WIRING

A. All devices in the digital temperature control panel or remote shall be final connected under this Section.

B. Wire:

1. General:

   a. All power wiring, class 1, 2 or 3 wiring and communications wiring required for satisfactory installation and operations of all equipment required on this project for the section of work specified under temperature control shall be supplied and installed by the Temperature Control Contractor (TCC).
   Exception: When specifically specified to be provided by another trade.
   All wiring shall be installed in accordance to wiring specifications found in Division 26 and those found in this section.
   Note: Should any discrepancy be found between wiring specifications in this Division 23 and Division 26, wiring requirements of Division 23 will prevail for work specified in Division 23.

b. All wiring shall be installed in accordance with all applicable electrical codes and shall comply with equipment manufacturer's recommendations.
Exception: When specifically specified materials or installation methods exceed applicable electrical codes and equipment manufacturer's recommendations.

c. The TCC shall be responsible for all required permits for his work.
d. Provide a commercial telephone connection to the Network/Global controller.

2. Raceway System:

a. All wiring shall be installed in a complete conduit raceway system of a minimum trade size of 1/2 inch. Conduit shall be installed continuous from terminal to terminal and shall be mechanically and electrically connected. The entire system shall be grounded.
b. Conduits passing from the building exterior to interior or passing between conditioned and non-conditioned spaces shall be sealed to prevent condensation in the conduit.
c. Conduits crossing building-expansion joints shall be provided with expansion fittings and flexible grounded bonds by-passing the fittings to insure ground continuity.

3. Wire and Cable

a. All wire shall be copper and meet the minimum wire size and insulation class listed.

Wire Class	Min. Wire Size	Min. Insulation Class
Power	12 Gauge	600 Volt
Class One	14 Gauge	600 Volt
Class Two	18 Gauge Stranded	300 Volt
Class Three	18 Gauge Stranded	300 Volt
Communications	Per Manufacturer	Per Manufacturer

b. Power and Class One wiring may be run in the same conduit. Class Two and Three wiring and communications wiring may be run in the same conduit. Power and Class One may not be run together with Class Two and Three or communications.
c. Where different wiring classes terminate within the same enclosure, maintain clearances and install barriers per NEC.
d. All sensor wiring shall have a 100 percent grounded shield.
e. All sensor wiring shall use crimped or soldered connections. Wire nuts are not allowed.
f. Conduit, in finished areas, shall be concealed in ceiling cavity spaces, plenums, furred spaces and wall construction.
Exception: Metallic surface raceway may be used in finished areas on masonry walls. All surface raceway in finished areas must be color matched to the existing finish within the limitations of standard manufactured colors.
Note: Finished areas include offices, hallways, restrooms, etc.

g. Conduit, in non-finished areas where possible, shall be concealed in ceiling cavity spaces, plenums, furred spaces and wall construction. Exposed conduit shall run parallel to or at right angles to the building structure.
Note: Non-finished areas include equipment rooms; such as HVAC equipment, telephone equipment, batteries, work shops, janitorial closets, etc.

New conduit shall be blue EMT for all low voltage and control wiring.

h. Identify all control/signal wires with labeling tape using either words, letters or numbers that can be exactly cross-referenced with as-built drawings.
i. Pull spare control cables as noted on drawings.

PART 3 - EXECUTION

3.1 GENERAL

A. The temperature control contractor will supply an approved digital controller complete with all required hardware and software to meet the minimum requirements specified for each of the four areas of performance.

1. Building system control.
2. Alarming/monitoring.
3. Operator interface.
4. Data collection and formatting.

B. In meeting these performance specifications, the temperature control contractor will provide a total system of a configuration.

1. Compatible with good industry practice.
2. Composed of components meeting minimum hardware quality specified.
3. Compatible with specified system architecture.

3.2 MONITOR/ALARM-INPUT/OUTPUT

A. The temperature control contractor will provide both the hardware and software required to monitor points listed in the input/output summary.

B. Provide software as described in this section completely programmed such that when turned over to the Owner, all alarming functions will be available to the Owner without additional programming.

C. Upon the input of a simple command, the operator will be able to examine the status or value of any input/output. All analog values examined will be in correct engineering units and all binary inputs/outputs will be indicated as open/closed, on/off, low/high, etc.

D. Each analog input point will be assigned maximum and minimum operating or expected value. When the sensed variable exceeds the assigned operating range, an alarm will be generated.

E. The commanded state of each binary output will be compared to the actual state. If these are not the same, an alarm will be generated. Time delays will be provided as required to prevent false alarms.

F. Alarms shall be classified as either critical or informational.

G. Critical alarms will output in the following manner.

1. The digital controller will dial out to a designated phone number after being acknowledged by a terminal. A printed alarm message will be sent to the designated

terminal giving time, date, location and alarm description. This message shall consist of up to fifty (50) characters.
2. A similar alarm message to that sent off site will appear on the local access terminal.
3. A binary output will energize a light and horn located at the field interface panel. A silence switch shall be provided for the horn. The alarm will only be manually reset. If reset and the silence switch is on, the horn will be activated until the silence switch is returned to its normal position.

H. Both critical and information alarms will be stored in memory and will be available through an operator command.

3.3 OPERATOR INTERFACE

A. General

1. The temperature control contractor will provide integration with the existing operator interface. Provide updated graphics for new systems and room sensors.

3.4 DATA COLLECTION AND FORMATTING

A. The temperature control contractor will provide both the hardware and software required to provide operator logs.

B. Provide software as described in this section completely programmed such that when turned over to the Owner, these logs will be available to the Owner without additional programming.

1. Point Summary: Will print out every currently programmed point showing:

a. The descriptive name.
b. Current analog value or current digital state.

2. Trend Log: Set up a trend log for every input and output point to record, at minimum, the last thirty (30) values. Time intervals shall initially all be set at two (2) minutes; however, they may be user changeable up to one (1) hour.
3. Alarm Log: Set up an alarm log which will print the last thirty (30) alarms giving time, date, description and location.
4. Daily Report: Set up a software program which will be able to initiate any alarm log, trend log, or point summary on a time programmed weekly basis. Allow for up to four (4) reports per day. Preceded report with time and date.

3.5 CONTROL STRATEGY

A. It will be the responsibility of the temperature control contractor to provide the following:

1. Temperature control programs to accomplish the desired sequence of operation as indicated. These computer programs shall be provided to the Architect/Engineer for approval with the hardware submittals. The responsibility will remain with the temperature control contractor to modify the program to accomplish the desired sequence of operation.
2. The new digital temperature control panel shall be:

a. Completely user programmable and setpoints alterable; user programmable to mean allowing the user to completely alter and/or change operating strategies, program and/or software algorithms, operating programs and setpoints.

B. The temperature control contractor shall provide the programs or software necessary to implement all sequence of operations, methods, alarm programs, etc., needed in this project.

3.6 APPLICATION PROGRAMS: PROVIDE SOFTWARE TO ACCOMPLISH THE FOLLOWING

A. Perform all functions specified in the I/O summary tables by use of the appropriate application programs.

1. Program Inputs: Use all of the program inputs specified for each application program to calculate the specified program output(s). Where the specific program inputs are not available (no status indication called for in the I/O summary table), provide a "default" value to place the missing input, thus maintaining the integrity of the algorithm used.
2. Analog Commands:

a. Setpoint Adjustment: using an AO or DO in conjunction with an AI signal from the sensed media, achieve changes in operating setpoints via electric transducers actuators.
b. Position Adjustment: Provide position adjustment as specified by using an AO or DO in conjunction with an AI signal from a controlled device to close the control loop.

3. Analog Monitoring: The system shall measure all analog values specified in the I/O summary tables including calculated analog points, and shall express analog values in proper engineering units with sign.
4. Data Environment Restart: Provide a DE restart program based on detection of power failure. Upon restoration of power to the DE, restart all equipment and restore all loads to the state at time of power failure or to the state as commanded by time programs or other overriding programs. Provide appropriate time delays to prevent demand surges or overload trips.
5. Failure Mode: Provide a "watch-dog" timer function for detection of failures. Upon detection of system failure, force all outputs to a predetermined state, consistent with the control device interfacing with the DE.
6. Device Operation: All control devices connected to the system shall have memory resident constraints checked before each command or CPA is issued to insure that no equipment damage will result from improper operation.
7. Time Programs: Time programs shall automatically be initiated based on pre-established time schedules for those items specified. Provide capacity to control on/off and event initiation times for each day of the week (Monday through Sunday). Provide an additional time program(s) for holidays. To eliminate power surges, the system shall enter an adjustable time delay between consecutive start commands generated by the time program for electrical loads over 20 horsepower or 50 kw.
8. Event Programs: Event programs shall be manually or automatically initiated based on events, either hardware or software derived.
9. Scheduled Start/Stop Program: Provide software to start and stop equipment based on the time of day and day of week including holidays. The program shall monitor the controlled equipment status to verify that the start and stop command has been carried out (and provide the system with an alarm when the equipment does not start or stop, fails, or is locally started or stopped). The schedule start/stop program shall operate in conjunction and be coordinated with optimum start/stop, day/night setback, ventilation/recirculation and lighting control programs. The software requirements are:

a. Program Inputs:

1) Day of week.
2) Time of day.
3) Summer or winter operation.
4) Equipment constraints.

b. Program Outputs:

1) Start signal.
2) Stop signal.

10. Systems Reports: The system shall be capable of outputting reports to a printer. This reporting capability shall be upon operator request or when triggered by pre-programmed events or times as described in the various sequence of operations. All reports from the system whether activated automatically or in response to an operator request shall be preceded by an approved identification scheme followed by the text of report. As a minimum, these reports shall consist of the following:

a. Every 3-hour readings of all input and output points in the system during occupied times only. The initial 3-hour time span between all input and output points scans shall be fully changeable/alterable to other time spans by software or program modification. The readings shall be whatever sensed conditions, i.e. temperatures, on/off status, humidity, enthalpy, refrigeration, etc., at each respective points identified in the system. All reporting shall be done automatically without operator assistance.
b. History Report: Upon operator request, provide a record of the following:

1) Highest and lowest sensed value from all points over the operating time of the temperature control system.

c. Input/Output Reports: Print the value or state of a specified input and/or output and/or group of inputs and/or outputs in standard engineering units as may be applicable. The particular input and/or output shall be fully identified in the report.
d. Alarm Reports: Print an english language - based message(s) indicating the occurrence of pre-programmed alarm condition(s). The message(s) shall be fully changeable and/or alterable by software modifications in its entirety. Each alarm message shall consist of a minimum of 50 ASCII characters.
e. Error Report: Print a historical record of errors encountered in running the required self-test diagnostics and a record of power interruptions.
f. Over-ride Reports: Print a listing of those inputs and outputs that are currently overridden. The listing shall contain overrides due to use of the output hand-off-auto switches as well as overrides initiated via the operators terminal.
g. Trace: Print a record of the operation of given control sequence.
h. System Integrity Tests: The unit shall continuously perform discrete tests to verify the performance of its CPU and memory (both RAM and ROM). These tests shall be performed in background and shall determine whether a fault has occurred. These shall include:

1) Performance checks on the CPU.
2) Correctness of data/programs stored in ROM.
3) Correctness of application programs stored in RAM.

i. ROM Check: This background test shall validate check sums maintained for each 2K of ROM. If an error is detected, it shall be logged.

j. RAM Integrity Checks: As each drum control decision is processed, it shall be checked to insure data validity before execution of a control decision. If an error is detected, the condition shall be logged and the line exempted from further processing.

END OF SECTION 23 09 00

SECTION 23 10 00 – VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Variable frequency drives shall be provided by the Mechanical Contractor and installed by the Electrical Contractor.

B. Extent of variable frequency drives work is indicated by drawings and schedules, and by requirements of this section for the following equipment:

1. Pumps.

C. The variable frequency drives for this project shall be Pulse Width Modulation type.

D. Refer to other Division-23 sections for motors, pumps, air handling equipment, and controls not factory installed.

E. Refer to Division-26 sections for the following work:

1. Power wiring for unit.

F. Provide the following electrical work as work of this section, complying with requirements of Division-26 sections.

1. Control and interlock wiring between operating controls, indicating devices, unit temperature control panels and variable frequency drive.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of variable frequency drives, of types and capacities required, where products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: A firm specializing and experienced in variable frequency drive installations for not less than 5 years.

C. Codes and Standards:

1. Electrical Standards: Provide electrical components of variable frequency drives which have been UL-listed and labeled, and comply with NEC standards.
2. NEMA Compliance: Comply with NEMA standards pertaining to components and devices.
3. ETL Compliance: Provide variable frequency drives with ETL approved label.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data, including rated capacities of selected model clearly indicated, weights, furnished specialties and accessories; and installation and start-up instructions.

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 for variable frequency drives. 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. Maintenance Data: Submit maintenance data and parts list for each variable frequency drive, control, and accessory; including "trouble-shooting" maintenance guide. Include this data and product data in maintenance manual; in accordance with requirements of Section 23 00 00.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Handle variable frequency drives carefully to prevent damage, breaking, denting and scoring. Do not install damaged units or components; replace with new.

B. Store variable frequency drives 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 variable frequency drives and moving units to final location for installation.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Basis of Design Manufacturers: Subject to compliance with requirements, provide variable frequency drives of one of the following:

1. ABB (ASEA Brown Boveri) Model No. ACH580

B. Alternate Manufacturers: Subject to compliance with requirements, provide variable frequency drives of one of the following:

1. Graham Company
2. Square D

2.2 GENERAL

A. Establish requirements for variable voltage variable frequency motor controls, for speed control of fans, blowers, or pumps driven with AC motors.

B. Contractor shall coordinate exact locations of all motors controlled from a pulse width modulated VFD and provide motor with Class F insulation rating.

2.3 VARIABLE FREQUENCY MOTOR CONTROL

A. Pulse Width Modulation VFD:

1. The controller shall produce an adjustable AC voltage/frequency output. It should have an output voltage regulator to maintain correct output V/Hz. despite incoming voltage variations.
2. The controller shall have a continuous output current rating of 100% of motor nameplate current.
3. The VFD shall be of the Pulse-Width Modulated type and shall consist of a full-wave diode bridge converter to convert incoming fixed voltage/frequency/ to a fixed DC voltage.
4. The inverter output shall be generated by power transistors or IGBT's (isolated gate bipolar transistors).
5. The logic control section shall be microprocessor based.

2.4 SPECIFICATION

A. Verify power input requirements with drawings.

1. Nominal input voltage +/-10%
2. Input frequency stability +/-5%

B. Provide minimum 3% Line Reactor.

C. Output power; 3 phase, 1.5 to 60 Hz with variable voltage to give proper and efficient operation of variable torque load.

D. Overload capacity of 125% for 1 minute.

E. Displacement power factor - Minimum of 90% over the entire speed range.

F. VFD shall be rated for HP rating indicated on drawings. Additionally amp rating shall not be less than National Electrical Code, Table 430-250 for corresponding HP size indicated. HP and current ratings noted above shall be minimum values after any/all derating factors such as frequency, etc. have been applied.

2.5 MINIMUM REQUIREMENTS FOR CONTROL OPERATION

A. Fused input door interlocked disconnect.

B. Isolated 115VAC control transformer.

A. Operator Interface: Provide detachable multifunction control panel with full graphic LCD display and multiple language capability. Control panel shall have a green power on and red fault LED indicators, and shall display fault indication, operational parameters, and time clock functions. The control panel shall contain a keypad to scroll through and set or display operational parameters. Operator interface shall include Hand-Off-Auto (HOA) selector switch.

B. Annunciated fault and limit functions for:

1. Thermal overload relay trip
2. Microprocessor self-check function

3. Output overcurrent trip
4. DC bus overvoltage trip
5. Inverse time overload trip
6. Heat sink overtemperature trip
7. DC bus fuse open
8. DC bus overvoltage (regen. limit)
9. Output ground fault
10. Inverter ready light
11. Inverter run light
12. Bypass run light
13. Bypass safety lockout light (red)
14. Inverter safety lockout light (red)
15. Power line on light
16. Control voltage enabled light

2.6 MINIMUM REQUIRED STANDARD FEATURES

A. Where indicated, VFD's shall be provided with a bypass to allow operation of motor(s) across the line.

B. Provide fused disconnect integral to enclosure on load side of VFD's with integral electronic bypass. Disconnect shall be capable of being locked in the open position.

C. Provide fused input disconnect switch or circuit breaker on line side of VFD and also on line side of Bypass supply for VFD's with external bypass. Disconnect shall be capable of being locked in the open position.

D. Provide fused disconnect for each motor when one VFD serves more than one motor. Provide overload relays for each motor.

E. Door Mounted Components:

1. Inverter run indication
2. Bypass run indication
3. Remote safety indication
4. Digital speed (frequency or percent speed) and motor ammeter
5. Manual speed potentiometer
6. Inverter / Off / Bypass switch
7. Reset push-button for fault and enable
8. Manual / Auto reference selector switch
9. Annunciation as in Section 2.04

F. DC bus charged indicator

G. Current limit circuit active to prevent nuisance tripping during accel or run conditions.

H. Regeneration limit circuit active to prevent nuisance OV tripping during deceleration.

I. Minimum and maximum speed set, separate and non-interactive.

J. Power loss restart selectable for Auto Restart in auto mode only.

1. Automatic restart from undervoltage, power failure, or control fault, or both.

K. Critical frequency lockout for up to 2 points, available from 10 to 100% speed with at least a 6 Hz bandwidth.

L. Only non-filament type indicating lights may be used.

M. Control shall survive without component failure, and annunciate, output phase to phase and phase to ground faults.

N. The VFD shall be provided with the following resident serial communications protocols and/or fieldbus adapter modules to allow integration to the Building Automation System (BAS):

1. Serial Communications protocols:

a. Modbus RTU
b. BACnet

2. Fieldbus Adapter Modules:

a. Ethernet/IP
b. Modbus/TCP
c. Profinet IO

O. Control shall have the following isolated instrument signal follower:

1. 4 to 20 madc
2. 0 to 10 vdc
3. 3 to 15 psi (optional)
4. Floating point (optional)

P. Loss of reference protection, VFD shall reset to predetermined minimum speed until such time as the control is commanded to stop or the analog reference returns to normal.

Q. Control shall have available 15 selectable volts per hertz patterns.

R. Volts per hertz ratio shall be automatic, tracking motor load requirements to achieve most efficient operation within the parameters set by the volts per hertz pattern. Potentiometer adjustments not allowed.

S. VFD shall have automatic restart capabilities and be capable of starting into a spinning motor.

T. Control must be capable of starting into a spinning motor and switching from inverter to bypass back to inverter without delay and without tripping off line of the inverter, also must be capable of stopping a motor rotating in the reverse direction and then accelerating that motor in the proper direction.

U. Control shall have a fused door interlocked disconnect with fuses rated for proper branch circuit protection.

V. All components must be supplied in an enclosure.

W. Electronic Bypass Control: An integrated electronic bypass control shall be provided for the purpose of running the AC motor at full speed with line power while the VFD is inoperative. Bypass and drive shall be electronically interlocked. VFD shall be serviceable while operating in the bypass mode. The bypass control shall include:

1. Safety Circuit Terminal Strip
2. Door Interlocked Disconnect
3. Drive Off-Line Selector
4. Power On Light
5. VFD Output Contactor
6. VFD Select Light
7. Overload Relay
8. Line Select Light
9. 115 VAC Control Transformer

X. Manual Bypass Control. A bypass control shall be provided for the purpose of running the AC motor at full speed with line power while the VFD is being serviced. Bypass and drive shall be electrically interlocked. The VFD package shall be configured so that the VFD can be removed for service with the bypass control left in place. The bypass control shall include:

1. NEMA 1 Enclosure
2. Safety Circuit Terminal Strip
3. Door Interlocked Disconnect
4. Drive Off-Line Selector
5. Bypass Contactor
6. Power On Light
7. VFD Output Contactor
8. VFD Select Light
9. Overload Relay
10. Line Select Light
11. 115 VAC Control Transformer

Y. BAS Integration: Variable frequency drive shall be provided with the resident serial communications protocol or interface module necessary to integrate the drive with the Siemens BAS. Resident serial communications protocol or interface module shall provide all microprocessor operation and diagnostics information to the Siemens BAS for a fully integrated system.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which variable frequency drive systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF VARIABLE FREQUENCY DRIVE SYSTEMS

A. General: Install system and materials in accordance with manufacturer's instructions and roughing-in drawings, and details on drawings. Install electrical components and use electrical products complying with requirements of applicable Division-26 sections of these specifications. Mount controllers at convenient locations and heights.

3.3 ADJUSTING AND CLEANING

A. Start-Up: Start-up, test, and adjust variable frequency drive systems in presence of manufacturer's authorized representative. Demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

B. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

C. Final Adjustment: After completion of installation, coordinate with temperature control contractor to verify that all controls are operating correctly with the variable frequency drive system.

3.4 CLOSEOUT PROCEDURES

A. Owner's Instructions: Provide services of manufacturer's technical representative for one 4-hour day to instruct Owner's personnel in operation and maintenance of variable frequency drive systems.

1. Schedule instruction with Owner, provide at least 7-day notice to Contractor and Engineer of training date.

END OF SECTION 23 10 00

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SECTION 23 21 13 – HYDRONIC PIPING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This Section includes piping systems for hot water heating, chilled water cooling, condenser water, make-up water for these systems, blow-down drain lines, and condensate drain piping. Piping materials and equipment specified in this Section include:

1. Piping and fittings.
2. Calibrated plug valves.
3. Pump discharge valves.
4. Safety relief valves.
5. Pressure reducing valves.
6. Air vents.
7. Air separators.
8. Combination air and dirt separators.
9. Compression tanks.
10. Pump suction diffusers.
11. Chemical feeder.
12. Diverting fittings.
13. Y-Pattern strainers.
14. T-Pattern strainers.
15. Basket strainers.

B. The following Division-23 sections apply to this section:

1. Mechanical General Provisions
2. Basic Mechanical Materials and Methods.
3. General Duty Valves.
4. Supports and Anchors.

C. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 23 Section "Basic Mechanical Materials and Methods" for materials and methods for sealing pipe penetrations through basement walls, and fire and smoke barriers.
2. Division 23 Section "General Duty Valves" for gate, globe, ball, butterfly, and check valves.
3. Division 23 Section "Meters and Gauges" for thermometers, flow meters, and pressure gages.
4. Division 23 Sections Mechanical Identification and Basic Mechanical Materials and Methods for labeling and identification of hydronic piping system.
5. Division 23 Section "Mechanical Insulation" for pipe insulation.
6. Division 23 Section "HVAC Pumps" for pumps, motors, and accessories for hydronic systems.
7. Division 23 Section "Building Automation System" for temperature control valves and sensors.
8. Division 23 Section "Testing, Adjusting, and Balancing" for procedures for hydronic systems adjusting and balancing.

1.2 DEFINITIONS

A. Pipe sizes used in this Specification are Nominal Pipe Size (NPS).

1.3 SYSTEM DESCRIPTION

A. General: The hydronic piping systems are the "water-side" of an air-and-water or all-water heating and air conditioning system. Hydronic piping systems specified in this Section include 4-pipe, hot water and chilled water piping system, and condenser water piping system. These systems are classified by ASHRAE as Low Water Temperature, Forced, Recirculating systems.

B. 4-Pipe System: The 4-pipe system includes independent chilled water and hot water supply and return piping mains in a closed loop, connecting the boilers and chillers to the terminal heat transfer units by means of primary/secondary piping loops. Circulation is accomplished by parallel, constant volume, primary pumps and independent secondary pumps. Design flow rates and water temperatures are specified in the various equipment specifications and schedules. Control sequences and temperature reset schedules are specified on the drawings.

1.4 SUBMITTALS

A. Product Data including rated capacities of selected models, weights (shipping, installed, and operating), furnished specialties and accessories, and installation instructions for each hydronic specialty and special duty valve specified.

1. Furnish flow and pressure drop curves for diverting fittings and calibrated plug valves, based on manufacturer's testing.

B. Maintenance Data for hydronic specialties and special duty valves, for inclusion in operating and maintenance manual specified in Division 1 and Division-23 Section "Mechanical General Provisions."

C. Welders certificates certifying that welders comply with the quality requirements specified in Quality Assurance below.

D. Certification of compliance with ASTM and ANSI manufacturing requirements for pipe, fittings, and specialties.

E. Reports specified in Part 3 of this Section.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the provisions of the following:

1. ASME B 31.9 "Building Services Piping" for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.
2. Fabricate and stamp air separators and compression tanks to comply with ASME Boiler and Pressure Vessel Code, Selection VIII, Division 1.
3. ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualification" for qualifications for welding processes and operators.
4. PPI TR-4 – Recommended Hydrostatic Strengths and Design Stresses for Thermoplastic Pipe and Fittings Compounds.

5. ASTM F 714 – Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.
6. ASTM D 3035 - Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.
7. ASTM D 3261 – Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
8. ASTM F 2389-07 - Standard Specification for Pressure-rated Polypropylene (PP) Piping Systems
9. CSA B137.11 - Polypropylene (PP-R) Pipe and Fittings for Pressure Applications
10. NSF/ANSI 14 – Plastic Piping System Components and Related Materials
11. Local, City, and State Codes.

1.6 SEQUENCING AND SCHEDULING

A. Coordinate the size and location of concrete equipment pads. Cast anchor bolt inserts into pad. Concrete, reinforcement, and formwork requirements are specified in Division 23 Section “Basic Mechanical Materials and Methods”.

B. Coordinate the installation of pipe sleeves for foundation wall penetrations.

1.7 SPECIAL WARRANTY

A. Manufacturer of propylene pipe and fittings shall warrant pipe and fittings for 10 years to be free of defects in materials or workmanship. Warranty shall cover labor and material costs of repairing and/or replacing defective materials and repairing any incidental damage caused by failure of the piping system due to defects in materials or workmanship.

1.8 EXTRA STOCK

A. Maintenance Stock: Furnish a sufficient quantity of chemical for initial system start-up and for preventative maintenance for one year from Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide hydronic piping system products from one of the following:

1. Calibrated Plug Valves:

   a. American Wheatley.
   b. Bell & Gossett ITT; Fluid Handling Div.
   c. Dezurik.
   d. Milliken Valve.
   e. Taco, Inc.

2. Pump Discharge Valves:

   a. Amtrol, Inc.

b. Armstrong Pumps, Inc.
c. Bell & Gossett ITT; Fluid Handling Div.
d. Taco, Inc.

3. Safety Relief Valves:

a. Amtrol, Inc.
b. Bell & Gossett ITT; Fluid Handling Div.
c. Spirax Sarco.
d. Watts Regulator Co.

4. Pressure Reducing Valves:

a. Amtrol, Inc.
b. Armstrong Pumps, Inc.
c. Bell & Gossett ITT; Fluid Handling Div.
d. Taco, Inc.

5. Balancing Valve System:

a. Flow Set by Flow Design, Inc.
b. Flo-Pac.
c. Macon.
d. Victaulic/TA Hydronic Series 700

6. Air Vents (manual and automatic):

a. Armstrong Machine Works.
b. Bell & Gossett ITT; Fluid Handling Div.
c. Hoffman Specialty ITT; Fluid Handling Div.
d. Spirax Sarco.
e. Taco, Inc.

7. Bladder-Type Compression Tanks:

a. Amtrol, Inc.
b. Armstrong Pumps, Inc.
c. Bell & Gossett ITT; Fluid Handling Div.
d. Wessels Company.

8. Pump Suction Diffusers:

a. Amtrol, Inc.
b. Armstrong Pumps, Inc.
c. Bell & Gossett ITT; Fluid Handling Div.
d. Flow Conditioning Corp.
e. Paco.
f. Taco, Inc.

9. Chemical Feeder:

a. Culligan USA.
b. Vulcan Laboratories, Subsidiary of Clow Corp.
c. York-Shipley, Inc.

10. Diverting Fittings:

    a. Amtrol, Inc.
    b. Armstrong Pumps, Inc.
    c. Bell & Gossett ITT; Fluid Handling Div.
    d. Taco, Inc.

2.2 PIPE AND TUBING MATERIALS

A. General: Refer to Part 3 Article "PIPE APPLICATIONS" for identification of where the below materials are used.

B. Annealed Temper Copper Tubing: ASTM B 88, Type K.

C. Drawn Temper Copper Tubing: ASTM B 88, Type L.

D. Steel Pipe: ASTM A 53, Schedule 40, welded, black steel pipe, made in USA.

2.3 FITTINGS

A. Cast-Iron Threaded Fittings: ANSI B16.4, Class 125, standard pattern, for threaded joints. Threads shall conform to ANSI B1.20.1.

B. Malleable-Iron Threaded Fittings: ANSI B16.3, Class 150, standard pattern, for threaded joints. Threads shall conform to ANSI B1.20.1.

C. Steel Fittings: ASTM A 234, seamless or welded, for welded joints.

D. Wrought-Copper Fittings: ANSI B16.22, streamlined pattern.

E. Cast-Iron Threaded Flanges: ANSI B16.1, Class 125; raised ground face, bolt holes spot faced.

F. Cast Bronze Flanges: ANSI B16.24, Class 150; raised ground face, bolt holes spot faced.

G. Steel Flanges and Flanged Fittings: ANSI B16.5, including bolts, nuts, and gaskets of the following material group, end connection and facing:

    1. Material Group: 1.1.
    2. End Connections: Butt Welding.
    3. Facings: Raised face.

H. Unions: ANSI B16.39 malleable-iron, Class 150, hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends. Threads shall conform to ANSI B1.20.1.

I. Dielectric Unions: Threaded or soldered end connections for the pipe materials in which installed; constructed to isolate dissimilar metals, prevent galvanic action, and prevent corrosion.

J. Flexible Connectors (Stainless Steel Type): stainless steel bellows with woven flexible bronze wire reinforcing protective jacket; minimum 150 psig working pressure, maximum 250°F

operating temperature. Connectors shall have flanged or threaded end connections to match equipment connected; and shall be capable of 3/4 inch misalignment.

2.4 JOINING MATERIALS

A. Solder Filler Metals: ASTM B 32, 95-5 Tin-Antimony, for chilled water, condenser water, heating hot water, low pressure steam, make-up water and drain piping.

B. Brazing Filler Metals: AWS A5.8, Classification BAg 1 (Silver).

1. WARNING: Some filler metals contain compounds which produce highly toxic fumes when heated. Avoid breathing fumes. Provide adequate ventilation.

C. Welding Materials: Comply, with Section II, Part C. ASME Boiler and Pressure Vessel Code for welding materials appropriate for the wall thickness and chemical analysis of the pipe being welded.

D. Gasket Material: Thickness, material, and type suitable for fluid to be handled, and design temperatures and pressures.

2.5 GENERAL DUTY VALVES

A. General duty valves (i.e., gate, globe, check, ball, and butterfly valves) are specified in Division-23 Section "General Duty Valves." Special duty valves are specified below by their generic name; refer to Part 3 Article "VALVE APPLICATION" for specific uses and applications for each valve specified.

2.6 SPECIAL DUTY VALVES

A. Calibrated Plug Valves: 125 psig water working pressure, 250°F maximum operating temperature, bronze or ductile iron body, plug valve with calibrated orifice. Provide with connections for portable differential pressure meter with integral check valves and seals. Valve shall have integral pointer and calibrated scale to register degree of valve opening. Valves 2 inches and smaller shall have threaded connections and valves 2-1/2 inches and larger shall have flanged connections.

B. Pump Discharge Valves: 175 psig working pressure, 300°F maximum operating temperature, cast-iron body, bronze disc and seat, stainless steel stem and spring, and "Teflon" packing. Valves shall have flanged connections and straight or angle pattern as indicated. Features shall include non-slam check valve with spring-loaded weighted disc, and calibrated adjustment feature to permit regulation of pump discharge flow and shutoff.

C. Pressure Reducing Valves: Diaphragm operated, cast-iron or brass body valve, with low inlet pressure check valve, inlet strainer removable without system shut-down, and noncorrosive 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.

D. Safety Relief Valves: 125 psig working pressure and 250°F maximum operating temperature; designed, manufactured, tested, and labeled in accordance with the requirements of Section IV of the ASME Boiler and Pressure Vessel Code. Valve body shall be cast-iron, with all wetted

internal working parts made of brass and rubber. Select valve to suit actual system pressure and Btu capacity.

E. Combined Pressure/Temperature Relief Valves: Diaphragm operated, cast-iron or brass body valve, with low inlet pressure check valve, inlet strainer removable without system shut-down, and noncorrosive 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. Safety relief valve designed, manufactured, tested, and labeled in accordance with the requirements of Section IV of the ASME Boiler and Pressure Vessel Code. Valve body shall be cast-iron, with all wetted internal working parts made of brass and rubber; 125 psig working pressure and 250°F maximum operating temperature. Select valve to suit actual system pressure and Btu capacity. Provide with fast fill feature for filling hydronic system.

F. Automatic Flow Control Valves: Class 150, cast iron housing, stainless steel operating parts; threaded connections for 2 inch and smaller, flanged connections for 2-1/2 inches and larger. Factory set to automatically control flow rates within plus or minus 5 percent design, while compensating for system operating pressure differential. Provide quick disconnect valves for flow measuring equipment. Provide a metal identification tag with chain for each valve, factory marked with the zone identification, valve model number, and rate flow in GPM.

G. Flow Measurement Venturi's:

1. 2-1/2" and Larger: The flow measuring venturi section shall be of steel construction with extended inlet and integrally designed with the butterfly valve section and sized for maximum pressure recovery and a flow accuracy of ±3% for direct flow measurement conditions. The valve accuracy is obtained with no provision for external clearances on the butterfly valves or the inlet through 14" size. The required clearances are contained entirely within the assembly. The flow section is furnished with two dual-core temperature/pressure taps with color coded removable retained safety cap assemblies. The unit shall also contains a 150# raised face flange connection on the inlet and outlet to allow for full service.

2.7 HYDRONIC SPECIALTIES

A. Manual Air Vent: Bronze body and nonferrous internal parts; 150 psig working pressure, 225°F operating temperature; manually operated with screwdriver or thumbscrew; and having 1/8 inch discharge connection and 1/2 inch inlet connection.

B. Automatic Air Vent; Designed to vent automatically with float principle; bronze body and nonferrous internal parts; 150 psig working pressure, 240°F operating temperature; and having 1/4 inch discharge connection and 1/2 inlet connection.

C. Bladder-Type Compression Tanks: Size and number as indicated; construct of welded carbon steel for 125 psig working pressure, 240°F maximum operating temperature. Separate air charge from system water to maintain design expansion capacity, by means of a heavy duty butyl replaceable bladder. Provide taps for pressure gage and air charging fitting (standard tire valve), and drain fitting. Support vertical tanks with steel legs or ring 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. (Note: Diaphragm type tanks will not be considered as a substitute for bladder type tanks.)

D. Pump Suction Diffusers: Cast-iron body, with threaded connections for 2 inches and smaller, flanged connections for 2-1/2 inches and larger; 175 psig working pressure, 230°F maximum operating temperature; and complete with the following features:

1. Inlet vanes with length 2-1/2 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.
6. Blowdown tapping in bottom; gage tapping in side.

E. Chemical Feeder: Bypass type chemical feeder of 5 gallon capacity, welded steel construction; 125 psig working pressure; complete with fill funnel and inlet, outlet, and drain valves.

1. Chemicals shall be specially formulated to prevent accumulation of scale and corrosion in piping system and connected equipment, developed based on a water analysis of make-up water.

F. Diverting Fittings: Cast iron body with threaded ends, or wrought copper with solder ends; 125 psig working pressure, 250°F maximum operating temperature. Indicate flow direction on fitting.

PART 3 - EXECUTION

3.1 PIPE APPLICATIONS

A. Install Type L, drawn copper tubing with wrought copper fittings and solder joints for 2 inch and smaller, above ground, within building. Install Type K, annealed temper copper tubing for 2 inch and smaller without joints, below ground or within slabs.

B. Install steel pipe with threaded joints and fittings for 2 inch and smaller, and with welded joints for 2-1/2 inch and larger.

3.2 PIPING INSTALLATIONS

A. 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.

B. Use fittings for all changes in direction and all branch connections.

C. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.

D. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.

E. Install piping tight to slabs, beams, joists, columns, walls, and other permanent elements of the building. Provide space to permit insulation applications, with 1" clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.

F. Locate groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

G. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4" ball valve, and short 3/4" threaded nipple and cap.

H. Exterior Wall Penetrations: Seal pipe penetrations through exterior walls using sleeves and mechanical sleeve seals. Pipe sleeves above grade shall be steel and pipe sleeves below grade shall be Schedule 80 PVC or reusable molded PE .

I. Fire Barrier Penetrations: Where pipes pass through fire rated walls, partitions, ceilings, and floors, maintain the fire rated integrity. Refer to Division 23 Section “Basic Mechanical Materials and Methods” for special sealers and materials.

J. Install piping at a uniform grade of 1 inch in 40 feet upward in the direction of flow.

K. Make reductions in pipe sizes using eccentric reducer fitting installed with the level side up.

L. Install 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.

M. Install unions in pipes 2 inches and smaller, adjacent to each valve, at final connections each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.

N. Install flanges on valves, apparatus, and equipment having 2-1/2 inches and larger connections.

O. Install flexible connectors at inlet and discharge connections to pumps (except inline pumps) and other vibration producing equipment.

P. Anchor piping to ensure proper direction of expansion and contraction. Expansion loops and joints are indicated on the Drawings and specified in Division-23 Section "Expansion Compensation."

Q. PIPING INSTALLATIONS

1. Install hangers and supports at intervals specified in the applicable Plumbing or Mechanical Code and as recommended by pipe manufacturer.
2. Support vertical piping at each floor and as specified in the applicable Plumbing or Mechanical Code.
3. Fire stopping shall be provided to both be compatible with the Aquatherm Piping and meet the requirements of ASTM E 814 or ULC S115 , “Fire Tests of Through-Penetration Firestops”. Pipe insulations or fire resistive coating shall be removed where the pipe passes through a fire stop and, if required by the firestop manufacturer, for 3 inches beyond the firestop outside of the fire barrier.
4. When installed in systems with pumps in excess of 7.5 HP, piping shall be protected from excessive heat generated by operating the pump at shut-off conditions. Where the possibility exists that the pump will operate with no flow, the protection method shall be a temperature relief valve or comparable level of protection, set to a maximum temperature of 185°F.

5. If heat tracing is specified for the piping, it should be installed on the pipe interior or exterior, and it must be suitable for use with plastic piping and self-regulating to ensure the surface temperature of the pipe and fittings will not exceed 158°F.

3.3 HANGERS AND SUPPORTS

A. General: Hanger, supports, and anchors devices are specified in Division 23 Section "SUPPORTS AND ANCHORS." Conform to the table below for maximum spacing of supports:

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet in length.
2. Adjustable roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
3. Pipe roller complete - MSS Type 44 for multiple horizontal runs, 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.

C. Install hangers with the following minimum rod sizes and maximum spacing:

Nom. Pipe Size	Max. Span-Ft.	Min. Rod Size-Inches
1	7	3/8
1-1/2	9	3/8
2	10	3/8
3	12	1/2
3-1/2	13	1/2
4	14	5/8
5	16	5/8
6	17	3/4
8	19	7/8
10	22	7/8
12	23	7/8

D. For HDPE piping, install with the following minimum rod sizes and maximum spacing:

Nom. Pipe Size	Max. Span-Ft.	Min. Rod Size-Inches
3	6.0	1/2
4	6.8	5/8
5	7.6	5/8
6	8.3	3/4
8	9.4	7/8

E. Support vertical runs at each floor.

3.4 PIPE JOINT CONSTRUCTION

A. Brazed Joints: Comply with the procedures contained in the AWS "Brazing Manual."

1. CAUTION: Remove stems, seats, and packing of valves and accessible internal parts at piping specialties before brazing.
2. Fill the pipe and fittings during brazing, with an inert gas (i.e., nitrogen or carbon dioxide) to prevent formation of scale.

3. Heat joints using oxy-acetylene torch. Heat to proper and uniform temperature.

B. Threaded Joints: Conform to ANSI B1.20.1, tapered pipe threads for field cut threads. Join pipe fittings and valves as follows:

1. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
2. Align threads at point of assembly.
3. Apply approximate tape or thread compound to the external pipe threads (except where dry seal threading is specified).
4. Assemble joint wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.

a. Damaged Threads: Do not use pipe with threads which are corroded or damaged. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.

C. Welded Joints: Comply with the requirement in ASME Code B31.9-"Building Services Piping."

D. Flanged Joints: Align flanges surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contract of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.

3.5 VALVE APPLICATIONS

A. Install balancing valve system on the outlet of each heating or cooling element and elsewhere as required to facilitate system balancing.

B. Install drain valves at low points in mains, risers, branch lines, and elsewhere as required for system drainage.

C. Install check valves on each pump discharge and elsewhere as required to control flow direction.

D. Install pump discharge valves with stem in upward position; allow clearance above stem for check mechanism removal.

E. Install safety relief valves on boilers, hot water generators, and elsewhere as required by ASME Boiler and Pressure Vessel Code.

1. Pipe discharge to floor without valves. Comply with ASME Boiler and Pressure Vessel Code Section VIII, Division 1 for installation requirements.

F. Install pressure reducing valves on make-up water to boilers, hot water generators, and elsewhere as required to regulate system pressure.

3.6 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in the system, at heat transfer coils, and elsewhere as required for system air venting. For unaccessible vent locations, the vent piping shall be piped to a location where vent will be accessible.

B. Install automatic air vents at air separators as required for system air venting. Vent piping shall be piped to a floor drain.

C. Install pump suction diffusers on pump suction inlet, adjust foot support to carry weight of suction piping. Install nipple and ball valve in blowdown connection.

D. Install pump discharge valves in horizontal or vertical position with stem in upward position. Allow clearance above stem for check mechanism removal.

E. Install shot-type chemical feeders in each hydronic system where indicated; in upright position with top of funnel not more than 48 inches above floor. Install feeder across pump using globe or ball valves on each side of feeder. Pipe drain, with ball valve, to nearest equipment drain.

F. Install bladder-type compression tanks on floor as indicated. Vent and purge air from hydronic system, charge tank with proper air charge to suit system design requirements. Connect compression tank off bottom of hydronic system main downstream of air separator. Run piping from hydronic system to compression tank with 1/4 inch per foot (2 percent) downward slope towards tank.

3.7 FIELD QUALITY CONTROL

A. Preparation for testing: Prepare hydronic piping in accordance with ASME B 31.9 and as follows:

1. Leave joints including welds uninsulated and exposed for examination during the test.
2. Provide temporary restraints for expansion joints which cannot sustain the reactions due to test pressure. If temporary restraints are not practical, isolate expansion joints from testing.
3. Flush system with clean water. Clean strainers.
4. Isolate equipment that is not to be subjected to the test pressure from the piping. If a valve is used to isolate the equipment, its closure shall be capable of sealing against the test pressure without damage to the valve. Flanged joints at which blinds are inserted to isolate equipment need not be tested.
5. Install relief valve set at a pressure no more than 1/3 higher than the test pressure, to protect against damage by expansion of liquid or other source of overpressure during the test.

B. Testing: Test hydronic piping as follows:

1. Use ambient temperature water as the testing medium, except where there is a risk of damage due to freezing. Another liquid may be used if it is safe for workmen and compatible with the piping system components.
2. Use vents installed at high points in the system to release trapped air while filling the system. Use drains installed at low points for complete removal of that liquid.
3. Examine system to see that equipment and parts that cannot withstand test pressures are properly isolated. Examine test equipment to ensure that it is tight and that low pressure filling lines are disconnected.
4. Subject piping system to a hydrostatic test pressure which at every point in the system is not less than 1.5 times the design pressure. The test pressure shall not exceed the maximum pressure for any vessel, pump, valve, or other component in the system under test. Make a check to verify that the stress due to pressure at the bottom of vertical runs does not exceed either 90 percent of specified minimum yield strength, or 1.7 times the "SE" value in Appendix A of ASME B31.9, Code For Pressure Piping, Building Services Piping.

5. After the hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components as appropriate, and repeat hydrostatic test until there are no leaks.

3.8 ADJUSTING AND CLEANING

A. Clean and flush entire 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.

B. Mark calibrated name plates of pump discharge valves after hydronic system balancing has been completed, to permanently indicate final balanced position.

C. Chemical Treatment: Provide 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.

3.9 COMMISSIONING

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 direction of rotation and correct improper 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 valves.
8. Check and set operating temperatures of boilers, chillers, and cooling towers to design requirements.
9. Lubricate motors and bearings.

END OF SECTION 23 21 13

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SECTION 23 21 23 – HYDRONIC PUMPS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Extent of HVAC pumps work required by this section is indicated on drawings and schedules, and by requirements of this section.

B. Types of pumps specified in this section include the following:

1. Base-Mounted, Separately-Coupled, End Suction.

1.2 RELATED SECTIONS

A. Refer to Section 23 00 00 for equipment certification requirements.

B. Refer to Division-26 sections for the following work:

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.

C. Provide the following electrical work as work of this section, complying with requirements of Division-26 sections:

1. Control and interlock wiring between operating controls, indicating devices, and temperature control panels.

D. Refer to the following:

1. Section 23 05 00 Basic Mechanical Materials and Methods Concrete For Mechanical Work for specifications on concrete and reinforcing materials and concrete placing requirements for equipment pads.
2. Division 23 Section "Electrical Provisions of Mechanical Work and Mechanical Provisions of Electrical Work" for electrical motors, connections, and accessories.
3. Division 23 Section "Meters and Gauges" for temperature and pressure gages and connectors.
4. Division 23 Section " Building Automation System" for interlock wiring between pumps, and between pumps and field-installed control devices.
5. Division 26 Section "General Electrical" for power supply wiring including field-installed disconnects and required electrical devices.
6. Division 23 Section “Variable Frequency Drives” for variable frequency drives.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract, Division 1 Specification Sections and Section 23 01 00.

B. Product data including certified performance curves of selected models indicating selected pump's operating point, weights (shipping, installed, and operating), furnished specialties, and accessories.

C. Shop drawings showing layout and connections for HVAC pumps. Include setting drawings with templates, and directions for installation of foundation bolts and other anchorages.

D. Wiring diagrams detailing wiring for power, signal, and control systems, differentiating between manufacturer-installed wiring and field-installed wiring.

E. Maintenance data for HVAC pumps for inclusion in Operating and Maintenance Manual specified in Division 1 and Section 23 00 00.

1.4 QUALITY ASSURANCE

A. Hydraulic Institute Compliance: Design, manufacture, and install HVAC pumps in accordance with "Hydraulic Institute Standards."

B. National Electrical Code Compliance: Provide components complying with NFPA 70 "National Electrical Code."

C. UL Compliance: Provide HVAC pumps which are listed and labeled by UL, and comply with UL Standard 778 "Motor Operated Water Pumps."

D. NEMA Compliance: Provide electric motors and components that are listed and labeled NEMA.

E. Single Source Responsibility: Obtain HVAC pumps from a single manufacturer.

F. Design Criteria: The Drawings indicate sizes, profiles, connections, and dimensional requirements of HVAC pumps, and are based on the specific manufacturer types and models indicated. Pumps having equal performance characteristics by other manufacturers may be considered, provided deviations in dimensions and profiles and efficiencies do not change the design concept or intended performance as judged by the Architect.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store pumps in a dry location.

B. Retain shipping flange protective covers and protective coatings during storage.

C. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

D. For storage times greater than 5 days, dry internal parts with hot air or a vacuum-producing device to avoid rusting internal parts. Upon drying, coat internal parts with a protective liquid, such as light oil, kerosene, or antifreeze. Dismantle bearings and couplings, dry and coat them with an acid-free heavy oil, and then tag and store in dry location.

E. Comply with Manufacturer's rigging instructions for handling.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the following:.

1. Base-Mounted, Separately-Coupled, End-Suction Pumps:

a. "Series 4030," Armstrong Pumps, Inc.
b. "360 Series," Aurora Pumps.
c. "Series 1510," Bell & Gossett, ITT.
d. Paco
e. "Uni-Pumps, Type GB, GLB, KB, KHB, AND KLB," Weinman, Mueller Pump.

2.2 PUMPS, GENERAL

A. Pumps and Circulators: Factory-assembled and factory-tested. Fabricate casings to allow removal and replacement of impellers without necessity of disconnecting piping. Type, sizes, and capacities shall be as indicated.

B. Preparation for Shipping: After assembly and testing, clean flanges and exposed machined metal surfaces and treat with an anti-corrosion compound. Protect flanges, pipe openings, and nozzles.

C. Motors: Conform to NEMA Standard MG-1, general purpose, continuous duty, Design B, except Design C where required for high starting torque; single, multiple, or variable speed with type of enclosure and electrical characteristics as indicated; have built-in thermal- overload protection, and grease-lubricated ball bearings. Select motors that are non-overloading within the full range of the pump performance curve.

D. Efficiency: Motors shall be premium efficiency type having a minimum efficiency as indicated in accordance with IEEE Standard 112, Test Method B. If efficiency is not specified, motor shall have a higher efficiency than the "average standard industry motors," in accordance with IEEE Standard 112, Test Method B.

1. Motor Frame: NEMA Standard 48 or 54; use pump manufacturer's standard.

E. Apply factory finish paint to assembled, tested units prior to shipping.

2.3 BASE-MOUNTED, SEPARATELY-COUPLED, END-SUCTION PUMPS

A. General Description: Pumps shall be base-mounted, centrifugal, separately-coupled, end-suction, single-stage, bronze-fitted, radially split case design, and rated for 175 psig working pressure and 225°F continuous water temperature.

B. Casings Construction: Cast iron, with flanged piping connections, and threaded gage tappings at inlet and outlet flange connections.

C. Impeller Construction: Statically and dynamically balanced, closed, overhung, single-suction, fabricated from cast bronze conforming to ASTM B 584, keyed to shaft and secured by a locking capscrew.

D. Wear Rings: Replaceable, bronze.

E. Pump Shaft and Sleeve Bearings: Steel shaft, with bronze sleeve.

F. Seals: Mechanical seals consisting of carbon steel rotating ring, stainless steel spring, ceramic seat, and flexible bellows and gasket.

G. Pump Couplings: Flexible, capable of absorbing torsional vibration and shaft misalignment; complete with metal coupling guard.

H. Mounting Frame: Factory-welded frame and cross members, fabricated of steel channels and angles conforming to ASTM B 36. Fabricate for mounting pump casing, coupler guard, and motor. Grind welds smooth prior to application of factory finish. Motor mounting holes for field-installed motors shall be field-drilled.

I. Motor: Secured to mounting frame with adjustable alignment on mounting frame. Select motors based on the following requirements:

1. The motor shall operate the driven pump under all conditions without exceeding the motor nameplate horsepower.
2. Provide a motor that is suitable for its connected power source. Coordinate the power source available with the electrical trade.
3. For motors 5 horsepower and larger, construct the motor frame and end brackets of cast iron.
4. Use either an open drip proof (ODP) or totally enclosed fan cooled (TEFC) enclosure.
5. Provide a premium efficiency design rated for continuous duty and a service factor of 1.15. The temperature rise shall not exceed 80°C with a 40°C ambient. The motor shall use at least a Class F insulation.
6. Select a nominal 1,150 or 1,800 RPM synchronous speed 4 pole design. Motors shall be premium efficiency type except that where motors are to be driven by an adjustable frequency drive, motors shall also be rated for invertor duty. Provide invertor duty motors with shaft grounding kits.
7. Factory lubricate the motor using a premium grease with rust inhibitors that are suitable for an operating range of minus 20 to 300°F. Provide the motor with grease fittings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment foundations, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of HVAC pumps.

B. Examine rough-in for piping systems to verify actual locations of piping connections prior to installation.

C. Examine equipment foundations and inertia bases for suitable conditions where pumps are to be installed.

D. Do not proceed until unsatisfactory conditions have been corrected.

3.2 EQUIPMENT BASES

A. Construct concrete equipment pads as follows:

1. Form concrete pads using framing lumber with form release compounds of size and location as indicated. Chamfer top edge and corners of pad. Anchor or key to floor slab.
2. Install reinforcing bars, tied to frame, and place anchor bolts and sleeves using manufacturer's installation template.
3. Place concrete and allow to cure before installation of pumps. Use Portland Cement conforming to ASTM C150, 4,000 psi compressive strength, and normal weight aggregate.
4. Clean exposed steel form and apply 2 coats of rust-preventative metal primer and 2 coats of exterior, gloss, alkyd enamel. Color shall be as selected by the Architect.

3.3 INSTALLATION

A. General: Comply with the manufacturer's written installation and alignment instructions.

B. Install pumps in locations and arranged to provide access for periodic maintenance, including removal of motors, impellers, couplings, and accessories.

C. Support pumps and piping separately so that the weight of the piping system does not rest on the pump.

D. Set base-mounted pumps on concrete foundation. Disconnect coupling halves before setting. Do not reconnect couplings until the alignment operations have been completed.

1. Support pump base plate on rectangular metal blocks and shims. or on metal wedges having a small taper, at points near the foundation bolts to provide a gap of 3/4 to 1-1/2 inches between the pump base and the foundation for grouting.
2. Adjust the metal supports or wedges until the shafts of the pump and driver are level. Check the coupling faces and suction and discharge flanges of the pump to verify that they are level and plumb.

3.4 ALIGNMENT

A. Align pump and motor shafts and piping connections after setting on foundations, after grout has been set and foundations bolts have been tightened, and after piping connections have been made.

1. Adjust alignment of pump and motor shafts for angular and parallel alignment by one of the two methods specified in the Hydraulic Institute "Centrifugal Pumps - Instructions for Installation, Operation and Maintenance."

B. After alignment is correct, tighten the foundation bolts evenly, but not too firmly. Fill the base plate completely with nonshrink, nonmetallic grout, with metal blocks and shims or wedges in place. After grout has cured, fully tighten foundation bolts.

1. Alignment tolerances shall meet manufacturers recommendations.

3.5 CONNECTIONS

A. General: Install valves that are same size as the piping connecting the pump.

B. Install suction and discharge pipe sizes equal to or greater than the diameter of the pump nozzles.

C. Install a globe style silent check valve, plug valve, and butterfly valve on the discharge side of base-mounted, end-suction pumps. Plug valves are not required on variable speed pumps.

D. Install a pump suction diffuser and butterfly valve on the suction side of base-mounted, end-suction pumps.

E. Install flexible connectors on the suction and discharge side of each base-mounted pump. Install flexible connectors between the pump casing and the discharge valves, and upstream from the pump suction diffuser.

F. Install a pressure gage with tee fitting between the suction and discharge of each pump with isolation ball valves on each side of the tee fitting. Connect pressure gage piping to the pump at the integral suction and discharge pressure gage tappings provided.

G. Install temperature and pressure gage connector plugs in suction and discharge piping around pump. Temperature and pressure gage connector plugs are specified in Division 23 Section "Meters and Gages."

H. Electrical wiring and connections are specified in Division 26 sections.

I. Control wiring and connections are specified in other Division 23 sections.

3.6 FIELD QUALITY CONTROL

A. Check suction line connections for tightness to avoid drawing air into the pump.

3.7 COMMISSIONING

A. Final Checks Before Start-Up: Perform the following preventative maintenance operations and checks before start-up:

1. Lubricate oil-lubricated bearings.
2. Remove grease-lubricated bearing covers and flush the bearings with kerosene and thoroughly clean. Fill with new lubricant in accordance with the manufacturer's recommendations.
3. Disconnect coupling and check motor for proper rotation. Rotation shall match direction of rotation marked on pump casing.
4. Check that pump is free to rotate by hand. For pumps handling hot liquids, pump shall be free to rotate with the pump hot and cold. If the pump is bound or even drags slightly, do not operate the pump until the cause of the trouble is determined and corrected.

B. Starting procedure for pumps with shutoff power not exceeding the safe motor power:

1. Prime the pump, opening the suction valve, closing the drains, and prepare the pump for operation.
2. Open the valve in the cooling water supply to the bearings, where applicable.
3. Open the cooling water supply valve if the stuffing boxes are water-cooled.
4. Open the sealing liquid supply valve if the pump is so fitted.

5. Open the warm-up valve of a pump handling hot liquids if the pump is not normally kept at operating temperature.
6. Open the recirculating line valve if the pump should not be operated against dead shutoff.
7. Start the motor.
8. Open the discharge valve slowly.
9. Observe the leakage from the stuffing boxes and adjust the sealing liquid valve for proper flow to ensure the lubrication of the packing. Do not tighten the gland immediately, but let the packing run in before reducing the leakage through the stuffing boxes.
10. Check the general mechanical operation of the pump and motor.
11. Close the recirculating line valve once there is sufficient flow through the pump to prevent overheating.

C. If the pump is to be started against a closed check valve with the discharge valve open, the steps are the same, except that the discharge valve is opened some time before the motor is started.

D. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for detailed requirements for testing, adjusting, and balancing hydronic systems.

END OF SECTION 23 21 23

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SECTION 23 25 00 – WATER TREATMENT SYSTEMS

PART 1 - GENERAL

1.1 WORK INCLUDED

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 to inhibit development of scale, corrosion, and biological growth in the following systems:

1. Chilled water systems.
2. Glycol Feeders.

B. Service Period: Provide chemicals and service program for period of one year from start-up date of condensing 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, (Minimum of 4 per year).
5. Customer report charts and log sheets.
6. Laboratory technical assistance.

C. Refer to Division-26 sections for the following work:

1. Power supply wiring from power source to power connection on water treatment equipment. Include starters, disconnects, and required electrical devices, except where specified as furnished, or factory-installed, by manufacturer.

D. Provide the following electrical work as work of this section, complying with requirements of Division-26 sections:

1. Control and interlock wiring between operating controls, indicating devices, and unit control panels.

1.2 QUALITY ASSURANCE

A. Supplier: Water treatment chemical and service supplier who has been active in field of industrial water treatment for not less than 5 years, and who has full-time service personnel located within trading area of job site.

B. Codes and Standards:

1. UL and NEMA Compliance: Provide electrical components required as part of water treatment equipment, which are UL-listed and labeled and comply with NEMA Standards.
2. NEC Compliance: Comply with National Electrical Code (NFPA 70) as applicable to installation, electrical connections, and ancillary electrical components of water treatment equipment.

3. Chemical Standards: Provide only chemical products which are acceptable under state and local pollution control regulations.

1.3 SUBMITTALS

A. Product Data: Include rated capacities; water-pressure drops; shipping, installed, and operating weights; and furnished products listed below:

1. Pumps.
2. Chemical solution tanks.
3. Agitators.
4. Control equipment and devices.
5. Test equipment.
6. Chemicals.
7. Chemical feeders.
8. Glycol Feeders.

B. Shop Drawings: Detail equipment assemblies indicating dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Detail power and control wiring and differentiate between manufacturer-installed and field-installed wiring.

C. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

D. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

E. Maintenance Data: For pumps, agitators, filters, system controls, and accessories to include in maintenance manuals specified in Division 1.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, products by one of the following:

1. Glycol Feeders:

a. Neptune Chemical Pump Co., Inc.
b. Pulsafeeder.

2. Glycol:

a. Dow Chemical Company.

2.2 PERFORMANCE OF EQUIPMENT

A. General: Provide system sized and equipped to treat raw water available at project site to maintain the following condenser water characteristics (tested values for condenser operation):

1. Hardness: 400-500.
2. Total Alkalinity: 200-300.
3. Conductivity or TDS: 1300-1500.
4. Sequestrant (Corrosion Scale Inhibitor): 15-20.
5. pH: 8.0-8.5.

2.3 CHEMICAL TREATMENT TEST EQUIPMENT

A. Existing to remain.

2.4 GLYCOL FEEDERS

A. General: Provide packaged system consisting of steel frame, tank with lid, pump, motor, pipe, fittings, valves, accessories, and controls.

B. Frame: The frame shall be constructed of steel angles, plates, and channel members, designed to support the tank, feed pump, piping, and controls. Frame shall be finished with a powdercoat epoxy paint finish.

C. Tank and Lid: The tank and lid shall be polyethylene construction with a capacity of 50 gallons.

D. Pump and Motor: The pump and motor shall be a direct driven rotary gear type. Pump shall be constructed of bronze.

E. Pipe and Fittings: Piping and fittings shall be constructed of schedule 80 PVC.

F. Suction Valves and Accessories:

1. Ball valve.
2. Cast Iron Y-Strainer.

G. Discharge Valves and Accessories:

1. Ball valve.
2. Check valve.
3. Pressure gauge.
4. Brass relief valve with return to tank tubing.

H. Control Devices: Provide with the following control devices factory wired to the control panel:

1. System pressure switch.
2. Tank low level float switch.

I. Controls Panel: Provide NEMA 4X control panel with a solid state controller. Control panel shall have the following features:

1. Hand-Off-Auto switch.
2. Pump “On” indicator light.
3. Low Tank Level indicator light.

4. Audible alarm indication.
5. Alarm silence pushbutton.
6. Dry contacts for BAS alarm monitoring as follows:

    a. Low pressure alarm.
    b. Low tank level alarm.

2.5 Glycol

A. Propylene Glycol: Propylene glycol shall be an industrial grade consisting of a mixture of 94% propylene glycol and a 6% specially designed industrial package of corrosion inhibitors. The corrosion inhibitor package shall be suitable for both steel and copper piping systems. Fluid shall have the following characteristics:

1. Operating Temperature Range: -50 to 325°F.
2. Color: Fluorescent yellow.
3. Specific Gravity: 1.053 to1.063
4. Solution pH: 9.0 to 10.7
5. Minimum Reserve Alkalinity: 16.0ml.
6. Chilled Water System Concentration: Provide 30% concentration by weight for freeze protection down to 10°F and burst protection down to -10°F.

PART 3 - EXECUTION

3.1 TRAINING OF OWNER'S PERSONNEL

A. Provide services of supplier's representative for one-half day to instruct Owner's personnel in operation, maintenance, and testing procedures of condenser water treatment system.

END OF SECTION 23 25 00

SECTION 23 64 23 - SCROLL WATER CHILLER

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. Packaged, air-cooled, electric-motor-driven, scroll water chillers.

1.3 DEFINITIONS

A. COP: Coefficient of performance. The ratio of the rate of heat removal to the rate of energy input using consistent units for any given set of rating conditions.

B. EER: Energy-efficiency ratio. The ratio of the cooling capacity given in terms of Btu/h to the total power input given in terms of watts at any given set of rating conditions.

C. IPLV: Integrated part-load value. A single number part-load efficiency figure of merit calculated per the method defined by ARI 550/590 and referenced to ARI standard rating conditions.

D. kW/Ton: The ratio of total power input of the chiller in kilowatts to the net refrigerating capacity in tons at any given set of rating conditions.

E. NPLV: Nonstandard part-load value. A single number part-load efficiency figure of merit calculated per the method defined by ARI 550/590 and intended for operating conditions other than the ARI standard rating conditions.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Scroll water chillers shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.5 SUBMITTALS

A. Product Data: Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.

1. Performance at ARI standard conditions and at conditions indicated.
2. Performance at ARI standard unloading conditions.
3. Minimum evaporator flow rate.
4. Refrigerant capacity of water chiller.
5. Oil capacity of water chiller.
6. Fluid capacity of evaporator.
7. Fluid capacity of condenser.
8. Characteristics of safety relief valves.
9. Minimum entering condenser-water temperature.
10. Performance at varying capacity with constant design condenser-water temperature. Repeat performance at varying capacity for different condenser-water temperatures from design to minimum in **5 deg F** increments.
11. Minimum entering condenser-air temperature
12. Performance at varying capacity with constant design entering condenser-air temperature. Repeat performance at varying capacity for different entering condenser-air temperatures from design to minimum in **10 deg F** increments.

B. Shop Drawings: Complete set of manufacturer's prints of water chiller assemblies, control panels, sections and elevations, and unit isolation. Include the following:

1. Assembled unit dimensions.
2. Weight and load distribution.
3. Required clearances for maintenance and operation.
4. Size and location of piping and wiring connections.
5. Wiring Diagrams: For power, signal, and control wiring.

C. Coordination Drawings: Floor plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Structural supports.
2. Piping roughing-in requirements.
3. Wiring roughing-in requirements, including spaces reserved for electrical equipment.
4. Access requirements, including working clearances for mechanical controls and electrical equipment, and tube pull and service clearances.

D. Certificates: For certification required in "Quality Assurance" Article.

E. Seismic Qualification Certificates: For water chillers, accessories, and components from manufacturers.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

F. Source quality-control test reports.

G. Startup service reports.

H. Operation and Maintenance Data: For each water chiller to include in emergency, operation, and maintenance manuals.

I. Warranty: Sample of special warranty.

1.6 QUALITY ASSURANCE

A. ARI Certification: Certify chiller according to ARI 590 certification program.

B. ARI Rating: Rate water chiller performance according to requirements in ARI 550/590, "Water Chilling Packages Using the Vapor Compression Cycle."

C. ASHRAE Compliance:

1. ASHRAE 15 for safety code for mechanical refrigeration.
2. ASHRAE Guideline 3 for refrigerant leaks, recovery, and handling and storage requirements.
3. ASHRAE/IESNA 90.1 for energy efficiency.

D. ASME Compliance: Fabricate and stamp water chiller heat exchangers to comply with ASME Boiler and Pressure Vessel Code.

E. Comply with NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Ship water chillers from the factory fully charged with refrigerant and filled with oil.

B. Package water chiller for export shipping.

1.8 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures.

C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of water chillers that fail in materials or workmanship within specified period.

1. Compressor Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PACKAGED AIR-COOLED WATER CHILLERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings a comparable product by one of the following:

1. Trane Company.

B. Description: Factory-assembled and run-tested water chiller complete with base and frame, condenser casing, compressors, compressor motors and motor controllers, evaporator, condenser coils, condenser fans and motors, electrical power, controls, and accessories.

C. Fabricate base, frame, and attachment to water chiller components strong enough to resist movement during a seismic event when water chiller base is anchored to field support structure.

D. Cabinet:

1. Base: Galvanized-steel base extending the perimeter of water chiller. Secure frame, compressors, and evaporator to base to provide a single-piece unit.
2. Frame: Rigid galvanized-steel frame secured to base and designed to support cabinet, condenser, control panel, and other chiller components not directly supported from base.
3. Casing: Galvanized steel.
4. Finish: Coat base, frame, and casing with a corrosion-resistant coating capable of withstanding a **500**-hour salt-spray test according to ASTM B 117.
5. Sound-reduction comprehensive package consisting of the following:

    a. Acoustic enclosure around compressors.
    b. Reduced-speed fans with acoustic treatment.
    c. Designed to reduce sound level without affecting performance.

E. Compressors:

1. Description: Suction gas-cooled scroll-type direct drive with hermetically sealed casing.
2. Each compressor provided with suction and discharge service valves, crankcase oil heater, and suction strainer.
3. Operating Speed: Nominal 3600 rpm for 60-Hz applications.
4. Capacity Control: On-off compressor cycling**.**.
5. Oil Lubrication System: Automatic pump with strainer, sight glass, filling connection, filter with magnetic plug, and initial oil charge.
6. Vibration Isolation: Mount individual compressors on vibration isolators.

F. Compressor Motors:

1. Hermetically sealed and cooled by refrigerant suction gas.
2. High-torque, two-pole induction type with inherent thermal-overload protection on each phase.

G. Compressor Motor Controllers:

1. Across the Line: NEMA ICS 2, Class A, full voltage, nonreversing.

H. Refrigeration:

1. Refrigerant: R-410a. Classified as Safety Group A1 according to ASHRAE 34.
2. Refrigerant Compatibility: Parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.
3. Refrigerant Circuit: Each circuit shall include a thermal-expansion valve, refrigerant charging connections, a hot-gas muffler, compressor suction and discharge shutoff

valves, a liquid-line shutoff valve, a replaceable-core filter-dryer, a sight glass with moisture indicator, a liquid-line solenoid valve, and an insulated suction line.

4. Refrigerant Isolation: Factory install positive shutoff isolation valves in the compressor discharge line and the refrigerant liquid-line to allow the isolation and storage of the refrigerant charge in the chiller condenser.

I. Evaporator:

1. Brazed-plate or shell-and-tube design, as indicated.
2. Shell and Tube:

   a. Description: Direct-expansion, shell-and-tube design with fluid flowing through the shell and refrigerant flowing through the tubes within the shell.
   b. Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code.
   c. Shell Material: Carbon steel.
   d. Shell Heads: Removable carbon-steel heads with multipass baffles designed to ensure positive oil return and located at each end of the tube bundle.
   e. Shell Nozzles: Fluid nozzles located along the side of the shell and terminated with mechanical-coupling end connections for connection to field piping.
   f. Tube Construction: Individually replaceable copper tubes with enhanced fin design, expanded into tube sheets.

3. Heater: Factory-installed and -wired electric heater with integral controls designed to protect the evaporator to minus 20 deg F.

J. Air-Cooled Condenser:

1. Plate-fin coil with integral subcooling on each circuit, rated at 450 psig.

   a. Construct coils of copper tubes mechanically bonded to aluminum with precoated epoxy-phenolic fins.
   b. Coat coils with a baked epoxy corrosion-resistant coating after fabrication.
   c. Hail Protection: Provide condenser coils with louvers, baffles, or hoods to protect against hail damage.

2. Fans: Direct-drive propeller type with statically and dynamically balanced fan blades, arranged for vertical air discharge.
3. Fan Motors: Totally enclosed nonventilating (TENV) or totally enclosed air over (TEAO) enclosure, with permanently lubricated bearings, and having built-in overcurrent- and thermal-overload protection.
4. Fan Guards: Steel safety guards with corrosion-resistant coating.

K. Electrical Power:

1. Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to water chiller.
2. House in a unit-mounted, NEMA 250, Type 3R enclosure with hinged access door with lock and key or padlock and key.
3. Wiring shall be numbered and color-coded to match wiring diagram.
4. Install factory wiring outside of an enclosure in a raceway.
5. Field power interface shall be to NEMA KS 1, heavy-duty, fused disconnect switch.
6. Provide branch power circuit to each motor and to controls with one of the following disconnecting means:

a. NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.
b. NEMA AB 1, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

7. Provide each motor with overcurrent protection.
8. Overload relay sized according to UL 1995, or an integral component of water chiller control microprocessor.
9. Phase-Failure and Undervoltage: Solid-state sensing with adjustable settings.
10. Provide power factor correction capacitors to correct power factor to **0.95** at full load.
11. Transformer: Unit-mounted transformer with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.

a. Power unit-mounted controls where indicated.
b. Power unit-mounted, ground fault interrupt (GFI) duplex receptacle.

12. Control Relays: Auxiliary and adjustable time-delay relays.
13. Indicate the following for water chiller electrical power supply:

a. Current, phase to phase, for all three phases.
b. Voltage, phase to phase and phase to neutral for all three phases.
c. Three-phase real power (kilowatts).
d. Three-phase reactive power (kilovolt amperes reactive).
e. Power factor.
f. Running log of total power versus time (kilowatt hours).
g. Fault log, with time and date of each.

L. Controls:

1. Stand-alone, microprocessor based.
2. Enclosure: Share enclosure with electrical power devices or provide a separate enclosure of matching construction.
3. Operator Interface: Keypad or pressure-sensitive touch screen. Multiple-character, backlit, liquid-crystal display or light-emitting diodes. Display the following:

a. Date and time.
b. Operating or alarm status.
c. Operating hours.
d. Outside-air temperature if required for chilled-water reset.
e. Temperature and pressure of operating set points.
f. Entering and leaving temperatures of chilled water.
g. Refrigerant pressures in evaporator and condenser.
h. Saturation temperature in evaporator and condenser.
i. No cooling load condition.
j. Elapsed time meter (compressor run status).
k. Pump status.
l. Antirecycling timer status.
m. Percent of maximum motor amperage.
n. Current-limit set point.
o. Number of compressor starts.

4. Control Functions:

a. Manual or automatic startup and shutdown time schedule.

b. Entering and leaving chilled-water temperatures, control set points, and motor load limit. Chilled-water leaving temperature shall be reset based on outside-air temperature.
c. Current limit and demand limit.
d. External water chiller emergency stop.
e. Antirecycling timer.
f. Automatic lead-lag switching.

5. Manual-Reset Safety Controls: The following conditions shall shut down water chiller and require manual reset:

a. Low evaporator pressure or high condenser pressure.
b. Low chilled-water temperature.
c. Refrigerant high pressure.
d. High or low oil pressure.
e. High oil temperature.
f. Loss of chilled-water flow.
g. Control device failure.

6. Building Management System Interface: Factory-installed hardware and software to enable building management system to monitor, control, and display water chiller status and alarms.

a. Hardwired Points:

1) Monitoring: On/off status, common trouble alarm, electrical power demand (kilowatts), electrical power consumption (kilowatt hours).
2) Control: On/off operation, chilled-water discharge temperature set-point adjustment, electrical power demand limit.

b. BACNet communication interface with building management system shall enable building management system operator to remotely control and monitor the water chiller from an operator workstation. Control features and monitoring points displayed locally at water chiller control panel shall be available through building management system.

M. Insulation:

1. Material: Closed-cell, flexible elastomeric, thermal insulation complying with ASTM C 534, Type I, for tubular materials and Type II, for sheet materials.
2. Thickness: 1-1/2 inches.
3. Factory-applied insulation over cold surfaces of water chiller components.

a. Adhesive: As recommended by insulation manufacturer and applied to 100 percent of insulation contact surface. Seal seams and joints.

4. Apply protective coating to exposed surfaces of insulation.

N. Accessories:

1. Factory-furnished, chilled-water flow switches for field installation.
2. Individual compressor suction and discharge pressure gages with shutoff valves for each refrigeration circuit.
3. Factory-furnished **neoprene or spring** isolators for field installation.

O. Capacities and Characteristics: Refer to drawings.

2.2 SOURCE QUALITY CONTROL

A. Perform functional test of water chillers before shipping.

B. Factory performance test water chillers, before shipping, according to ARI 550/590, "Water Chilling Packages Using the Vapor Compression Cycle."

1. Allow Owner and Engineer access to place where water chillers are being tested. Notify Engineer 14 days in advance of testing.

C. Factory test and inspect evaporator according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Stamp with ASME label.

D. Rate sound power level according to ARI 370 procedure.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Before water chiller installation, examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, and electrical connections to verify actual locations, sizes, and other conditions affecting water chiller performance, maintenance, and operations.

1. Water chiller locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

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

3.2 WATER CHILLER INSTALLATION

A. Install water chillers on support structure indicated.

B. Equipment Mounting: Install water chiller using elastomeric mounts. Comply with requirements for vibration isolation devices specified in Division 23 Section "Noise and Vibration Controls."

1. Minimum Deflection: 1/4 inch.

C. Maintain manufacturer's recommended clearances for service and maintenance.

D. Charge water chiller with refrigerant if not factory charged and fill with oil if not factory installed.

E. Install separate devices furnished by manufacturer and not factory installed.

3.3 CONNECTIONS

A. Comply with requirements in Division 23 Section "Hydronic Piping" Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to chiller to allow service and maintenance.

C. Evaporator Fluid Connections: Connect to evaporator inlet with shutoff valve, strainer, flexible connector, thermometer, and plugged tee with pressure gage. Connect to evaporator outlet with shutoff valve, balancing valve, flexible connector, flow switch, thermometer, plugged tee with pressure gage, and drain connection with valve. Make connections to water chiller with a flange.

3.4 STARTUP SERVICE

A. **Engage a factory-authorized service representative to perform** startup service.

B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.

C. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

1. Verify that refrigerant charge is sufficient and water chiller has been leak tested.
2. Verify that pumps are installed and functional.
3. Verify that thermometers and gages are installed.
4. Operate water chiller for run-in period.
5. Check bearing lubrication and oil levels.
6. Verify proper motor rotation.
7. Verify static deflection of vibration isolators, including deflection during water chiller startup and shutdown.
8. Verify and record performance of chilled-water flow and low-temperature interlocks.
9. Verify and record performance of water chiller protection devices.
10. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
11. Coordinate control point mapping with BAS contractor onsite.

D. Prepare a written startup report that records results of tests and inspections.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain water chillers.

END OF SECTION 23 64 23

SECTION 26 00 00 - ELECTRICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This Section applies to all Division 26 (electrical) work.

B. Related Documents: The general provisions of the Contract, including General and Supplementary Conditions and General Requirements applies to all Division 26 work.

1.2 COORDINATION BETWEEN SPECIFICATION SECTIONS

A. Each specification section within their respective division shall be coordinated with all other sections in that division for related work.

1.3 COORDINATION OF WORK

A. General:

1. Refer to the Division 1 sections for general coordination requirements applicable to the entire work. The contractor shall recognize that the contract documents are diagrammatic in showing certain physical relationships which must be established within the plumbing, mechanical and electrical work, and in its interface with other work including utilities and that such establishment is the exclusive responsibility of the Contractor. Because the drawings are diagrammatic and on a small scale, all rises, drops, offsets, etc., have not been shown. The Contractor shall agree to provide and install the necessary conduit and other specialties to suit such conditions without additional cost to the Owner.
2. Electric conduits shall not be hung on hangers with any other service, unless approved by the Engineer and shall be hung above all other service pipes. Exact location of electric outlets receptacles, switches, disconnects, and panels shall be coordinated to avoid interferences between lighting fixtures, piping, ducts, and similar items.
3. Locate operating and control equipment properly to provide easy access, and arrange entire mechanical and electrical work with adequate access for operation and maintenance.
4. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
5. Electrical contractor shall provide heavy duty disconnects and starters for all mechanical and plumbing equipment. Provide soft start starters for motors greater than 5-HP. Provide HOA switches on all starters.
6. Electrical contractor shall review all mechanical, plumbing, and other discipline drawings. Provide electrical as required for a complete and operational system.
7. Provide power to all fire/smoke dampers shown on mechanical drawings
8. Provide power to all HVAC dampers shown on mechanical drawings.
9. Provide duct smoke detectors and interlocks as required per code.
10. Provide shunt trip breakers and electrical interlocks as required by code for commercial kitchens and fire suppression systems.
11. Provide electrical circuits as required for building automation system.

12. Where equipment is being replaced, extend the electrical circuit as required. This may include additional junction boxes, conduit, and wire, and demolition as required.
13. DEFINITIONS
    a. (N) indicates "NEW" equipment to be provided under this contract.
    b. (E) indicates "EXISTING" equipment to remain or be relocated.
    c. (D) existing equipment for “DEMOLITION”.
    d. “DEMOLITION” means to remove the piece of equipment or item in its entirety. This shall include all appurtenances, conduit, cable, and accessories not required for new installation. Do not abandon anything unless noted otherwise. Patch and paint all surfaces where demolition required.
    e. "FURNISH" means to supply.
    f. "INSTALL" means to "set in place, connect and place in full operation".
    g. "PROVIDE" means to “FURNISH AND INSTALL".

B. Contract Document Discrepancies:

1. If work is required in manner to make it impossible to produce first class work, or should discrepancies appear among contract documents, request interpretation before proceeding with work. If Contractor fails to make such request, no excuse will thereafter be entertained for failure to carry out work in satisfactory manner. Should conflict occur in or between drawings, and specifications, Contractor is deemed to have estimated on more expensive way of doing work unless he shall have asked for and obtained written decision before submission of proposal as to method or materials required.

1.4 FEES, PERMITS, LICENSES, UTILITY CONNECTION CHARGES, AND UTILITY COST.

A. The Contractor shall obtain and pay for all fees, permits, licenses, utility connection charges and utility cost for services to the building required.

B. The Contractor shall maintain all necessary signal lights, guard against danger and use all proper means for the safety of the public.

C. The Contractor shall pay for opening and repairing all pavement cuts.

D. The Contractor shall furnish to the Architect copies of all fees, permits and licenses required for all mechanical work herein specified before any mechanical work is started.

1.5 CONTRACTORS RESPONSIBILITY FOR CONSULTANTS ADDITIONAL SERVICES

A. The Consultant is entitled to compensation for additional services not included in their contract but provided on this project. Since our contract is with the Owner or Architect, the Owner or Architect has the responsibility to compensate us for these additional services. The Consultant will provide, without advance authorization from the Client, the Additional Services listed below. These services will be tracked in our office and billed to the Client upon completion of the project. The client will in turn deduct the sum of these additional services from the contractors final payment. The following is a list of services that have been included in our contract with the client along with a description of services that will be charged against the contractors final payment due to services brought about due to the contractors actions:

1. Re-submittals: The consultant has included in their contract with our Client, one (1) review for each submittal item. The contractor is required to carefully review each submittal from their suppliers and subcontractors for compliance with the contract

documents along with a written notice of deviations of any type prior to submitting them to the Engineer for review. The Contractor shall be responsible to the Client for all reasonable costs charged by the Consultant to the Client for the Additional Services required for re-submittals.

2. Substitutions: The Consultant has included in their contract with our Client, incorporation of minor changes to the contract documents to develop record documents in electronic format. These changes are limited to unforeseen site conditions and clarifications to the contract documents. Review of substitutions for compliance with the contract documents, and services required to modify and coordinate changes required due to contractor substitutions or deviations from the contract documents are not included in our contract with the Client. The Contractor shall be responsible to the Client for all reasonable costs charged by the Consultant to the Client for the Additional Services required to modify and coordinate documents or provide field coordination due to contractor substitutions or deviations from the contract documents.
3. Requests For clarification or Interpretation (RFI): The Contractor may, after exercising due diligence to locate required information, request from the Consultant clarification or interpretation of the requirements of the Contract Documents. The Consultant shall, with reasonable promptness, respond to such Contractor's request for clarification or interpretation. However, if the information requested by the Contractor is apparent from field observations, is contained in the Contract Documents or is reasonably inferable from them, the Contractor shall be responsible to the Client for all reasonable costs charged by the Consultant to the Client for the Additional Services required to provide such information.
4. Construction Meetings & Site Observations: The consultant has included a predetermined number of construction meetings and site observations in their contract with the owner based on the anticipated construction period specified. However if additional construction meetings and site observations are required due to the contractors delay in completion of the project, the Contractor shall be responsible to the Client for all reasonable costs charged by the Consultant to the Client for the Additional Services required to attend additional construction meetings or provide additional site observations.
5. Re-inspections: The contractor is responsible to prepare a final punch list for the project and to correct all items prior to calling for a final inspection from the consultant. Upon being notified, the consultant will then visit the site and prepare a final punch list. The contractor is then required to correct all items on the consultants final punch list and call for a re-inspection of the project. If all items have not been corrected, the final punch list will be updated and additional re-inspections will be required. However if additional re-inspections are required, the Contractor shall be responsible to the Client for all reasonable costs charged by the Consultant to the Client for the Additional Services required for the additional re-inspections.

1.6 SINGULAR NUMBER

A. Where any device or part of equipment is herein referred to in the singular number (such as "the pump"), such reference shall be deemed to apply to as many such devices as are required to complete the installation as shown on the drawings.

1.7 CLEANING AND PROTECTION

A. General: During handling and installation of work at project site, each contractor shall clean and protect work in progress and adjoining work on a basis of perpetual maintenance. Apply suitable protective covering on newly installed work where reasonably required to ensure freedom from damage or deterioration at time of substantial completion; otherwise, clean and

perform maintenance on newly installed work as frequently as necessary through remainder of construction period. Adjust and lubricate operable components to ensure operability without damaging effects.

1.8 MAINTENANCE AND OPERATION MANUALS

A. Prepare and submit four (4) copies of maintenance and operation instructions for all Division 23 and Division 26 equipment furnished. Organize maintenance and operating manual information into suitable sets of manageable size, and bind into individual binders properly identified and indexed (thumb-tabbed). Include emergency instructions, spare parts listing, copies of warranties, wiring diagrams, recommended "turn-around" cycles, inspection procedures, shop drawings, product data, and similar application information. Bind each manual of each set in a heavy-duty 2", 3-ring vinyl-covered binder, and include pocket folders for folded sheet information. Mark identification on both front and spine of each binder.

1.9 PROJECT CLOSE OUT

A. General: Refer to the Division 1 sections for general closeout requirements. Maintain a daily log of operational data on mechanical equipment and systems through the closeout period; record hours of operation, assigned personnel, fuel consumption and similar information; submit copy to Owner.

B. Record Drawings: For Division 26 and Division 23 work, give special attention to the complete and accurate recording of underground conduit, piping and ductwork, other concealed and non-accessible work, branching arrangement and valve location for piping systems, locations of dampers and coils in duct systems, locations of control system sensors and other control devices, and work of change orders where not shown accurately by contract documents.

C. Closeout Equipment/Systems Operations: Sequence operations properly so that work of project will not be damaged or endangered. Coordinate with seasonal requirements. Operate each item of equipment and each system in a test run of appropriate duration with the Owner's operating personnel present, to demonstrate sustained, satisfactory performance. Adjust and correct operations as required for proper performance. Clean and lubricate each system, and replace dirty filters, excessively worn parts and similar expendable items of the work.

D. Operating Instructions: Conduct a full-day walk-through instruction seminar for the Owner's personnel to be involved in the continued operation and maintenance of mechanical equipment and systems. Explain the identification system, operational diagrams, emergency and alarm provisions, sequencing requirements, seasonal provisions, security, safety, efficiency and similar features of the systems.

E. Turn-Over of Operation: At the time of substantial completion, turn over the prime responsibility for operation of the mechanical equipment and systems to the Owner's operating personnel.

1.10 FINAL COMPLETION

A. The following special requirements shall be provided in addition to these specifications elsewhere in these specifications:

1. The Division 26 Contractors shall not call for a final completion check until the entire Mechanical and Electrical Equipment and Systems have been installed, adjusted,

balanced and in full and complete satisfactory operation and the following certifications of inspection from equipment suppliers have been completed and submitted to the Architect/Engineer.

B. The Certifications shall consist of letters signed by Factory Trained and Authorized Service Engineers stating the following:

1. They have inspected all of their equipment on the project.
2. They approve the condition of the equipment and its installation.
3. They have fully checked its operation and certify that it is operating properly.
4. They will note any problems, conditions or objections that could lead to future operating problems.

C. Exceptions may be permitted upon written request from the Contractor listing any minor items that are uncompleted and beyond his reasonable control. The full guarantee that they will be completed at a named later date and the guarantee extended as required to provide a full warranty.

1.11 FINAL PAYMENT

A. Final Payment will not be made until the Contractor has satisfactorily completed all final inspection items.

1.12 GUARANTEE

A. The one-year guarantee period shall not start until the project is fully completed and the Contractor has received the Final Payment and Certification of Completion.

B. All equipment and all work shall be fully guaranteed, parts, and labor, for one full year from the date of the Certificate of Completion. Repairs made during this period must be fully guaranteed for an additional one year period from the date of repairs.

C. The Division 23 Contractor has the full responsibility to guarantee all equipment and work and shall assume full responsibility to repair any equipment at his cost that the manufacturer refuses to guarantee.

D. The Owner has the right to order repairs to any equipment or work provided hereon and to charge the Contractor for same if repairs are not made by the Contractor within a reasonable period of time not to exceed 24 hours during an emergency or 72 hours on a non-critical item.

E. Where equipment is furnished by the owner and installed by the contractor, the contractors responsibilities shall remain as indicated above except that the owner will assist in enforcing the stipulated manufacturer's warranty.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 26 00 00

SECTION 26 00 10 - GENERAL ELECTRICAL

PART 1 - GENERAL.

1.1 RESPONSIBILITIES

A. The Bidding Requirements, Conditions of Contract, General Specifications and General Requirements, and this specification shall be binding on the Contractor and shall apply to all electrical work to be completed under Division 26 and 28.

B. The Contractor shall be responsible for the work from the date of this contract until its acceptance by the Owner, and must repair all damages sustained from whatever cause. The contractor shall use proper care and diligence in bracing and securing all parts of the work and shall in all cases judge as to the amount of protection required.

1.2 ORDINANCES, LAWS AND CODES

A. All work shall conform to the rules and regulations of the National Electrical Code, Local Codes, Occupational Safety and Health Act and the Local Fire Marshall's Office. All certificates of approval shall be delivered to the Architect before final payment will be made.

B. Should any change in the drawings and/or specifications be required to conform to the above mentioned laws and ordinances, the Architect shall be notified by the Bidder prior to the bid date, so that the necessary changes may be completed. After the bid date, all work necessary to meet the requirements shall be at the Contractor's expense with no additional cost to the Owner.

C. The Contractor shall pay for all fees, permits, taxes, inspections, connections, etc., associated with the electrical work under this contract. Any costs, charges, or connection fees which are required to obtain permanent and temporary electrical service to the project facility will be paid by the Contractor as part of this contract.

1.3 DATA AND MEASUREMENT

A. The data given herein and on the drawings is as exact as could be secured insofar as building construction and existing conditions are concerned. Extreme accuracy is not guaranteed. The drawings and specifications are intended for the assistance of the Contractor in achieving the end result. Exact locations, measurements, distance, levels, etc., will be governed by conditions at the job site.

B. The Contractor shall verify that the size of the equipment supplied by the selected manufacturers does not exceed the available mounting space.

C. The Engineer reserves the right to change location or size of conduits, outlets, fixtures or other pieces of equipment as may be necessary to avoid conflicts. No extra compensation will be allowed for such changes unless additional cost to the Contractor is caused.

D. It is strongly recommended that the bidders visit the project site so that they may have knowledge of conditions at the job site and adapt their bids and work to such conditions.

1.4 DRAWINGS AND SPECIFICATIONS

A. Anything mentioned in this specification and not shown on the drawings, or vice versa, shall be of like effect, as shown or mentioned in both. In any case of discrepancy or differences in the figures, drawings or specifications, the Bidder shall promptly report such discrepancies to the Architect who shall make a decision in writing. Any adjustment by the Contractor without this decision shall be at the expense of the Contractor.

1.5 QUALITY OF WORKMANSHIP

A. The Contractor shall give his personal superintendence and direction to the work. He shall also keep a competent foreman or superintendent on the project at all times.

B. All equipment, controls and junction boxes shall be located for ready access, operation, repair and maintenance.

C. Any additional drawings necessary for the prosecution of the work will be furnished by the Architect as promptly as possible. The Contractor shall request any additional instructions needed and shall do no work without drawings and instructions.

D. Any discrepancies between the mechanical, electrical, structural and architectural drawings shall be reported to the Architect prior to the Bid Date.

1.6 GUARANTEE

A. The Contractor shall guarantee all materials, workmanship and the successful operation of all apparatus furnished and installed by him for a period of one year from the date of the final acceptance of the whole work, and shall guarantee to repair or replace at his own expense any part of the apparatus which may show defect during that time, provided such defect is, in the opinion of the Architect, due to imperfect material or workmanship and not to carelessness or improper operation. Guarantee period for the replacement shall begin with the date of replacement.

B. The Owner shall notify the Contractor of any failure of any part or parts which occur during the guarantee period.

C. The Contractor shall also guarantee the systems and the apparatus to be working properly to meet all conditions as specified.

1.7 SHOP DRAWINGS

A. Shop drawings, catalog sheets and manufacturer's data shall be submitted in accordance with the requirements of Paragraph "Shop Drawings" of the General Conditions. On or before thirty days after award of contract; the Contractor shall submit six copies of all fabricated work and equipment to be purchased. Data shall be sufficiently completed to permit evaluation and comparison with specified equipment and material. Refer to the table at the end of this section for a summary of the requirements. The table is not project specific and may indicate submittals that are not required for this project. Refer to the individual specification sections for the required submittals.

B. All drawings shall bear the Contractor's stamp of approval and must be dated.

C. Shop drawings and/or catalog and data sheets shall include, but not be limited to the following:

1. Panelboards, Switchboard, Motor Control Centers, Disconnect Devices, Transformers
2. Fire Alarm System Components
3. Boxes and Devices
4. Fuses
5. Wiring Devices (switches, receptacles, etc.)
6. Device Wall Plates

D. A notation shall be made on each item submitted as to its specified use or description of specific location in the work.

E. None of the preceding items shall be purchased, delivered to the site or installed until the item has been properly submitted in writing and reviewed by the Engineer.

F. Submittals shall be made even though the item is exactly as specified.

G. Should the Contractor fail to comply with any of the requirements as stated, the Architect reserves the right to select a full line of materials, appliances, and equipment which shall be final and binding upon the Contractor.

1.8 SUBMITTAL DATA

A. Review of submittal data is only for general conformance with the design concept of the project and general compliance with the information given in the contract documents. Any action shown is subject to the requirements of the plans and specifications. Contractor is responsible for: dimensions that shall be confirmed and correlated at the job site, fabrication processes and techniques of construction, coordination of his work with that of all other trades and the satisfactory performance of his work.

B. Contractor will be limited to one review on a singular piece of equipment.

C. The listing of a manufacturer as "acceptable" does not imply automatic compliance with contract documents. It is the sole responsibility of the Contractor to insure that any price quotations received and submittals made are for equipment/systems which meet or exceed the specifications included herein.

1.9 EQUAL MANUFACTURERS/EQUIPMENT

A. Any approval requests for manufacturer/equipment to be considered as equal other than as specified herein and on the drawings shall be submitted to the Engineer not less than 10 days prior to bid date.

B. Requests for review shall be sufficiently complete to permit evaluation and comparison with specified equipment and material.

C. Requests for substitutions shall be accompanied by a written comparison between the specified item and the substituted item. Request submittals shall be accompanied by complete technical data, including laboratory reports, if applicable on the proposed product. Each item proposed for substitution shall be clearly identified. Explain fully the differences, if any, between the proposed product and the products named in the Specifications. Failure to provide the above information may result in the rejection of the submittal.

D. Only one request for substitution for each product will be considered. If the substitution is not accepted, provide specified product.

E. If at any time during the project it is determined that a product has been misrepresented as an equal to a specified product. The contractor shall be required to replace the product at their expense. This stipulation applies even if the engineer has provided his/her stamp of approval.

1.10 RE-SUBMITTAL AND ALTERNATE PRODUCT

A. Submittals: The Contractor is urged to carefully review each submittal from their suppliers and sub-subcontractors for compliance to minimize re-submittal review charges. The Engineer has included in their contract with the Owner, one (1) review for each submittal item. Therefore, the Contractor shall agree to pay the Engineer to review any and all re-submittals for this project. Re-submittal reviews will be billed at a rate of $75.00/hour and shall be paid before final payment to the Contractor for this project.

B. As-Built Drawings: The Engineer has included in their contract with the Owner, preparation of as-built drawings based on changes required due to conflicts with the bid documents only. Therefore, the contractor shall agree to pay the Engineer to make revisions required due to equipment substitution, or field changes requested or initiated by the Contractor. Whether or not the requirement for compensation is enforced is left to the discretion of the Engineer.

1.11 SCHEDULE OF VALUES

A. Schedule of values shall be submitted within 30 days after award of contract or as specified in Division 1 or General Conditions of contract.

B. The schedule of values shall be broken down by individual specification section and shall delineate materials and labor. Specific cost breakdown information provided to the engineer will be held in confidence.

PART 2 - PRODUCTS

2.1 PROTECTION OF FIXTURES AND WARES

A. The Contractor shall apply the necessary protective coverage to fixtures and other equipment to prevent scratches and mars to such equipment.

2.2 STORAGE

A. The Contractor shall provide and be responsible for safe storage of his materials and such storage shall not interfere with the work of others or progress of the project in any manner.

2.3 EQUIPMENT ENCLOSURES

A. Provide enclosures that mate properly with the equipment to be enclosed and are NEMA rated to suit the atmospheric conditions of the equipment surroundings.

B. Equipment in a corrosive atmosphere shall be rated NEMA 4X. All NEMA 4X equipment shall be fabricated from suitable non-metallic material or shall be stainless steel. Painted steel is not acceptable for NEMA 4X applications.

2.4 PAINTING (Refer to painting specification for appropriate preparation and materials)

A. All exposed conduit, boxes, mounting hardware, etc. in rooms to be painted shall be painted to match the surrounding surface. Exposed conduit, boxes, mounting hardware, etc. installed in rooms that are not painted may be left un-painted. Unless otherwise noted, prior approval must be obtained before mounting exposed conduit, boxes, etc.

B. All exposed conduit, boxes, covers, enclosures, etc. on the exterior of the building must be painted to match the surrounding surfaces. Unless otherwise noted, prior approval must be obtained before mounting exposed conduit, boxes, etc.

C. Exterior pad mounted transformers, generators, etc. shall be painted to blend into the building and/or landscape as directed by the Engineer/Architect.

PART 3 - EXECUTION

3.1 COORDINATION

A. Before installing any work, the Contractor shall coordinate the electrical work with all other contractors on the project, with the owner's representative, with the electric utility company and the City Code enforcing department.

B. All electrical work shall be installed in proper sequence and so arranged with other trades that there will be no delay in the proper installation and completion of any part or parts of all piping systems and mechanical equipment.

C. The Contractor shall carefully examine the drawings and shall be responsible for the proper fitting of equipment and conduit as indicated without major alteration. If alterations are required, a detailed drawing of the proposed departure due to actual field conditions or other causes shall be submitted to the Architect for approval.

D. Whenever interferences might occur, before installing any of the work in question, the Electrical Contractor shall consult with other contractors and shall come to an agreement with them as to the exact location and level of his conduit, light fixtures, and/or parts of his installation.

E. Where recessed electrical devices (speakers, fixtures, etc.) are installed in fire-rated ceilings, the Contractor shall provide an enclosure (approved by authorities having jurisdiction) to surround each device as required to maintain the fire integrity rating of the ceiling. Adequate clearance between device and enclosure shall be provided in accordance with device manufacturer's recommendations. Verify clearance requirements with device manufacturer prior to installation of fixture.

F. When low voltage cabling is required to penetrate through a fire rated partition and the cabling is not installed in a sealed metallic conveyance, provide an approved fire rated "Thru-Wall Fitting" such as the Wiremold Flame Stopper Series unit.

G. All changes in the work of the Contractor, caused by their neglect to follow these instructions, shall be made at this Contractor's expense.

3.2 DITCHING, EXCAVATION, AND BACKFILLING

A. Contractor shall do all excavation required to install conduits and equipment shown on drawings or required for proper operation. Excess excavation below the required level shall be backfilled with earth and thoroughly tamped.

3.3 EQUIPMENT CONNECTIONS

A. Coordinate and provide the hook up of the following equipment with the Contractor required to furnish and install them. See the appropriate sections in the General Construction Work specifications for further information.

1. Mechanical Equipment
2. Cabinetry Equipment
3. Owner Furnished Equipment

B. Verify fuse or circuit breaker requirements for electrical connections to equipment and provide overcurrent devices accordingly.

3.4 WORK IN EXISTING BUILDING

A. Inasmuch as work under this contract includes adding to the existing building, it shall be the responsibility of each bidder to fully inform themselves of any and all conditions which influence or are influenced by work contemplated by these specifications and accompanying drawings. The submission of a proposal by any bidder will be construed as an admission by them that they have examined and are fully familiar with the premises and all conditions thereon and adjacent thereto, and has included in this proposal a proper and adequate amount to cover rearrangement of old work for the proper installation and operation of the new and existing equipment as shown on the drawings specified herein, or as required. Such work shall be neatly and properly done.

B. Maintain existing electrical service and feeders to occupied areas and operational facilities, unless otherwise indicated, or when authorized otherwise in writing by Owner, or Architect. Provide temporary service during interruptions to existing facilities. When necessary, schedule momentary outages for equipment replacement and the system cut-overs. When the "cutting-over" has been successfully accomplished, remove, relocate, or abandon existing wiring as indicated.

C. The operation of all special systems within the building shall be maintained, including but not limited to; fire alarm, telephone, intercom, data communications, security, emergency call, etc. Provide temporary connections and/or equipment as required to maintain operations during construction. Anticipated momentary outages in any system must be scheduled with the owner before starting work.

3.5 DEMOLITION AND REMOVAL OF EXISTING EQUIPMENT AND MATERIALS

A. Existing conduits may, at the Contractor's option, be removed, or reused.

B. Conduits may not be abandoned in place in unfinished and accessible areas. Conduits may be abandoned in place when concealed in walls, floors and/or above hard ceilings.

C. All conduits to be reused shall be thoroughly tested and checked for continuity.

D. Electrical items must be removed where they interfere with or are not concealed by new construction such as new ceilings, walls, etc.

E. Existing fixtures, outlets, receptacles and other equipment and material shall be relocated, removed, reconnected or left in place as indicated on the drawings. Where an existing device is shown removed from an existing circuit, new wiring shall be provided as required to insure continuity of existing circuit. If existing devices or other electrical items, such as electrically operated equipment interfere with the location of a new partition, relocation of existing equipment, new equipment, etc., the existing items including electrical components of electrically operated equipment shall be disconnected and removed or satisfactorily relocated and reconnected even though not specifically indicated on the drawings. All material removed which is considered salvageable by the Owner and is not specifically designated to be reused on the drawings or not practical to be reused shall remain in the property of the Owner and shall be neatly stockpiled in a specially designated location.

3.6 TEMPORARY WIRING (Existing Electrical Service)

A. The Contractor shall provide temporary power.

B. Temporary power may be derived from the existing electrical service.

C. All materials for the temporary service and wiring may be used and remain the property of the electrical contractor.

D. Temporary wiring materials are not to be installed as part of the permanent wiring system.

E. Wiring need not be installed in conduit, but must be adequately installed and protected from mechanical injury to prevent shock.

F. Permanent wiring including feeders, panels, receptacles, etc., may be used as soon as installed.

G. The Contractor shall bear all installation costs necessary to connect and disconnect the temporary service.

3.7 CLEANING

A. The Contractor shall at all times keep the premises free of waste, surplus materials, rubbish, and debris which are caused by the electrical crew or resulting from their work.

B. After all equipment and fixtures have been installed and building is ready for occupancy, the Electrical Contractor shall remove all stickers, rust stains, labels, temporary covers, plaster marks, paint spots, etc. on new electrical equipment. All foreign matter shall be blown out or flushed out of all conduits, panels, motors, devices, switches, fixtures, etc.

C. Identification plates and trims on all equipment shall be free of paint and polished.

D. The Contractor shall leave the electrical portion of the work in a safe, clean and very neat condition ready for operation.

3.8 RECORD DRAWINGS

A. The Contractor shall maintain an up-to-date set of plans and specifications on the job site. He shall annotate all field changes, addendums, change orders, etc. on this set. Once the job is complete, the contractor shall supply this set of drawings, updated in AutoCAD (minimum Version 2015) to the Engineer for review.

B. The drawings shall also include as-built conditions such as equipment and device locations, routing of service entrance and major feeders, branch circuit changes, final panelboard schedules, etc.

3.9 INSTRUCTION IN OPERATION BOOKS AND SPARE PARTS

A. After all tests and adjustments have been made, the Contractor shall furnish the necessary qualified personnel to place the special systems in continuous operation, during which time they shall provide complete operating and maintenance instructions to the Owner's representative with an outline of instructions in written form. These personnel shall reserve adequate time to instruct an Owner's representative on proper operation (including all phases of the system and each of its component parts).

B. Contractor shall furnish Owner with three sets of all operating instructions, maintenance instruction and spare parts lists of all equipment furnished under this contract. Lists shall include current unit prices and sources of supply for each item of operable equipment.

3.10 TESTS AND ADJUSTMENTS

A. Upon completion of installation of electrical connections, and after circuitry has been energized with rated power source, test connections to demonstrate capability and compliance with requirements. Ensure that direction of rotation of each motor fulfills requirement. Correct malfunctioning units at site, then retest to demonstrate compliance.

B. During the progress and after completion of the work included under this specification, the Contractor shall make all required tests at his own expense in the presence of the Architect as required hereinafter and by local ordinances, codes, laws, and regulations. Such tests shall be in accordance with other sections of this division. The Owner’s representative shall be notified five days in advance as to the time when such tests are to be performed that a representative of the Architect may be present.

3.11 DISPOSAL OF HAZARDOUS ELECTRICAL MATERIALS - (BALLASTS AND LAMPS)

A. The Contractor shall be responsible for the removal, storage and disposal of all electrical related hazardous material from the work site in an EPA approved manner.

B. All hazardous material shall be stored in a safe and secure area pending disposal. All PCB ballasts shall be stored in metal 55 gallon drums with a bolt on lid securing ring, or in other locked metal containers. The enclosure shall be properly labeled per EPA guidelines while awaiting shipment to a disposal facility.

C. Fluorescent lamps containing mercury or other hazardous materials shall be sent to an EPA approved Recycling Center. Disposal of lamps at a standard landfill shall not be permitted.

D. PCB ballasts shall only be disposed of by incineration at an EPA registered PCB incineration facility. Disposal of ballasts at a standard landfill shall not be permitted.

E. The contractor shall keep accurate records of all such hazardous materials and provide the engineer with properly completed Certificates of Disposal, issued by the receiving disposal facility. Certificates of disposal issued by a third party other than the final disposal facility itself will not be acceptable. Final project payment may be withheld pending the engineer's receipt of properly completed Certificates of Disposal.

3.12 HOUSEKEEPING PADS

A. The Electrical Contractor is responsible for providing concrete housekeeping pads for all floor-mounted electrical equipment (i.e. transformers, switchboards, etc.). Concrete shall be in accordance with the concrete specification included as part of this project or as called out on the drawings. Pads shall be 4" high (above finished floor or grade as appropriate) and shall extend 3" beyond the equipment edge at the front, rear and sides. The corners of the pad shall have a 3/4" chamfered edge. Pads shall be provided whether or not they are shown on the drawings.

ELECTRICAL SUBMITTAL REQUIREMENTS

		SUBMITTAL TYPE						
SECTION	ITEM	PD	SD	OM	CA	WC	TR	O
26 00 10	Contactors and Time Clocks	X						
26 00 10	Low Voltage Switching System	X						
26 00 10	Panelboards, Switchboards, MCC, Disconnect Devices, Transformers	X						
26 00 10	Boxes and Devices	X						
26 00 10	Fuses	X						
26 00 10	Wireway, Cable Tray, Surface Mounted Raceway	X						
26 00 10	Product Substitutions *	X	X					
26 00 10	Schedule of Values							X
26 00 10	Record Drawings		X					
26 00 10	Operations and Maintenance Manuals			X				
26 05 26	Inspection Wells	X						

Abbreviations:
PD: Product Data
SD: Shop Drawings
OM: Operation & Maintenance Manuals
CA: Calculations
WC: Welding Certificates
TR: Test Reports
O: Other
*: Required Prior to Bid Opening

END OF SECTION 26 00 10

SECTION 26 01 00 – ELECTRICAL SUBMITTALS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 GENERAL

A. Shop drawing Submittals shall comply with the requirements of Division 1, Section 01300, and with the requirements of this Section. Shop Drawing Submittals shall include specially-prepared technical data for this project, including drawings, diagrams, performance curves, data sheets, schedules, templates, patterns, reports, calculations, instructions, measurements and similar information not in standard printed form for general application to a range of similar projects. Performance curves shall show the full operating range of the proposed equipment

B. Shop Drawing Submittals shall also include product data which includes standard printed information on materials, products and systems; not specially-prepared for this project, but with the designation of selections from among available choices for this project clearly identified.

1.3 SUBMITTAL REQUIREMENTS

A. Coordination and Sequencing: Coordinate preparation and processing of submittals with performance of the work so that work will not be delayed by submittals. Coordinate and sequence different categories of submittals for same work, and for interfacing units of work, so that one will not be delayed for coordination of Architect/Engineer's review with another.

B. Preparation of Submittals: Provide permanent marking on each submittal to identify project, date, contractor, subcontractor, submittal name and similar information to distinguish it from other submittals. Show Contractor's executed review and approval marking and provide space for Architect's/Engineer's "Action" marking. Package each submittal appropriately for transmittal and handling. Submittals which are received from sources other than through Contractor's office will be returned by Architect/Engineer "without action".

C. Provide Contractor's certification on form, ready for execution, stating that information submitted complies with requirements of contract documents. Failure to fully review submittals for compliance with contract documents may result in rejection by the Architect/Engineer requiring re-submittal by the contractor. Contractor shall pay the Architect/Engineer for review of all re-submittals in accordance with Section 15000 “Mechanical General Provisions”.

1.4 SUBMITTAL LIST

A. Shop drawings shall be submitted for, but not limited to, the items listed in each section of the specifications. Submittals, in addition to those listed, may be required by the Architect/Engineer. The following is a summary list of submittals required for the project.

SECTION	ITEM	DATE RECEIVED BY A/E	TRANSMITTAL NO.	DATE RETURNED
	Record Drawings			
	Maintenance & Operations Manuals			

END OF SECTION 23 01 00

SECTION 26 05 19 - LOW VOLTAGE POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Extent of electrical wire and cable work is indicated by drawings and schedules.

B. Types of electrical wire, cable, and connectors specified in this section include the following:

1. Copper conductors.
2. Tap type connectors.
3. Compression type connectors.
4. Wire nut connectors.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements of this specification.

2.2 WIRES AND CABLES

A. General: All references to size in these specifications or on drawings is for copper conductors (THHN/THWN). Provide electrical wires, cables, and connectors of manufacturer's standard materials, as indicated by published product information; designed and constructed as recommended by manufacturer, for a complete installation, and for application indicated. Except as otherwise indicated, provide copper conductors with conductivity of not less than 98% at 20^{o}C (68^{o}F).

B. Aluminum conductors may not be provided in lieu of copper conductors.

C. Building Wires: Provide factory-fabricated wires of sizes, ampacity ratings, and materials for applications and services indicated. Where not indicated, provide proper wire selection as determined by Installer to comply with project's installation requirements, NEC, and NEMA standards.

D. Cables: Provide UL-type factory-fabricated cables of sizes, ampacity ratings, materials and jacketing/sheathing as indicated for services indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements, NEC and NEMA standards.

2.3 CONNECTORS

A. General: Provide UL-type factory-fabricated, metal connectors of sizes, ampacity ratings, materials, types, and classes for applications and for services indicated. Where not indicated, provide proper selection as determined by Installer to comply with project's installation requirements, NEC, and NEMA standards.

B. Compression type connectors: Compression connections shall be the type requiring hydraulic compression tools operating at a minimum pressure of 7000psi with an output pressure of no less than 10 tons.

PART 3 - EXECUTION

3.1 INSTALLATION OF WIRES AND CABLES

A. General: Install electrical cables, wires, and wiring connectors as indicated, in compliance with applicable requirements of NEC, NEMA, UL, and NECA's "Standard of Installation", and in accordance with recognized industry practices.

B. Unless specifically indicated otherwise, all low voltage cabling shall be installed in conduit. When indicated the low voltage cabling may be routed exposed above accessible ceilings. Prior approval is required prior to installing any exposed low voltage cabling.

C. The minimum size shall be 12 AWG. All wire No. 10 and smaller to be solid, all No. 8 and larger shall be stranded.

D. All service entrance, feeder, and branch circuit wiring shall be type THHN/THWN.

E. Pull conductors simultaneously where more than one is being installed in the same raceway.

F. Use pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Use of soap will not be permitted as pulling lubricant.

G. Insulation on conductors shall be permanently marked with wire size, insulation type, voltage range, and manufacturer's name. The insulation on conductors shall be color coded as follows:

1. 120/208 volt circuit: Phase A - Black; Phase B - Red; Phase C - Blue; Neutral - White; Ground - Green.
2. 277/480 volt circuit: Phase A - Brown; Phase B - Orange; Phase C - Yellow; Neutral - White w/stripe (not green); Ground - Green w/stripe.

H. The phase conductors shall be tagged and shall remain the same throughout the circuit.

I. Switch legs shall be color coded to distinguish them from the un-switched Phase Conductors.

J. Switch legs occurring in the same box or enclosure shall be color coded separately.

K. Exceptions to the color coding as listed above shall be as follows:

1. Wiring for special systems shall be color coded or labeled as required by the manufacturer.

L. Use pulling means including fish tape, cable, rope and basket weave wire/cable grips that will not damage cables or raceway.

M. Install exposed cable, parallel and perpendicular to surfaces, or exposed structural members, and follow surface contours, where possible. Prior approval is required for all exposed cabling.

N. Keep conductor splices to a minimum.

O. Install splices and taps that possess equivalent-or-better mechanical strength and insulation ratings than conductors being spliced.

P. Use splice and tap connectors that are compatible with conductor material.

Q. All splices and taps shall be made in outlet, junction, and pull boxes. Splices on circuit wiring shall be of the pigtail type using solderless connectors. Larger sizes of conductors requiring un-insulated connectors of the bolt type shall be taped with pressure sensitive vinyl tape.

R. For branch circuit wiring, conductor fill per conduit run shall not contain more than eight current carrying wires. Conduits containing both circuit switch legs and/or traveler wires may contain more than the number stated above, providing the conduit is of adequate size and the wire size is de-rated as required by the National Electrical Code. Whenever a 120V, single-phase branch circuit is over 70 feet in length, or a 277V, single-phase branch circuit is over 150 feet, and the load is in excess of 50 percent of the branch circuit protective device, the conductors shall be increased one size to the first outlet box unless specifically noted otherwise. For special systems, conductor fill of conduit is per manufacturer's specifications furnished with each system, noted on the drawings or shall be as required by code.

S. Tighten electrical connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Std. 486A and B.

T. On occasion, the Contractor might have to route branch circuits in a non-direct path to the equipment/device to avoid unforeseen obstacles. The contractor shall evaluate and upgrade these branch circuits (either low voltage or 600V) as needed to minimize voltage drop. The maximum allowable voltage drop for branch circuits is 3% and a total of 5% for both feeders and branch circuits combined.

U. Multi-wire branch circuits as defined by the National Electrical code (circuits with common neutral) shall not be used. Exception: Where an equipment manufacturer requires a multi-wire branch circuit for only one piece of utilization equipment and where all ungrounded conductors of that circuit are opened simultaneously by the branch circuit over-current device.

3.2 FIELD QUALITY CONTROL

A. Prior to energization of circuitry, check installed wires and cables with megaohm meter to determine insulation resistance levels to ensure requirements are fulfilled.

B. Prior to energization, test wires and cables for electrical continuity and for short-circuits.

C. Subsequent to wire and cable hook-ups, energize circuitry and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

3.3 ABANDONED WIRING

A. All existing wiring and cabling left unused as a result of this project shall be removed and disposed of. In the case of cabling, all associated fastening systems such as wire staples, tie-wraps, electrical tape, etc. shall also be removed. All wiring/conductors in unused conveyances shall be removed. The conveyances may or may not require removal. Refer to the drawings and other specification sections for direction regarding unused conveyances.

B. On rare occasions, where noted specifically on the drawings wiring may be abandoned in place. However, the wire/cable must be tagged or otherwise identified at all of its termination and junction points as "Abandoned in Place". The individual conductors must be insulated from contact with other conductors and/or electrical equipment/devices.

END OF SECTION 26 05 19

SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Extent of grounding work is indicated by drawings, schedules and as specified herein.

B. Types of grounding specified in this section include the following:

1. Solid grounding

C. Requirements of this section apply to electrical grounding work specified elsewhere in these specifications.

PART 2 - PRODUCTS

2.1 GROUNDING SYSTEMS

A. Materials and Components:

1. General: Except as otherwise indicated, provide electrical grounding systems indicated; with assembly of materials, including, but not limited to, cables/wires, connectors, crimp type lugs, compression type lugs, grounding rods/electrodes, bonding jumper braids and additional accessories needed for complete installation. Where more than one type of unit meets indicated requirements, selection is Installer's option. Where materials or components are not indicated, provide products complying with NEC, UL, IEEE, and established industry standards for applications indicated.

B. Conductors: Provide copper electrical grounding conductors for grounding connections matching power supply wiring materials and sized according to NEC. All conduits shall contain a minimum of one separate equipment grounding conductor identified and sized according to NEC. Where Isolated Grounds (IG) are indicated on the plans provide a second ground conductor (green with yellow stripe) for each phase conductor shown. Terminate all Isolated Ground conductors on the appropriate Isolated Ground Bus.

C. Bonding Jumper Braids: Copper braided tape, constructed of 30-gage bare copper wires and properly sized for indicated applications.

D. Connectors, Terminals and Clamps: Provide electrical connectors, terminals, lugs and clamps as recommended by connector, terminal and clamp manufacturers for indicated applications.

E. Ground Rods:

1. Standard Ground Rods: Steel with copper welded exterior, 3/4" dia. x 10' (Unless otherwise noted).
2. Chemically Enhanced Ground Rods: A self-contained, electrolytically enhanced grounding rod shall be provided on the drawings where indicated. The rod shall be made of 2" dia. hollow copper tube with a wall thickness of not less than .079". The tube shall be permanently capped at the top and bottom and shall have breather holes for electrolyte drainage into the surrounding soil. The rod shall be a minimum of 10 feet long

and shall have a #4/0 bare copper conductor exothermically welded to the side for connection to the system. The rod shall be U.L. Listed for a minimum of 5 years and shall be 100% self-activated/sealed and maintenance free. Each chemical rod shall be equipped with an inspection well and enhanced backfill material such as Bentonite.

F. EUFER Ground:

1. Concrete Encased Electrode, located within and near the bottom of the foundation, encased with a minimum of 2" of concrete.
   a. Where foundation re-enforcing bars are available for use (20' or more of ½" diameter rebar), provide bare copper conductor (size as shown on the drawings) for the connection to the equipment. Connection of the copper conductor to the rebar shall be by exothermic weld or approved compression type fitting listed for the purpose. Provide ½" or ¾" PVC conduit sleeve as applicable for conductor transition out of the concrete. All re-enforcing bars along the 20' length shall be tied together via wire ties.
   b. Where foundation re-enforcing bars are not available for use, provide 20' of #4/0 bare copper laid in the bottom of the foundation (encased by a minimum of 2" of concrete). Extend the #4/0 conductor up through the foundation for connection to equipment. Provide ¾" PVC conduit sleeve as applicable for conductor transition out of the concrete.

G. Inspection Wells:

1. Standard Well: The standard inspection well shall be constructed of poly plastic material and shall be rated for indoor and outdoor use. The assembly shall be able to withstand light traffic and the cover shall be bolted in place. The cover shall be vented and labeled as grounding. The assembly shall be mounted flush with the finished grade/material. The assembly shall be at least 10" deep and 9" wide.
2. Traffic Rated Well: The traffic rated inspection well shall be constructed of concrete material and shall be rated for outdoor use. The assembly shall be able to withstand light vehicle traffic and the cover shall be bolted in place. The cover shall be constructed of steel, vented and labeled as grounding. The assembly shall be mounted flush with the finished grade/material. The assembly shall be at least 10" deep and 9" wide.

H. Ground Bar: Free-standing ground bars shall be constructed of solid copper 1/4" thick. The bars shall be 4" wide, 20" long and shall have threaded holes for cable connections. The ground bar shall be equipped with steel mounting brackets and dielectric insulators that isolate the mounting system from the grounding bar.

I. Electrical Grounding Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing, welding materials, bonding straps, as recommended by accessories manufacturers for type of services indicated.

J. Exothermic Welded Connections: Comply with AWS Code for procedures, appearance, and quality of welds; and methods used in correcting welding work. Provide welded connections where grounding conductors connect to underground rods, electrodes, cables and equipment.

PART 3 - EXECUTION

3.1 INSPECTION

A. Installer must examine areas and conditions under which electrical grounding connections are to be made and notify Contractor in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to owner's representative.

3.2 INSTALLATION OF ELECTRICAL GROUNDING

A. General: Install electrical grounding systems where shown, in accordance with applicable portions of NEC, with NECA's "Standard of Installation", and in accordance with recognized industry practices to ensure that products comply with requirements and serve intended functions.

B. The equipment grounding conductor shall be connected directly to the equipment grounding screw provided on receptacles.

C. At switch outlets, where self-grounding type switches are installed in metal boxes, the equipment grounding conductor shall be connected directly to the metal box.

D. Where switches installed in non-metallic boxes have metallic cover plates or screws, provide switches with green hexagonal equipment ground screw and connect to the equipment grounding conductor.

E. Coordinate with other electrical work as necessary to interface installation of electrical grounding system with other work.

F. Weld grounding conductors to underground grounding rods/electrodes. (Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable).

G. Install bonding jumpers with ground clamps on water meter piping to electrically bypass water meters.

H. Install clamp-on connectors only on thoroughly cleaned metal contact surfaces to ensure electrical conductivity and circuit integrity.

I. Install all ground rods (standard or chemical) in an enhanced backfill material such as Bentonite. Provide a minimum of 4" around the entire rod.

J. Rods installed in electrical rooms and communication rooms shall be provided with inspection wells.

K. The secondary of all interior transformers shall be bonded to a proven ground source.

3.3 FIELD QUALITY CONTROL

A. Upon completion of installation of electrical grounding systems, test ground resistance with ground resistance tester. Where tests show resistance to ground is over 10 ohms, take appropriate action to reduce resistance to 10 ohms, or less. If necessary drive additional ground rods or provide chemically enhance rods, then connect them together with #4/0 bare copper grounding wire. Retest to demonstrate compliance. Coordinate any rework required

with the engineer prior to beginning work.

END OF SECTION 26 05 26

SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 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. Refer to other Division 26 sections for additional specific support requirements that may be applicable to specific items.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements of this specification.

2.2 COATINGS

A. Coatings: 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.

2.3 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: Lead, carbon steel wedge or sleeve type. Plastic expansion anchors (for conduit 1" and smaller only).
2. Toggle Bolts: All steel springhead type.
3. Power-Driven Threaded Studs: Heat-treated steel, designed specifically for the intended service.

C. Conduit Sealing Bushings: Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit, or tubing passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.

D. 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.

E. U-Channel Systems: 16-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 the U-channel and are of the same manufacture.

2.4 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.

C. Pipe Sleeves: Provide pipe sleeves of one of the following:

1. Sheet Metal: Fabricate from galvanized sheet metal: round tube closed with snap lock joint, welded spiral seams, or welded longitudinal joint. Fabricate sleeves from the following gage metal for sleeve diameter noted:

a. 3 inch and smaller: 20-gage.
b. 4 inch to 6-inch: 16-gage.
c. Over 6 inch: 14-gage.

2. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe.
3. Plastic Pipe: Fabricate from Schedule 80 PVC plastic pipe.

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 installations.

C. 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) raceways 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. Support parallel runs of horizontal raceways together on trapeze-type hangers.
5. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 1-inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings only. For hanger rods with spring

steel fasteners, use 1/4-inch diameter or larger threaded steel. Use spring steel fasteners that are specifically designed for supporting single conduits or tubing.

6. Support exposed and concealed raceway within 1 foot of an unsupported box and access fittings. In horizontal runs, support at the box and access fittings may be omitted where box or access fittings are independently supported and raceway terminals are not made with chase nipples or thread-less box connectors.
7. In vertical runs, arrange supports so that loads 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.

D. Vertical Conductor Supports: Install simultaneously with installation of conductors.

E. Miscellaneous Supports: Support miscellaneous electrical components 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.

F. Support sheet metal boxes directly from the building structure or by bar hangers.

G. Sleeves: Install in concrete slabs and walls and all other fire rated floors and walls for raceways and cable installations. For sleeves through fire rated-wall or floor construction, apply UL-listed fire stopping sealant in gaps between sleeves and enclosed conduits and cables.

H. Conduit Seals: Install seals for conduit penetrations of slabs on grade and exterior walls below grade and where indicated. Tighten sleeve seal screws until sealing grommets have expanded to form watertight seals.

I. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including but not limited to conduits, raceways, cables, cable trays, busways, cabinets, panelboards, transformers, boxes, 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. 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 depths of more than 1-1/2 inches in reinforced concrete beams or to depths 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.

END OF SECTION 26 05 29

SECTION 26 05 33 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

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. Metal conduits, tubing, and fittings.
2. Nonmetal conduits, tubing, and fittings.
3. Metal wireways and auxiliary gutters.
4. Nonmetal wireways and auxiliary gutters.
5. Surface raceways.
6. Boxes, enclosures, and cabinets.
7. Handholes and boxes for exterior underground cabling.

1.3 DEFINITIONS

A. ARC: Aluminum rigid conduit.

B. GRC: Galvanized rigid steel conduit.

C. IMC: Intermediate metal conduit.

1.4 ACTION SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

C. Samples: For surface raceways and for each color and texture specified, 12 inches long.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
1. Structural members in paths of conduit groups with common supports.
2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

B. Qualification Data: For professional engineer.

C. Seismic Qualification Certificates: For enclosures, cabinets, and conduit racks and their mounting provisions, including those for internal components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
   4. Detailed description of conduit support devices and interconnections on which the certification is based and their installation requirements.

D. Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

A. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. GRC: Comply with ANSI C80.1 and UL 6.

C. ARC: Comply with ANSI C80.5 and UL 6A.

D. IMC: Comply with ANSI C80.6 and UL 1242.

E. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
   1. Comply with NEMA RN 1.
   2. Coating Thickness: 0.040 inch, minimum.

F. EMT: Comply with ANSI C80.3 and UL 797.

G. FMC: Comply with UL 1; zinc-coated steel or aluminum.

H. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

I. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
   1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
   2. Fittings for EMT:
      a. Material: Steel.
      b. Type: Setscrew or compression.
   3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
   4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

J. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

A. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ENT: Comply with NEMA TC 13 and UL 1653.

C. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

D. LFNC: Comply with UL 1660.

E. Rigid HDPE: Comply with UL 651A.

F. Continuous HDPE: Comply with UL 651B.

G. Coilable HDPE: Preassembled with conductors or cables, and complying with ASTM D 3485.

H. RTRC: Comply with UL 1684A and NEMA TC 14.

I. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

J. Fittings for LFNC: Comply with UL 514B.

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 3R unless otherwise indicated, and sized according to NFPA 70.
   1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

C. Wireway Covers: Hinged type unless otherwise indicated.

D. Finish: Manufacturer's standard enamel finish.

2.4 SURFACE RACEWAYS

A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect.

C. Surface Nonmetallic Raceways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC with texture and color selected by Architect from manufacturer's

standard colors. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.

D. Tele-Power Poles:
1. Material: Galvanized steel with ivory baked-enamel finish.
2. Fittings and Accessories: Dividers, end caps, covers, cutouts, wiring harnesses, devices, mounting materials, and other fittings shall match and mate with tele-power pole as required for complete system.

2.5 BOXES, ENCLOSURES, AND CABINETS

A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

D. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

E. Metal Floor Boxes:
1. Material: Cast metal or sheet metal.
2. Type: Fully adjustable.
3. Shape: Rectangular.
4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Nonmetallic Floor Boxes: Nonadjustable,.
1. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.

H. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb.
1. Listing and Labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

I. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

J. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.

K. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

L. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.

M. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 3R with continuous-hinge cover with flush latch unless otherwise indicated.
   1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
   2. Nonmetallic Enclosures: Plastic.
   3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

N. Cabinets:
   1. NEMA 250, Type 3R galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
   2. Hinged door in front cover with flush latch and concealed hinge.
   3. Key latch to match panelboards.
   4. Metal barriers to separate wiring of different systems and voltage.
   5. Accessory feet where required for freestanding equipment.
   6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.6 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
   1. Tests of materials shall be performed by an independent testing agency.
   2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
   3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012 and traceable to NIST standards.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
   1. Exposed Conduit: GRC.
   2. Concealed Conduit, Aboveground: EMT.
   3. Underground Conduit: RNC or as required code or utility company
   4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC .
   5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:
   1. Exposed, Not Subject to Physical Damage: EMT.
   2. Exposed, Not Subject to Severe Physical Damage: EMT.
   3. Exposed and Subject to Severe Physical Damage: GRC. Raceway locations include the following:
      a. Loading dock.
      b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
      c. Mechanical rooms.
      d. Gymnasiums.
   4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
   5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.

6. Damp or Wet Locations: IMC.
7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

C. Minimum Raceway Size: 3/4-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. EMT: Use setscrew or compression, steel fittings. Comply with NEMA FB 2.10.
4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

F. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

G. Install surface raceways only where indicated on Drawings.

H. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.2 INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for hangers and supports.

E. Arrange stub-ups so curved portions of bends are not visible above finished slab.

F. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.

G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

H. Support conduit within 12 inches of enclosures to which attached.

I. Raceways Embedded in Slabs:

1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-footintervals.
2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
3. Arrange raceways to keep a minimum of 2 inches of concrete cover in all directions.
4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
5. Change from ENT to RNC, Type EPC-40-PVC, GRC or IMC before rising above floor.

J. Stub-ups to Above Recessed Ceilings:
1. Use EMT, IMC, or RMC for raceways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

L. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

M. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

N. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

O. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

P. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

Q. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

R. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

S. Surface Raceways:
1. Install surface raceway with a minimum 2-inch radius control at bend points.
2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

T. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

U. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
   1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
   2. Where an underground service raceway enters a building or structure.
   3. Where otherwise required by NFPA 70.

V. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

W. Expansion-Joint Fittings:
   1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
   2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
      a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
      b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
      c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
      d. Attics: 135 deg F temperature change.
   3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
   4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
   5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

X. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
   1. Use LFMC in damp or wet locations subject to severe physical damage.
   2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

Y. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements.

Z. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

AA. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

BB. Locate boxes so that cover or plate will not span different building finishes.

CC. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

DD. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

EE. Set metal floor boxes level and flush with finished floor surface.

FF. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 05 44 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.4 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

3.5 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.
   1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 26 05 33

SECTION 26 05 34 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. The extent of wiring device work is indicated by drawings and schedules. Types of electrical wiring devices in this section include the following:

1. Receptacles
2. Ground-fault circuit interrupters
3. Switches
4. Wall plates
5. Dimmers
6. Plugs and connectors

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements of this specification.

2.2 WIRING DEVICES

A. General: Provide factory-fabricated wiring devices in types, colors, and electrical ratings for applications indicated and which comply with NEMA Standards Pub/No. WD 1. Provide gray color devices except as otherwise indicated; color selection to be verified by Contractor with Architect/Engineer. All devices shall be federal specification grade unless otherwise noted. Pigtail receptacles with a connector assembly built into the back of the device and a separate polycarbonate connector housing with wire leads are acceptable.

1. Devices on emergency circuits shall be red.
2. Devices on UPS circuits shall be in orange.

B. Receptacles

1. Heavy-Duty Simplex: Provide single heavy-duty self-grounding type receptacles, 2-pole, 3-wire, with green hexagonal equipment ground screw, 20-amperes, 125 volts, with metal plaster ears; design for side and back wiring with spring loaded, screw activated pressure plate, with NEMA configuration 5-20R unless otherwise indicated.
2. Heavy-Duty Duplex: Provide heavy-duty self-grounding type duplex receptacles, 2-pole, 3-wire, 20-amperes, 125-volts, with green hexagonal equipment ground screw, metal plaster ears, design for side and back wiring with screw activated pressure plate, with NEMA configuration 5-20R unless otherwise indicated.
3. Ground-Fault Interrupters: Provide "feed-thru" type ground-fault circuit interrupters, with heavy-duty duplex receptacles, capable of protecting connected downstream receptacles on single circuit, and of being installed in a 2-3/4" deep outlet box without adapter, grounding type UL-rated Class A, Group 1, rated 20-amperes, 120-volts, 60 Hz; with solid-state ground-fault sensing and signaling; with 5 milliamperes ground-fault trip level; equip with NEMA configuration 5-20R. GFCI Devices used for exterior applications must be Weather Resistant (WR) rated and be provided with an “In Use Cover”.

4. Tamper Resistant Duplex Receptacles (TR):

   Tamper Resistant Receptacles shall have:

   a. Tamper resistant dual mechanism shutter system to help prevent insertion of foreign objects.
   b. Heavy-duty brass, one-piece mounting strap with integral ground.
   c. One-piece, nickel-plated, triple-wipe power contacts for lasting retention.
   d. Strap tabs wrap around and lock down on face to prevent strap from separating from face and back body.
   e. Impact-resistant nylon face and back body.
   f. Two drive screws anchor strap to back body and face.
   g. External screw-pressure-plate back wire clamp on ground terminal for faster, easier installation.
   h. External screw-pressure-plate back wire clamps with #10 brass terminal screws for visual assurance of a good connection.
   i. Auto ground clip assures positive ground.
   j. The tamper resistant receptacle shall meet the latest version of the following standards:
      1) FSUL WC 596
      2) ANSI/IEEE 62.41
      3) CSA TIL #1-11B/Standard C22.2 #42.
      4) Federal Specification WC 896

C. Plugs and Connectors

1. Plugs and Connectors: Provide plugs and connectors with required amperage ratings, voltage ratings and NEMA configurations, which are designed to suit the atmospheric conditions of the equipment surroundings.

D. Switches

1. General: Switches shall be provided as specified in this section. Additional features such as key operator, rocker and lighted toggle shall be provided where indicated on the drawings. All switches shall be Federal Specification Grade (WC896).
2. Single-Pole: Provide heavy-duty flush single-pole AC quiet type, self-grounding type switches, 20-amperes, 120-277 volts, with mounting yoke insulated from mechanism, equip with plaster ears, toggle switch handle, and side-wired screw terminals.
3. Three Way: Provide heavy-duty flush 3-way AC quiet type, self-grounding type switches, 20-amperes, 120-277 volts, with mounting yoke insulated from mechanism, equip with plaster ears, toggle switch handles, and side-wired screw terminals.
4. Four Way: Provide heavy-duty flush 4-way AC quiet type, self-grounding type switches, 20-amperes, 120-277 volts, with mounting yoke insulated from mechanism, equip with plaster ears, toggle switch handles, and side-wired screw terminals.

2.3 WIRING DEVICE ACCESSORIES

A. Wall plates: Provide wall plates for single and combination wiring devices of types, sizes, and with ganging and cutouts as indicated. Select plates which mate and match wiring devices to which attached. Construct with metal screws for securing plates to devices. The screw heads colored to match finish of plates. Wall plates shall be colored to match wiring devices except as noted below. Provide plates possessing the following additional construction features:

1. Finished Areas
   Material and Finish: 0.04" thick, type 302 satin finished stainless steel.
2. Unfinished Areas
   Material and Finish: Steel plate, galvanized.
3. Surface mounted boxes in unfinished areas shall be furnished with 4" square raised covers, with openings to fit device or devices to be installed.

B. Furnish outdoor weatherproof receptacles with cast type steel "in-use" protective covers for the installation of cords.

PART 3 - EXECUTION

3.1 INSTALLATION OF WIRING DEVICES

A. Install wiring devices as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in accordance with recognized industry practices to fulfill project requirements.

B. Provide tamper resistant receptacles in all residential applications as required by the NEC.

C. Provide arc-fault receptacles in all residential applications as required by the NEC.

D. Coordinate with other work including painting, electrical boxes and wiring work as necessary to interface installation of wiring devices with other work.

E. Install wiring devices only in electrical boxes that are clean; free from excess building materials, dirt, and debris.

F. Install wiring devices after wiring work is completed.

G. Install wall plates after painting work is completed.

H. Connections of wire to devices shall be screw tightened. Connections using only spring pressure are not acceptable.

I. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for wiring devices. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals to comply with tightening torque specified in UL Standards 486A and B. Use properly scaled torque indicating hand tool.

J. All switches and receptacles with exposed terminals shall be wrapped with insulating tape equal to Scotch No. 33 such that no live parts are left exposed.

3.2 PROTECTION OF WALL PLATES AND RECEPTACLES

A. Upon installation of wall plates and receptacles, advise Contractor regarding proper and cautious use of convenience outlets. At time of Substantial Completion, replace those items which have been damaged, including those burned and scored by faulty plugs and those which are not clean and free from paint, dirt and debris.

3.3 GROUNDING

A. Provide equipment grounding connections for all wiring devices, unless otherwise indicated. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounds.

B. Where IG type devices are shown provide two ground wires: 1) green wire, equipment ground bonded to the device box and 2) green wire with yellow stripe, isolated ground connected to the ground terminal on the receptacle.

3.4 TESTING

A. Prior to energizing circuitry, test wiring for electrical continuity and short-circuits. Ensure proper polarity of connections is maintained. Subsequent to energization, test wiring devices to demonstrate compliance with requirements.

END OF SECTION 26 05 34

SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

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. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Underground-line warning tape.
5. Warning labels and signs.
6. Instruction signs.
7. Equipment identification labels, including arc-flash warning labels.
8. Miscellaneous identification products.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for electrical identification products.

B. Samples: For each type of label and sign to illustrate composition, size, colors, lettering style, mounting provisions, and graphic features of identification products.

C. Identification Schedule: For each piece of electrical equipment and electrical system components to be an index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

D. Delegated-Design Submittal: For arc-flash hazard study.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with ASME A13.1 and IEEE C2.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 COLOR AND LEGEND REQUIREMENTS

A. Raceways and Cables Carrying Circuits at 600 V or Less:

1. Black letters on an orange field.
2. Legend: Indicate voltage and system or service type.

B. Raceways and Cables Carrying Circuits at More Than 600 V:

1. Black letters on an orange field.
2. Legend: "DANGER - CONCEALED HIGH VOLTAGE WIRING."

C. Warning labels and signs shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.3 LABELS

A. Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

B. Snap-Around Labels for Raceways and Cables Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters of raceways they identify, and that stay in place by gripping action.

C. Self-Adhesive Labels:
1. Preprinted, 3-mil-thick, vinyl flexible label with acrylic pressure-sensitive adhesive.

a. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized to fit the raceway diameter, such that the clear shield overlaps the entire printed legend.

2. Vinyl, thermal, transfer-printed, 3-mil-thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

a. Nominal Size: 3.5-by-5-inch.

3. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
4. Marker for Tags: Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.

2.4 BANDS AND TUBES:

A. Snap-Around, Color-Coding Bands for Raceways and Cables: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches long, with diameters sized to suit diameters of raceways or cables they identify, and that stay in place by gripping action.

B. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameters of and shrunk to fit firmly around cables they identify. Full shrink recovery occurs at a maximum of 200 deg F. Comply with UL 224.

2.5 TAPES AND STENCILS:

A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mils thick by 1 to 2 inches wide; compounded for outdoor use.

C. Tape and Stencil for Raceways Carrying Circuits 600 V or Less: 4-inch-wide black stripes on 10-inch centers placed diagonally over orange background that extends full length of raceway or duct and is 12 inches wide. Stop stripes at legends.

D. Floor Marking Tape: 2-inch-wide, 5-mil pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.

E. Underground-Line Warning Tape
1. Tape:

a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
b. Printing on tape shall be permanent and shall not be damaged by burial operations.
c. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.

2. Color and Printing:

a. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.
b. Inscriptions for Red-Colored Tapes: "ELECTRIC LINE, HIGH VOLTAGE".
c. Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE".

3. Tag: Type I:

a. Pigmented polyolefin, bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
b. Width: 3 inches.
c. Thickness: 4 mils.
d. Weight: 18.5 lb/1000 sq. ft..
e. Tensile according to ASTM D 882: 30 lbf and 2500 psi.

4. Tag: Type II:

a. Multilayer laminate, consisting of high-density polyethylene scrim coated with pigmented polyolefin; bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
b. Width: 3 inches.
c. Thickness: 12 mils.
d. Weight: 36.1 lb/1000 sq. ft..
e. Tensile according to ASTM D 882: 400 lbf and 11,500 psi.

5. Tag: Type ID:

a. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
b. Width: 3 inches.
c. Overall Thickness: 5 mils.
d. Foil Core Thickness: 0.35 mil.
e. Weight: 28 lb/1000 sq. ft..
f. Tensile according to ASTM D 882: 70 lbf and 4600 psi.

6. Tag: Type IID:

a. Reinforced, detectable three-layer laminate, consisting of a printed pigmented woven scrim, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
b. Width: 3 inches.
c. Overall Thickness: 8 mils.
d. Foil Core Thickness: 0.35 mil.
e. Weight: 34 lb/1000 sq. ft..
f. Tensile according to ASTM D 882: 300 lbf and 12,500 psi.

F. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.6 Tags

A. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.

B. Nonmetallic Preprinted Tags: Polyethylene tags, 0.023 inch thick, color-coded for phase and voltage level, with factory screened printed permanent designations; punched for use with self-locking cable tie fastener.

C. Write-On Tags:
1. Polyester Tags: 0.015 inch thick, with corrosion-resistant grommet and cable tie for attachment to raceway, conductor, or cable.
2. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
3. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.7 Signs

A. Baked-Enamel Signs:

1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal Size: 7 by 10 inches.

B. Metal-Backed Butyrate Signs:

1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with 0.0396-inch galvanized-steel backing and with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal Size: 10 by 14 inches.

C. Laminated Acrylic or Melamine Plastic Signs:

1. Engraved legend.
2. Thickness:

a. For signs up to 20 sq. inches, minimum 1/16-inch-.
b. For signs larger than 20 sq. inches, 1/8 inch thick.
c. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.8 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F according to ASTM D 638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black, except where used for color-coding.

B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F according to ASTM D 638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black.

C. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, self-locking.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F according to ASTM D 638: 7000 psi.
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F.
5. Color: Black.

2.9 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 PREPARATION

A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

B. Install identifying devices before installing acoustical ceilings and similar concealment.

C. Verify identity of each item before installing identification products.

D. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

E. Apply identification devices to surfaces that require finish after completing finish work.

F. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

G. Attach plastic raceway and cable labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.

H. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

I. Painted Identification: Comply with requirements in painting Sections for surface preparation and paint application.

J. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

K. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

L. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 inches overall.

3.3 IDENTIFICATION SCHEDULE

A. Concealed Raceways, Duct Banks, More Than 600 V, within Buildings: Tape and stencil 4-inch-wide black stripes on 10-inch centers over orange background that extends full length of raceway or duct and is 12 inches wide. Stencil legend "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch-high black letters on 20-inch centers. Stop stripes at legends. Apply stripes to the following finished surfaces:

1. Floor surface directly above conduits running beneath and within 12 inches of a floor that is in contact with earth or is framed above unexcavated space.
2. Wall surfaces directly external to raceways concealed within wall.
3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.

B. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits, More Than 30 A and 120 V to Ground: Identify with self-adhesive vinyl tape applied in bands. Install labels at 10-foot maximum intervals.

C. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels containing the wiring system legend and system voltage. System legends shall be as follows:

1. "EMERGENCY POWER."
2. "POWER."
3. "UPS."

D. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.

1. Color-Coding for Phase- and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded service feeder and branch-circuit conductors.

a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG if authorities having jurisdiction permit.

b. Colors for 208/120-V Circuits:

1) Phase A: Black.
2) Phase B: Red.
3) Phase C: Blue.

c. Colors for 480/277-V Circuits:

1) Phase A: Brown.
2) Phase B: Orange.
3) Phase C: Yellow.

d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

E. Power-Circuit Conductor Identification, More Than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use nonmetallic preprinted tags colored and marked to indicate phase, and a separate tag with the circuit designation.

F. Install instructional sign, including the color code for grounded and ungrounded conductors using adhesive-film-type labels.

G. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive vinyl labels with the conductor or cable designation, origin, and destination.

H. Control-Circuit Conductor Termination Identification: For identification at terminations, provide self-adhesive vinyl labels with the conductor designation.

I. Conductors To Be Extended in the Future: Attach write-on tags or marker tape to conductors and list source.

J. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
2. Use system of marker-tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.

K. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.

1. Limit use of underground-line warning tape to direct-buried cables.
2. Install underground-line warning tape for direct-buried cables and cables in raceways.

L. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

M. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.

1. Comply with 29 CFR 1910.145.
2. Identify system voltage with black letters on an orange background.
3. Apply to exterior of door, cover, or other access.
4. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:

    a. Power-transfer switches.
    b. Controls with external control power connections.

N. Arc Flash Warning Labeling: Self-adhesive thermal transfer vinyl labels.

1. Comply with NFPA 70E and ANSI Z535.4.
2. Comply with Section 26 05 74 "Overcurrent Protective Device Arc-Flash Study" requirements for arc-flash warning labels.

O. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

P. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch-high letters for emergency instructions at equipment used for power transfer or load shedding.

Q. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm unless equipment is provided with its own identification.

1. Labeling Instructions:

    a. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine plastic label. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.
    b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
    c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
    d. Unless labels are provided with self-adhesive means of attachment, fasten them with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

2. Equipment To Be Labeled:

    a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be in the form of a self-adhesive, engraved, laminated acrylic or melamine label.
    b. Enclosures and electrical cabinets.
    c. Access doors and panels for concealed electrical items.
    d. Switchgear.
    e. Switchboards.

f. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
g. Motor-control centers.
h. Enclosed switches.
i. Enclosed circuit breakers.
j. Enclosed controllers.
k. Variable-speed controllers.
l. Push-button stations.
m. Power-transfer equipment.
n. Contactors.
o. Remote-controlled switches, dimmer modules, and control devices.
p. Monitoring and control equipment.

END OF SECTION 26 05 53

SECTION 26 24 16 - PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Extent of panelboard and enclosure work, including cabinets and cutout boxes is indicated by drawings and schedules.

B. Types of panelboards and enclosures in this section include the following:

1. Power-distribution panelboards.
2. Lighting and appliance type panelboards.
3. Load Centers

C. Refer to other Division-26 sections for cable/wire, connectors, and electrical raceway work required in conjunction with panelboards and enclosures; not work of this section.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide panelboard products of one of the following:

1. Eaton Cutler Hammer
2. General Electric Company
3. Siemens
4. Square D Company

2.2 PANELBOARDS

A. General: Except as otherwise indicated, provide panelboards, enclosures and auxiliary components, of types, sizes, and ratings indicated, which comply with manufacturer's standard materials; design and construction in accordance with published product information; equip with proper number of unit panelboard devices as required for complete installation. Where types, sizes, or ratings are not indicated, comply with NEC, UL and established industry standards for those applications indicated.

B. Power Distribution Panelboards: Provide circuit breaker type dead-front safety constructed power distribution panelboards as indicated, with panelboard switching and protective devices in quantities, ratings, types, and with arrangement shown; with anti-turn compression type main lug connectors approved for copper or aluminum conductors. Equip with copper bus bars with not less than 98% conductivity, and with full-sized neutral bus; provide suitable lugs on neutral bus for outgoing feeders requiring neutral connections. Provide molded-case circuit-breakers for each branch circuit, with toggle handles that indicate when tripped. Where multi-pole breakers are indicated, provide with common trip so overload on one pole will trip all poles simultaneously Provide panelboards with bare un-insulated grounding bars suitable for bolting to enclosures. Provide additional isolated ground bar where required. Power Distribution type panelboard enclosures shall be not less than 8" deep. Provide panelboards with UL markings indicating "suitable for use as service-entrance equipment". Label each switch/breaker with the

appropriate connected load and/or equipment identification. Labels shall be a minimum 1" x 4" black plastic with engraved white letters.

1. Breakers in 240 volt panelboards shall be fully rated and shall have an interrupting capacity of not less than 22,000 amperes symmetrical or as indicated on the drawings, whichever is greater.
2. Breakers in 480 volt panelboards shall be fully rated and shall have an interrupting capacity of not less than 35,000 amperes symmetrical or as indicated on the drawings, whichever is greater.
3. Circuit Breaker Distribution Panelboards shall be:
   a. General Electric Spectra Series
   b. Siemens S4, S5
   c. Square D I-LINE
   d. Eaton Cutler Hammer Pow-R-Line
4. Fusible Distribution Panelboards shall be:
   a. General Electric Spectra Series
   b. Siemens F2
   c. Square D QMB
   d. Eaton Cutler Hammer Pow-R-Line

C. Lighting and Appliance Panelboards: Provide dead-front safety type lighting and appliance panelboards as indicated, with switching and protective devices in quantities, ratings, types and arrangements shown; with anti-turn compression type lug connectors approved for copper or aluminum conductors; equip with copper bus bars, full-sized neutral bar, with bolt-on type heavy-duty, quick-make, quick-break, single-pole or multi-pole circuit breakers, as indicated, with toggle handles that indicate when tripped. Multi-pole breakers shall be provided with a common trip. Provide suitable lugs on neutral bus for each outgoing feeder required; provide bare un-insulated grounding bars suitable for bolting to enclosures. Provide additional isolated ground bus where required.

1. Lighting and Appliance Panelboards shall be type:

		240V Bolt-on	480V Bolt-on
a.	General Electric	AQ	AD, AE
b.	Siemens	S1	S2
c.	Square D	NQOD	NF
d.	Cutler Hammer	PRL1, PRL2	PLR2, PLR3

2. Breakers in 240 volt panelboards shall be fully rated and shall have an interrupting capacity of not less than 10,000 amperes symmetrical or as indicated on the drawings, whichever is greater.
3. Breakers in 480 volt panelboards shall be fully rated and shall have an interrupting capacity of not less than 14,000 amperes symmetrical or as indicated on the drawings, whichever is greater.

D. Lighting and Appliance Panelboard Enclosures: Provide galvanized sheet steel cabinet type enclosures, minimum 20" wide and 5-3/4" deep, code-gage, minimum 16-gage thickness. Construct with multiple knockouts and wiring gutters. Provide fronts with adjustable trim clamps, and doors with flush metal locks and keys, all panelboard enclosures keyed alike. Equip with interior circuit-directory frame, and card with clear plastic covering. Provide baked gray enamel finish over a rust inhibitor coating. Design enclosures for recessed or surface mounting as indicated. Provide enclosures which are fabricated by same manufacturer as panelboards, which mate properly with panelboards to be enclosed, and are NEMA rated to suit the atmospheric conditions of the equipment surroundings.

1. Furnish six spare keys for each type of panelboard cabinet lock.

E. Panelboard Accessories:

1. Provide Door in Door construction with hinged covers.
2. Ground-fault and arc fault protection units as indicated.
3. Shunt trip units as indicated.
4. Circuit breaker handle locking clips, for all breakers feeding fire alarm and security loads.

PART 3 - EXECUTION

3.1 INSPECTION

A. Installer must examine areas and conditions under which panelboards and enclosures are to be installed, and notify Contractor in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.2 INSTALLATION OF PANELBOARDS

A. General: Install panelboards and enclosures as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC standards and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.

B. Coordinate installation of panelboards and enclosures with cable and raceway installation work.

C. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standards 486A and B or Manufacturer's torque requirements when more stringent.

D. Anchor enclosures firmly to walls and structural surfaces, ensuring that they are permanently and mechanically secure.

E. Provide properly wired electrical connections within enclosures.

F. Provide panelboard circuit directory cards upon completion of installation work. Circuit directory cards shall be arranged with even numbered circuits separated by group or card from odd numbered circuits. All circuits, including spares and spaces, shall be labeled. All identification shall be at a minimum typewritten. Hand lettering is not acceptable. Provide a description of the load and its location for every circuit. The location must provide a written description and room number if available. Example: A receptacle circuit in a Science Classroom could be Recept. Science Rm. 203.

G. Provide four ¾" empty conduits for future from each flush mounted panelboard to an accessible space above the ceiling. Provide four ¾" EMT conduit fittings with knock out closers in the top of the panel for each surface mounted panelboard.

H. All wiring within panelboards shall be arranged in a neat and organized manner.

3.3 GROUNDING

A. Provide equipment grounding connections for panelboards as required by NEC and other Division-26 sections. Tighten connections to comply with tightening torques specified in UL Standard 486A and B to assure permanent and effective grounds.

3.4 FIELD QUALITY CONTROL

A. Prior to energizing circuitry, check all accessible connections to manufacturer's tightening torque specifications.

B. Prior to energizing panelboards, check with ground resistance tester phase-to-phase and phase-to-ground insulation resistance levels to ensure requirements are fulfilled.

C. Prior to energizing, check panelboards for electrical continuity of circuits, and for short-circuits.

D. Subsequent to wire and cable hook-ups, energize panelboards and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

END OF SECTION 26 24 16

SECTION 26 28 13 - FUSES

PART 1 - GENERAL

1.1 SUMMARY

A. Extent of fuse work is indicated by drawings and schedules.

B. Types of fuses specified in this section include the following:

1. Class RK1 time-delay
2. Class RK5 time-delay
3. Plug fuses

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements of this specification.

a. The fuse model numbers listed below are for comparative value and are the part numbers of the Bussman Company

2.2 FUSES

A. General: Except as otherwise indicated, provide fuses of types, sizes, ratings, and average time/current and peak let-through current characteristics indicated, which comply with manufacturer's standard design, materials, and construction in accordance with published product information, and with industry standards and configurations.

B. Class RK1 Time-Delay Fuses: Provide UL Class RK1 time-delay fuses rated 250V (Type LPN-RK) for voltages under 250V and 600V (Type LPS-RK) for voltages 250-600 V, 60 Hz, with 200,000 RMS symmetrical interrupting current rating for sizes 100 thru 600 amperes.

C. Class RK5 Time-Delay Fuses: Provide UL Class RK5 time-delay fuses rated 250V (Type FRN-R) for voltages under 250V and 600V (Type FRS-R) for voltages 250-600 V, 60 Hz, with 200,000 RMS symmetrical interrupting current rating for sizes 0.1 thru 90 amperes.

D. Plug fuses shall be permitted only for single-pole fuse holders with switch units. Plug fuses shall be dual-element Type S fuses.

PART 3 - EXECUTION

3.1 INSTALLATION OF FUSES

A. Install fuses as indicated, in accordance with the manufacturer's written instructions and with recognized industry practices to ensure that protective devices comply with requirements. Comply with NEC and NEMA standards for installation of fuses.

B. Coordinate with other work, including electrical wiring work, as necessary to interface installation of fuses with other work.

C. Install fuses in fused switches.

D. Short-circuit protection dual-element fuses installed in individual motor circuits with separate overload protection shall be sized at 150% of motor nameplate current rating or the next standard fuse size. Where excessive ambient temperature exist, high inertia motor loads or frequent "on-off" cycling requires larger fuses, consult the electrical engineer. Use fuse reducers where fuse gaps are larger than fuse dimension.

E. All fuse sizes shall be coordinated with manufacturer's requirements for each unit of equipment to be connected.

3.2 FIELD QUALITY CONTROL

A. Prior to energizing fusible devices, test devices for continuity of circuitry and for short-circuits. Correct malfunctioning units, and then demonstrate compliance with requirements.

3.3 EXTRA STOCK

A. Maintenance Stock, Fuses: Except as provided in other sections and for types and ratings required, furnish additional fuses, amounting to one unit for every 5 installed units, but not less than one unit of each.

1. Spare Fuse Cabinet: Provide wall mounted 18 gage minimum steel unit with full length, recessed piano-hinged door with key coded cam lock and pull. Size cabinet for orderly storage of all spare fuses of this project plus 15 percent spare capacity, minimum. Cabinet finish shall be gray baked enamel and shall be labeled as "SPARE FUSES".

END OF SECTION 26 28 13

SECTION 26 28 16 - ENCLOSED SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Extent of circuit and motor disconnect switch work is indicated on drawings and schedules.

B. Types of circuit and motor disconnect switches in this section include the following:

1. Equipment disconnects
2. Appliance disconnects
3. Motor-circuit disconnects

C. Wires/cables, raceways, and electrical boxes and fittings required in connection with circuit and motor disconnect work are specified in other Division-26 sections.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements on this specification and shall be of the same manufacturer as the electrical distribution equipment specified in the other Division 26 sections.

2.2 DISCONNECT SWITCHES

A. General-Duty Disconnect Switches: For switches rated less than 100 amps provide surface-mounted, general-duty type, sheet-steel enclosed switches, of types, sizes, and electrical characteristics indicated; rated for system voltage, 60 Hz, with required number of poles and solid neutral incorporating spring assisted, quick-make, quick-break switches. Equip with operating handle which is integral part of enclosure base and whose operating position is easily recognizable, and is capable of being padlocked in OFF position. Construct current carrying parts of high-conductivity copper, with silver-tungsten type switch contacts and positive pressure type reinforced fuse clips where fusing is required. The enclosure shall be NEMA rated to suit the atmospheric conditions of the equipment surroundings and of the manufacturer's standard finish. When used as service disconnect, provide with UL markings indicating "suitable for use as service equipment".

B. Heavy-Duty Disconnect Switches: For switches rated 100 amps or greater provide surface-mounted, heavy-duty type, sheet-steel enclosed switches, of types, sizes and electrical characteristics indicated; rated for system voltage 60 Hz, with required number of poles and solid neutral incorporating quick-make, quick-break type switches. Equip with operating handle which is integral part of enclosure base and whose position is easily recognizable, and is pad lockable in OFF position; construct current carrying parts of high-conductivity copper, with silver-tungsten type switch contacts, and positive pressure type reinforced fuse clips where fusing is required. The enclosure shall be NEMA rated to suit the atmospheric conditions of the equipment surroundings and of the manufacturer's standard finish. When used as service disconnect, provide with UL markings indicating "suitable for use as service equipment".

C. Motor-Circuit Disconnect Switches Must Be HP Rated.

D. Fuses: Provide fuses for disconnect switches, as recommended by switch manufacturer, of classes, types, and ratings needed to fulfill electrical requirements for service indicated.

PART 3 - EXECUTION

3.1 INSTALLATION OF MOTOR AND CIRCUIT DISCONNECT SWITCHES

A. Install circuit and motor disconnect switches where indicated, complying with manufacturer's written instructions, applicable requirements of NEC, NEMA, and NECA's "Standard of Installation", and in accordance with recognized industry practices.

B. Coordinate motor and circuit disconnect switch installation work with electrical raceway work, location of equipment, and as necessary for proper interface. Provide U-channel supports from floor and/or structure where required to mount disconnects at free-standing equipment.

C. Install disconnect switches used with motor-driven appliances, and motors and controllers within sight of controller position for motors greater than 1/8 HP.

3.2 GROUNDING

A. Provide equipment grounding connections, sufficiently tight to ensure a permanent and effective ground as required by NEC and in "Grounding" section of Division-26.

3.3 FIELD QUALITY CONTROL

A. Subsequent to completion of installation of electrical disconnect switches, energize circuitry and demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at project site, then retest to demonstrate compliance; otherwise remove and replace with new units and retest.

END OF SECTION 26 28 16