TABLE OF CONTENTS

SECTION NUMBER	TITLE
011000	Summary
012500	Substitution Procedures
012600	Contract Modification Procedures
012900	Payment Procedures
013100	Project Management and Coordination
013200	Construction Progress Documentation
013300	Submittal Procedures
014000	Quality Requirements
015000	Temporary Facilities and Controls
017300	Execution
017700	Closeout Procedures
019113	General Commissioning Requirements
021449	Selective Demolition
078413	Penetration Firestopping
221410	Plumbing Piping
221411	Disinfecting Water Supply System
230500	Basic Mechanical Requirements
230529	Basic Mechanical Materials and Methods
230540	Mechanical Sound and Vibration Control
230548	Mechanical Seismic Control
230593	Testing, Adjusting and Balancing
230700	Mechanical Insulation
230800	Commissioning of HVAC
230810	Variable Frequency Drive
230900	Electronic Controls
232113	HVAC Piping & Specialties
232123	HVAC Pumps
232500	HVAC Water Treatment
233300	Ductwork and Accessories
233400	Air Handling Fans
236400	Refrigeration
260500	Common Work Results For Electrical
260519	Low-Voltage Electrical Power Conductors And Cables
260526	Grounding And Bonding For Electrical Systems
260529	Hangers And Supports For Electrical Systems
260533	Raceway And Boxes For Electrical Systems

260548	Vibration And Seismic Controls For Electrical Systems
260553	Identification For Electrical Systems
260574	Electrical Testing
262416	Panelboards
262726	Wiring Devices
262813	Fuses
262816	Enclosed Switches And Circuit Breakers
265100	Interior Lighting

SECTION 011000 - SUMMARY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Project information.
2. Work covered by Contract Documents.
3. Owner-furnished products.
4. Access to site.
5. Coordination with occupants.
6. Work restrictions.
7. Specification and drawing conventions.
8. Miscellaneous provisions.

B. Related Requirements:

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

1.3 PROJECT INFORMATION

A. Project Identification: Dee Events Center Chiller Replacement, Weber State University; DFCM Project No. 10225810.

1. Project Location: Ogden, Utah.

B. Owner: State of Utah, Division of Facilities and Construction Management.

1. Owner's Representative: Tim Parkinson/DFCM (Tel: 801-538-3018).
2. Weber State University Representative: Chad Downs (Tel: 801-626-6642).

C. Mechanical Engineer: Roger Hamlet/Colvin Engineering Associates, Inc. (Tel: 801-322-2400)

1. Note that the terms ‘Architect’ and ‘Engineer’ are used interchangeably in this specification, and both refer to the Mechanical Engineer.

D. Mechanical Engineer Consultants: The Mechanical Engineer has retained the following design professionals who have prepared designated portions of the Contract Documents:

1. Electrical Engineer: John Michie / ECE (Tel: 801-521-8007)
2. Structural Engineer: Nolan Balls / Calder Richards (Tel: 801-466-1699)

1.4 WORK COVERED BY CONTRACT DOCUMENTS

A. The Work of Project is defined by the Contract Documents and consists of the following:

1. Replace three existing chillers and two existing cooling towers. Additional work includes:

a. Demolition of existing chillers, cooling towers, associated piping.
b. Installation of owner-furnished chillers.
c. New cooling towers.
d. New associated piping and HVAC water treatment.
e. New HVAC controls.
f. Associated wiring.

B. Type of Contract:

1. Project will be constructed under a single prime contract.

1.5 OWNER-FURNISHED PRODUCTS

A. Owner will furnish products indicated. The Work includes receiving, unloading, handling, storing, protecting, installing, and administering the one-year warranty period for Owner-furnished products and making all utility connections.

B. Owner-Furnished Products:

1. Three McQuay chillers described in Specification Section 236400-Refrigeration.

1.6 ACCESS TO SITE

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

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

C. Use of Site: Limit use of Project site to the existing chiller room and storage room to the south. Do not disturb portions of Project site beyond areas in which the Work is indicated.

1. Limits: Confine construction operations to the existing chiller room, cooling tower areaway, fan rooms, and storage room south of the chiller room.
2. Driveways, Walkways and Entrances: Keep driveways, loading areas, and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.

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

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

1.7 COORDINATION WITH OCCUPANTS

A. Full Owner Occupancy: Owner will occupy the premises during entire construction period, with the exception of areas under construction. Cooperate with Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with Owner's operations. Maintain existing exits unless otherwise indicated.

1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from Owner and authorities having jurisdiction.
2. Provide not less than 72 hours' notice to Owner of activities that will affect Owner's operations.

1.8 WORK RESTRICTIONS

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

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

B. On-Site Work Hours: Limit work in the existing building to normal business working hours of 6:00 a.m. to 10:00 p.m., Monday through Friday, unless otherwise indicated.

1. Weekend Hours: No restrictions, notify Owner in advance.
2. Hours for Utility Shutdowns: Coordinate with Owner.
3. Hours for Core Drilling or other noisy activity: No restrictions.

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

1. Notify Owner not less than two days in advance of proposed utility interruptions.

2. Obtain Owner's written permission before proceeding with utility interruptions.
3. Maintain heat to existing building at all times.

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

1. Notify Owner not less than two days in advance of proposed disruptive operations.
2. Obtain Owner's written permission before proceeding with disruptive operations.

E. Nonsmoking Building: Smoking is not permitted within the building or within 25 feet of entrances, operable windows, or outdoor-air intakes.

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

1.9 SPECIFICATION AND DRAWING CONVENTIONS

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

1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.

B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.

C. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:

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

1.10 PROJECT SCHEDULE

A. Demolition work can begin in the Dee Events Center on November 1, 2011. Maintain air-side economizer function on all air handlers in the building while chillers are being replaced.
B. Completion schedule:

1) All installation work, start-up services, testing, adjusting, and balancing must be complete by March 1, 2012.
2) Colvin Engineering Associates will act as the commissioning agent for this project. Commissioning will occur between March 1, 2012, and March 20, 2012.
3) Completed project that has been fully commissioned is to be handed over to WSU no later than April 1, 2012.

1.11 ADDITIONAL PROJECT REQUIREMENTS

A. This project is using ARRA funds. All work must comply with all ARRA requirements, including:
   1) Buy American Clause
   2) Davis Bacon Act Clauses
   3) All other requirements found in the supplemental conditions.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 011000

SECTION 012500 - SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for substitutions.

B. Related Requirements:

1. Section 012100 "Allowances" for products selected under an allowance.
2. Section 012300 "Alternates" for products selected under an alternate.
3. Section 016000 "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers.

1.3 DEFINITIONS

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

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

1.4 ACTION SUBMITTALS

A. 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 product or fabrication or installation cannot be provided, if applicable.

b. Coordination information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors, that will be necessary to accommodate proposed substitution.
c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
e. Samples, where applicable or requested.
f. Certificates and qualification data, where applicable or requested.
g. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners.
h. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
i. Research reports evidencing compliance with building code in effect for Project, from ICC-ES.
j. 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 date of receipt of purchase order, lack of availability, or delays in delivery.
k. Cost information, including a proposal of change, if any, in the Contract Sum.
l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents except as indicated in substitution request, is compatible with related materials, and is appropriate for applications indicated.
m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

3. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within seven days 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 seven days of receipt of additional information or documentation, whichever is later.

a. Forms of Acceptance: Change Order, Construction Change Directive, or Architect's Supplemental Instructions for minor changes in the Work.
b. Use product specified if Architect does not issue a decision on use of a proposed substitution within time allocated.

1.5 QUALITY ASSURANCE

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

1.6 PROCEDURES

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

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.

1. Conditions: 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:

    a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
    b. Requested substitution provides sustainable design characteristics that specified product provided.
    c. Substitution request is fully documented and properly submitted.
    d. Requested substitution will not adversely affect Contractor's construction schedule.
    e. Requested substitution has received necessary approvals of authorities having jurisdiction.
    f. Requested substitution is compatible with other portions of the Work.
    g. Requested substitution has been coordinated with other portions of the Work.
    h. Requested substitution provides specified warranty.
    i. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

B. Substitutions for Convenience: Not allowed.

PART 3 - EXECUTION (Not Used)

END OF SECTION 012500

SECTION 012600 - CONTRACT MODIFICATION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for handling and processing Contract modifications.

B. Related Requirements:

1. Section 012500 "Substitution Procedures" for administrative procedures for handling requests for substitutions made after the Contract award.

1.3 MINOR CHANGES IN THE WORK

A. Architect will issue through Mechanical Contractor supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time, on, "Architect's Supplemental Instructions."

1.4 PROPOSAL REQUESTS

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

1. Work Change Proposal Requests issued by Engineer are not instructions either to stop work in progress or to execute the proposed change.
2. Within time specified in Proposal Request after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.

a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
c. Include costs of labor and supervision directly attributable to the change.

d. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.

e. Quotation Form: Use forms acceptable to Architect.

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

1. Include a statement outlining 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 or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
3. Indicate applicable taxes, 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 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.
6. Comply with requirements in Section 012500 "Substitution Procedures" if the proposed change requires substitution of one product or system for product or system specified.
7. Proposal Request Form: Use CSI Form 13.6A, "Change Order Request (Proposal)," with attachments CSI Form 13.6D, "Proposal Worksheet Summary," and Form 13.6C, "Proposal Worksheet Detail."

1.5 ADMINISTRATIVE CHANGE ORDERS

A. Allowance Adjustment: See Section 012100 "Allowances" for administrative procedures for preparation of Change Order Proposal for adjusting the Contract Sum to reflect actual costs of allowances.

B. Unit-Price Adjustment: See Section 012200 "Unit Prices" for administrative procedures for preparation of Change Order Proposal for adjusting the Contract Sum to reflect measured scope of unit-price work.

1.6 CHANGE ORDER PROCEDURES

A. On Owner's approval of a Work Changes Proposal Request, Engineer will issue a Change Order for signatures of Owner and Contractor on AIA Document G701.

1.7 CONSTRUCTION CHANGE DIRECTIVE

A. Construction Change Directive: Engineer may issue a Construction Change Directive on AIA Document G714. Construction Change Directive instructs Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.

1. Construction Change Directive contains a complete description of change in the Work. It also designates method to be followed to determine change in the Contract Sum or the Contract Time.

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

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

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012600

SECTION 012900 - PAYMENT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements necessary to prepare and process Applications for Payment.

B. Related Requirements:

1. Section 012100 "Allowances" for procedural requirements governing the handling and processing of allowances.
2. Section 012200 "Unit Prices" for administrative requirements governing the use of unit prices.
3. Section 012600 "Contract Modification Procedures" for administrative procedures for handling changes to the Contract.
4. Section 013200 "Construction Progress Documentation" for administrative requirements governing the preparation and submittal of the Contractor's construction schedule.
5. Section 018113.13 "Sustainable Design Requirements - LEED for New Construction and Major Renovations" for administrative requirements governing submittal of cost breakdown information required for LEED documentation.
6. Section 018113.16 "Sustainable Design Requirements - LEED for Commercial Interiors" for administrative requirements governing submittal of cost breakdown information required for LEED documentation.
7. Section 018113.19 "Sustainable Design Requirements - LEED for Core and Shell Development" for administrative requirements governing submittal of cost breakdown information required for LEED documentation.
8. Section 018113.23 "Sustainable Design Requirements - LEED for Schools" for administrative requirements governing submittal of cost breakdown information required for LEED documentation.

1.3 DEFINITIONS

A. Schedule of Values: A statement furnished by Contractor allocating portions of the Contract Sum to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.

1.4 SCHEDULE OF VALUES

A. Coordination: Coordinate preparation of the schedule of values with preparation of Contractor's construction schedule.

1. Coordinate line items in the schedule of values with other required administrative forms and schedules, including the following:

a. Application for Payment forms with continuation sheets.
b. Submittal schedule.
c. Items required to be indicated as separate activities in Contractor's construction schedule.

2. Submit the schedule of values to Engineer at earliest possible date, but no later than seven days before the date scheduled for submittal of initial Applications for Payment.
3. Subschedules for Phased Work: Where the Work is separated into phases requiring separately phased payments, provide subschedules showing values coordinated with each phase of payment.
4. Subschedules for Separate Elements of Work: Where the Contractor's construction schedule defines separate elements of the Work, provide subschedules showing values coordinated with each element.
5. Subschedules for Separate Design Contracts: Where the Owner has retained design professionals under separate contracts who will each provide certification of payment requests, provide subschedules showing values coordinated with the scope of each design services contract as described in Section 011000 "Summary."

B. Format and Content: Use 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 schedule of values consistent with format of AIA Document G703.
3. 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 or fabricator.
e. Name of supplier.
f. Change Orders (numbers) that affect value.
g. Dollar value of the following, as a percentage of the Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent.

1) Labor.
2) Materials.
3) Equipment.

4. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with Project Manual table of contents. Provide multiple line items for principal subcontract amounts in excess of five percent of the Contract Sum.

   a. Include separate line items under Contractor and principal subcontracts for Project closeout requirements in an amount totaling five percent of the Contract Sum and subcontract amount.

5. Round amounts to nearest whole dollar; total shall equal the Contract Sum.
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.

   a. Differentiate between items stored on-site and items stored off-site. If required, include evidence of insurance.

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. Purchase Contracts: Provide a separate line item in the schedule of values for each purchase contract. Show line-item value of purchase contract. Indicate owner payments or deposits, if any, and balance to be paid by Contractor.
10. Each item in the schedule of values and Applications for Payment shall be complete. Include total cost and proportionate share of general overhead and profit for each item.

    a. Temporary facilities and other major cost items that are not direct cost of actual work-in-place may be shown either as separate line items in the schedule of values or distributed as general overhead expense, at Contractor's option.

11. Schedule Updating: Update and resubmit the schedule of values before the next Applications for Payment when Change Orders or Construction Change Directives result in a change in the Contract Sum.

1.5 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with 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 Times: Submit Application for Payment to Architect by the 20th of the month. The period covered by each Application for Payment is one month, ending on the last day of the month.

1. Submit draft copy of Application for Payment seven days prior to due date for review by Architect.

D. Application for Payment Forms: Use AIA Document G702 and AIA Document G703 as form for Applications for Payment.

E. Application for Payment Forms: Use forms provided by Owner for Applications for Payment. Sample copies are included in Project Manual.

F. Application for Payment Forms: Use forms acceptable to Architect and Owner for Applications for Payment. Submit forms for approval with initial submittal of schedule of values.

G. 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 for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.
4. Indicate separate amounts for work being carried out under Owner-requested project acceleration.

H. Stored Materials: Include in Application for Payment amounts applied for materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
3. Provide summary documentation for stored materials indicating the following:

a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.

c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.

I. Transmittal: Submit three signed and notarized original copies of each Application for Payment to Architect by a method ensuring receipt within 24 hours. One copy shall include waivers of lien and similar attachments if required.

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

J. Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's lien from entities lawfully entitled to file a mechanic's lien arising out of the Contract and related to the Work covered by the payment.

1. Submit partial waivers on each item for amount requested in previous application, after deduction for retainage, on each item.
2. When an application shows completion of an item, submit conditional final or full waivers.
3. Owner reserves the right to designate which entities involved in the Work must submit waivers.
4. Waiver Forms: Submit executed waivers of lien on forms acceptable to Owner.

K. Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's liens from subcontractors, sub-subcontractors, and suppliers for construction period covered by the previous application.

1. Submit partial waivers on each item for amount requested in previous application, after deduction for retainage, on each item.
2. When an application shows completion of an item, submit conditional final or full waivers.
3. Owner reserves the right to designate which entities involved in the Work must submit waivers.
4. Submit final Application for Payment with or preceded by conditional final waivers from every entity involved with performance of the Work covered by the application who is lawfully entitled to a lien.
5. Waiver Forms: Submit executed waivers of lien on forms, acceptable to Owner.

L. 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.
2. Schedule of values.
3. LEED submittal for project materials cost data.
4. Contractor's construction schedule (preliminary if not final).
5. Combined Contractor's construction schedule (preliminary if not final) incorporating Work of multiple contracts, with indication of acceptance of schedule by each Contractor.
6. Products list (preliminary if not final).
7. LEED action plans.
8. Schedule of unit prices.

9. Submittal schedule (preliminary if not final).
10. List of Contractor's staff assignments.
11. List of Contractor's principal consultants.
12. Copies of building permits.
13. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.
14. Initial progress report.
15. Report of preconstruction conference.
16. Certificates of insurance and insurance policies.
17. Performance and payment bonds.
18. Data needed to acquire Owner's insurance.

M. Application for Payment at Substantial Completion: After Architect issues the Certificate of Substantial Completion, submit an Application for Payment showing 100 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 Certificate(s) of Substantial Completion issued previously for Owner occupancy of designated portions of the Work.

N. Final Payment Application: After completing Project closeout requirements, 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.
2. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
3. Updated final statement, accounting for final changes to the Contract Sum.
4. AIA Document G706, "Contractor's Affidavit of Payment of Debts and Claims."
5. AIA Document G706A, "Contractor's Affidavit of Release of Liens."
6. AIA Document G707, "Consent of Surety to Final Payment."
7. Evidence that claims have been settled.
8. 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.
9. Final liquidated damages settlement statement.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012900

SECTION 013100 - PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1. General coordination procedures.
2. Coordination drawings.
3. Requests for Information (RFIs).
4. Project Web site.
5. Project meetings.

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

C. Related Requirements:

1. Section 011200 "Multiple Contract Summary" for a description of the division of work among separate contracts and responsibility for coordination activities not in this Section.
2. Section 013200 "Construction Progress Documentation" for preparing and submitting Contractor's construction schedule.
3. Section 017300 "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
4. Section 017700 "Closeout Procedures" for coordinating closeout of the Contract.
5. Section 019113 "General Commissioning Requirements" for coordinating the Work with Owner's Commissioning Authority.

1.3 DEFINITIONS

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

1.4 INFORMATIONAL SUBMITTALS

A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Use CSI Form 1.5A. 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.

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

1. Post copies of list in project meeting room, in temporary field office, and by each temporary telephone. Keep list current at all times.

1.5 GENERAL COORDINATION PROCEDURES

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

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

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

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

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

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

D. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities 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. Project closeout activities.
8. Startup and adjustment of systems.

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

1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. See other Sections for disposition of salvaged materials that are designated as Owner's property.

1.6 COORDINATION DRAWINGS

A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, and additionally where installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.

1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:

a. Use applicable Drawings as a basis for preparation of coordination drawings. Prepare sections, elevations, and details as needed to describe relationship of various systems and components.
b. Coordinate the addition of trade-specific information to the coordination drawings by multiple contractors in a sequence that best provides for coordination of the information and resolution of conflicts between installed components before submitting for review.

c. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
d. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
e. Show location and size of access doors required for access to concealed dampers, valves, and other controls.
f. Indicate required installation sequences.
g. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Architect indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

B. Coordination Drawing Organization: Organize coordination drawings as follows:

1. Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements, and mechanical, plumbing, fire-protection, fire-alarm, and electrical Work. Show locations of visible ceiling-mounted devices relative to acoustical ceiling grid. Supplement plan drawings with section drawings where required to adequately represent the Work.
2. Plenum Space: Indicate subframing for support of ceiling and wall systems, mechanical and electrical equipment, and related Work. Locate components within ceiling plenum to accommodate layout of light fixtures indicated on Drawings. Indicate areas of conflict between light fixtures and other components.
3. Mechanical Rooms: Provide coordination drawings for mechanical rooms showing plans and elevations of mechanical, plumbing, fire-protection, fire-alarm, and electrical equipment.
4. Structural Penetrations: Indicate penetrations and openings required for all disciplines.
5. Slab Edge and Embedded Items: Indicate slab edge locations and sizes and locations of embedded items for metal fabrications, sleeves, anchor bolts, bearing plates, angles, door floor closers, slab depressions for floor finishes, curbs and housekeeping pads, and similar items.
6. Mechanical and Plumbing Work: Show the following:

   a. Sizes and bottom elevations of ductwork, piping, and conduit runs, including insulation, bracing, flanges, and support systems.
   b. Dimensions of major components, such as dampers, valves, diffusers, access doors, cleanouts and electrical distribution equipment.
   c. Fire-rated enclosures around ductwork.

7. Electrical Work: Show the following:

   a. Runs of vertical and horizontal conduit 1-1/4 inches (32 mm) in diameter and larger.
   b. Light fixture, exit light, emergency battery pack, smoke detector, and other fire-alarm locations.
   c. Panel board, switch board, switchgear, transformer, busway, generator, and motor control center locations.
   d. Location of pull boxes and junction boxes, dimensioned from column center lines.

8. Fire-Protection System: Show the following:

    a. Locations of standpipes, mains piping, branch lines, pipe drops, and sprinkler heads.

9. Review: Architect will review coordination drawings to confirm that the Work is being coordinated, but not for the details of the coordination, which are Contractor's responsibility. If Architect determines that coordination drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, Architect will so inform Contractor, who shall make changes as directed and resubmit.
10. Coordination Drawing Prints: Prepare coordination drawing prints according to requirements in Section 013300 "Submittal Procedures."

C. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:

1. File Preparation Format: Same digital data software program, version, and operating system as original Drawings.
2. File Preparation Format: DWG, Version AutoCAD 2010, operating in Microsoft Windows operating system.
3. File Submittal Format: Submit or post coordination drawing files using Portable Data File (PDF) format.
4. Architect will furnish Contractor one set of digital data files of Drawings for use in preparing coordination digital data files.

    a. Architect makes no representations as to the accuracy or completeness of digital data files as they relate to Drawings.
    b. Digital Data Software Program: Drawings are available in AutoCAD 2010 format.
    c. Contractor shall execute a data licensing agreement in the form of Agreement form acceptable to Owner and Architect.

1.7 REQUESTS FOR INFORMATION (RFIs)

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

1. Architect will return RFIs submitted to Architect by other entities controlled by Contractor with no response.
2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.

B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:

1. Project name.
2. Project number.
3. Date.
4. Name of Contractor.

5. Name of Architect.
6. RFI number, numbered sequentially.
7. RFI subject.
8. Specification Section number and title and related paragraphs, as appropriate.
9. Drawing number and detail references, as appropriate.
10. Field dimensions and conditions, as appropriate.
11. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
12. Contractor's signature.
13. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.

    a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.

C. RFI Forms: AIA Document G716.

1. Attachments shall be electronic files in Adobe Acrobat PDF format.

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

1. The following Contractor-generated RFIs will be returned without action:

    a. Requests for approval of submittals.
    b. Requests for approval of substitutions.
    c. Requests for approval of Contractor's means and methods.
    d. Requests for coordination information already indicated in the Contract Documents.
    e. Requests for adjustments in the Contract Time or the Contract Sum.
    f. Requests for interpretation of Architect's actions on submittals.
    g. Incomplete RFIs or inaccurately prepared RFIs.

2. Architect's action may include a request for additional information, in which case Architect's time for response will date from time of receipt of additional information.
3. Architect's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Section 012600 "Contract Modification Procedures."

    a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect in writing within 10 days of receipt of the RFI response.

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

1. Project name.

2. Name and address of Contractor.
3. Name and address of Architect.
4. RFI number including RFIs that were returned without action or withdrawn.
5. RFI description.
6. Date the RFI was submitted.
7. Date Architect's response was received.

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

1. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.
2. Identification of related Field Order, Work Change Directive, and Proposal Request, as appropriate.

1.8 PROJECT MEETINGS

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

1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Architect of scheduled meeting dates and times.
2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner, and Architect, within three days of the meeting.

B. Preconstruction Conference: Schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner and Architect, but no later than 15 days after execution of the Agreement.

1. Conduct the conference to review responsibilities and personnel assignments.
2. Attendees: Authorized representatives of Owner, Owner's Commissioning Authority, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
3. Agenda: Discuss items of significance that could affect progress, including the following:

a. Tentative construction schedule.
b. Phasing.
c. Critical work sequencing and long-lead items.
d. Designation of key personnel and their duties.
e. Lines of communications.
f. Procedures for processing field decisions and Change Orders.

g. Procedures for RFIs.
h. Procedures for testing and inspecting.
i. Procedures for processing Applications for Payment.
j. Distribution of the Contract Documents.
k. Submittal procedures.
l. Preparation of record documents.
m. Use of the premises and existing building.
n. Work restrictions.
o. Working hours.
p. Owner's occupancy requirements.
q. Responsibility for temporary facilities and controls.
r. Procedures for moisture and mold control.
s. Procedures for disruptions and shutdowns.
t. Construction waste management and recycling.
u. Parking availability.
v. Office, work, and storage areas.
w. Equipment deliveries and priorities.
x. First aid.
y. Security.
z. Progress cleaning.

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

C. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity 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, and Owner's Commissioning Authority 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 RFIs.
d. Related Change Orders.
e. Purchases.
f. Deliveries.
g. Submittals.
h. Review of mockups.
i. Possible conflicts.
j. Compatibility requirements.
k. Time schedules.
l. Weather limitations.
m. Manufacturer's written instructions.
n. Warranty requirements.
o. Compatibility of materials.

p. Acceptability of substrates.
q. Temporary facilities and controls.
r. Space and access limitations.
s. Regulations of authorities having jurisdiction.
t. Testing and inspecting requirements.
u. Installation procedures.
v. Coordination with other work.
w. Required performance results.
x. Protection of adjacent work.
y. Protection of construction and personnel.

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

D. Project Closeout Conference: Schedule and conduct a project closeout conference, at a time convenient to Owner and Architect, but no later than 15 days prior to the scheduled date of Substantial Completion.

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

a. Preparation of record documents.
b. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance.
c. Submittal of written warranties.
d. Requirements for preparing operations and maintenance data.
e. Requirements for delivery of material samples, attic stock, and spare parts.
f. Requirements for demonstration and training.
g. Preparation of Contractor's punch list.
h. Procedures for processing Applications for Payment at Substantial Completion and for final payment.
i. Submittal procedures.
j. Coordination of separate contracts.
k. Owner's partial occupancy requirements.
l. Installation of Owner's furniture, fixtures, and equipment.
m. Responsibility for removing temporary facilities and controls.

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

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

1. Coordinate dates of meetings with preparation of payment requests.
2. Attendees: In addition to representatives of Owner, Owner's Commissioning Authority, 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 meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
3. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.

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

        1) Review schedule for next period.

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

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

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

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

F. Coordination Meetings: Conduct project coordination meetings at regular 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, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meetings shall be familiar with Project and authorized to conclude matters relating to the Work.
2. Agenda: Review and correct or approve minutes of the previous coordination meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.

a. Combined Contractor's Construction Schedule: Review progress since the last coordination meeting. Determine whether each contract is on time, ahead of schedule, or behind schedule, in relation to combined Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
b. Schedule Updating: Revise combined Contractor's construction schedule after each coordination meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with report of each meeting.
c. Review present and future needs of each contractor present, including the following:

1) Interface requirements.
2) Sequence of operations.
3) Resolution of BIM component conflicts.
4) Status of submittals.
5) Deliveries.
6) Off-site fabrication.
7) Access.
8) Site utilization.
9) Temporary facilities and controls.
10) Work hours.
11) Hazards and risks.
12) Progress cleaning.
13) Quality and work standards.
14) 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 013100

SECTION 013200 - CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:

1. Startup construction schedule.
2. Contractor's construction schedule.
3. Construction schedule updating reports.
4. Daily construction reports.
5. Material location reports.
6. Site condition reports.
7. Special reports.

1.3 INFORMATIONAL SUBMITTALS

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

1. Working electronic copy of schedule file, where indicated.
2. PDF electronic file.

B. Startup construction schedule.

1. Approval of cost-loaded, startup construction schedule will not constitute approval of schedule of values for cost-loaded activities.

C. Startup Network Diagram: Of size required to display entire network for entire construction period. Show logic ties for activities.

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

1. Submit a working electronic copy of schedule, using software indicated, and labeled to comply with requirements for submittals. Include type of schedule (initial or updated) and date on label.

E. CPM Reports: Concurrent with CPM schedule, submit each of the following reports. Format for each activity in reports shall contain activity number, activity description, cost and resource loading, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float in calendar days.

1. Activity Report: List of all activities sorted by activity number and then early start date, or actual start date if known.
2. Logic Report: List of preceding and succeeding activities for all activities, sorted in ascending order by activity number and then early start date, or actual start date if known.
3. Total Float Report: List of all activities sorted in ascending order of total float.
4. Earnings Report: Compilation of Contractor's total earnings from the Notice to Proceed until most recent Application for Payment.

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

G. Daily Construction Reports: Submit at monthly intervals.

H. Material Location Reports: Submit at monthly intervals.

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

J. Special Reports: Submit at time of unusual event.

K. Qualification Data: For scheduling consultant.

1.4 QUALITY ASSURANCE

A. Scheduling Consultant Qualifications: An experienced specialist in CPM scheduling and reporting, with capability of producing CPM reports and diagrams within 24 hours of Architect's request.

1.5 COORDINATION

A. Coordinate preparation and processing of schedules and reports with performance of construction activities and with scheduling and reporting of separate contractors.

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

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

PART 2 - PRODUCTS

2.1 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

A. Time Frame: Extend schedule from date established for the Notice to Proceed to date of[final completion.

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

B. Activities: Treat each separate area as a separate numbered activity for each main element of the Work. Comply with the following:

1. Activity Duration: Define activities so no activity is longer than 20 days, unless specifically allowed by Architect.
2. Procurement Activities: Include procurement process activities for the following long lead items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
3. Submittal Review Time: Include review and resubmittal times indicated in Section 013300 "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's construction schedule with submittal schedule.
4. Startup and Testing Time: Include no fewer than 10 days for startup and testing.
5. Commissioning Time: Include no fewer than 15 days for commissioning.
6. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Architect's administrative procedures necessary for certification of Substantial Completion.
7. Punch List and Final Completion: Include not more than 10 days for completion of punch list items and final completion.

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

1. Phasing: Arrange list of activities on schedule by phase.
2. Work Restrictions: Show the effect of the following items on the schedule:

a. Coordination with existing construction.
b. Limitations of continued occupancies.
c. Uninterruptible services.
d. Partial occupancy before Substantial Completion.
e. Use of premises restrictions.
f. Seasonal variations.
g. Environmental control.

3. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:

a. Subcontract awards.

b. Submittals.
c. Purchases.
d. Fabrication.
e. Deliveries.
f. Installation.
g. Tests and inspections.
h. Adjusting.
i. Commissioning
j. Startup and placement into final use and operation.

4. Construction Areas: Identify each major area of construction for each major portion of the Work. Indicate where each construction activity within a major area must be sequenced or integrated with other construction activities to provide for the following:

a. Structural completion.
b. Completion of mechanical installation.
c. Completion of electrical installation.
d. Substantial Completion.

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

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

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

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

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

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

2.2 STARTUP CONSTRUCTION SCHEDULE

A. Bar-Chart Schedule: Submit startup, horizontal, bar-chart-type construction schedule within seven days of date established for the Notice to Proceed.

B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line. Outline significant construction activities for first 30 days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.

2.3 REPORTS

A. Weekly Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:

1. List of subcontractors at Project site.
2. List of separate contractors at Project site.
3. Approximate count of personnel at Project site.
4. Equipment at Project site.
5. Material deliveries.
6. High and low temperatures and general weather conditions, including presence of rain or snow.
7. Accidents.
8. Meetings and significant decisions.
9. Unusual events (see special reports).
10. Stoppages, delays, shortages, and losses.
11. Meter readings and similar recordings.
12. Emergency procedures.
13. Orders and requests of authorities having jurisdiction.
14. Change Orders received and implemented.
15. Construction Change Directives received and implemented.
16. Services connected and disconnected.
17. Equipment or system tests and startups.
18. Partial completions and occupancies.
19. Substantial Completions authorized.

B. Material Location Reports: At weekly intervals, prepare and submit a comprehensive list of materials delivered to and stored at Project site. List shall be cumulative, showing materials previously reported plus items recently delivered. Include with list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from Project site. Indicate the following categories for stored materials:

1. Material stored prior to previous report and remaining in storage.
2. Material stored prior to previous report and since removed from storage and installed.
3. Material stored following previous report and remaining in storage.

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

2.4 SPECIAL REPORTS

A. General: Submit special reports directly to Owner within one day of an occurrence. Distribute copies of report to parties affected by the occurrence.

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

PART 3 - EXECUTION

3.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

A. Scheduling Consultant: Engage a consultant to provide planning, evaluation, and reporting using CPM scheduling.

1. In-House Option: Owner may waive the requirement to retain a consultant if Contractor employs skilled personnel with experience in CPM scheduling and reporting techniques. Submit qualifications.
2. Meetings: Scheduling consultant shall attend all meetings related to Project progress, alleged delays, and time impact.

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

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

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

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

END OF SECTION 013200

SECTION 013300 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes requirements for the submittal schedule and administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.

B. Related Requirements:

1. Section 012900 "Payment Procedures" for submitting Applications for Payment and the schedule of values.
2. Section 013200 "Construction Progress Documentation" for submitting schedules and reports, including Contractor's construction schedule.
3. Section 017839 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.

1.3 DEFINITIONS

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

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

C. Portable Document Format (PDF): An open standard file format licensed by Adobe Systems used for representing documents in a device-independent and display resolution-independent fixed-layout document format.

1.4 ACTION SUBMITTALS

A. Submittal Schedule: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making

corrections or revisions to submittals noted by Architect and additional time for handling and reviewing submittals required by those corrections.

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

    a. Submit revised submittal schedule to reflect changes in current status and timing for submittals.

4. Format: Arrange the following information in a tabular format:

    a. Scheduled date for first submittal.
    b. Specification Section number and title.
    c. Submittal category: Action; informational.
    d. Name of subcontractor.
    e. Description of the Work covered.
    f. Scheduled date for Architect's final release or approval.
    g. Scheduled date of fabrication.
    h. Scheduled dates for purchasing.
    i. Scheduled dates for installation.
    j. Activity or event number.

1.5 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

A. Architect's Digital Data Files: Electronic digital data files of the Contract Drawings will[not] be provided by Architect for Contractor's use in preparing submittals.

1. Architect will furnish Contractor one set of digital data drawing files of the Contract Drawings for use in preparing Shop Drawings.

    a. Architect makes no representations as to the accuracy or completeness of digital data drawing files as they relate to the Contract Drawings.
    b. Digital Drawing Software Program: The Contract Drawings are available in AutoCAD 2010.
    c. Contractor shall execute a data licensing agreement in the form of Agreement form acceptable to Owner and Architect.
    d. The following digital data files will by furnished for each appropriate discipline:

        1) Floor plans.

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

1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
4. Coordinate transmittal of 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 reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.

1. Initial Review: Allow 15 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Architect will advise Contractor when a submittal being processed must be delayed for coordination.
2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
3. Resubmittal Review: Allow 15 days for review of each resubmittal.
4. Sequential Review: Where sequential review of submittals by Architect's consultants, Owner, or other parties is indicated, allow 21 days for initial review of each submittal.
5. Concurrent Consultant Review: Where the Contract Documents indicate that submittals may be transmitted simultaneously to Architect and to Architect's consultants, allow 15 days for review of each submittal. Submittal will be returned to Architect, before being returned to Contractor.

D. Paper Submittals: Place a permanent label or title block on each submittal item for identification.

1. Indicate name of firm or entity that prepared each submittal on label or title block.
2. Include the following information for processing and recording action taken:

    a. Project name.
    b. Date.
    c. Name of Engineer.
    d. Name of Contractor.
    e. Name of subcontractor.
    f. Name of supplier.
    g. Name of manufacturer.
    h. Submittal number or other unique identifier, including revision identifier.
        1) Submittal number shall use Specification Section number followed by a decimal point and then a sequential number (e.g., 061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., 061000.01.A).

i. Number and title of appropriate Specification Section.
j. Drawing number and detail references, as appropriate.
k. Location(s) where product is to be installed, as appropriate.
l. Other necessary identification.

3. Additional Paper Copies: Unless additional copies are required for final submittal, and unless Architect observes noncompliance with provisions in the Contract Documents, initial submittal may serve as final submittal.

   a. Submit one copy of submittal to concurrent reviewer in addition to specified number of copies to Architect.

4. Transmittal for Paper Submittals: Assemble each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form. Architect will return without review submittals received from sources other than Contractor.
   a. Transmittal Form for Paper Submittals: Provide locations on form for the following information:

      1) Project name.
      2) Date.
      3) Destination (To:).
      4) Source (From:).
      5) Name and address of Engineer.
      6) Name of Contractor.
      7) Name of firm or entity that prepared submittal.
      8) Names of subcontractor, manufacturer, and supplier.
      9) Category and type of submittal.
      10) Submittal purpose and description.
      11) Specification Section number and title.
      12) Indication of full or partial submittal.
      13) Transmittal number, numbered consecutively.
      14) Submittal and transmittal distribution record.
      15) Remarks.
      16) Signature of transmitter.

E. Options: Identify options requiring selection by Engineer or Owner.

F. Deviations and Additional Information: On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Architect on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same identification information as related submittal.

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

1. Note date and content of previous submittal.
2. Note date and content of revision in label or title block and clearly indicate extent of revision.

3. Resubmit submittals until they are marked with approval notation from Architect's action stamp or review comments.

H. 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.

I. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Architect's action stamp or review comments.

PART 2 - PRODUCTS

2.1 SUBMITTAL PROCEDURES

A. General Submittal Procedure Requirements: Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.

1. Submit electronic submittals via email as PDF electronic files.

   a. Architect will return annotated file. Annotate and retain one copy of file as an electronic Project record document file.

2. Action Submittals: Submit three paper copies of each submittal unless otherwise indicated. Architect will return two copies.
3. Informational Submittals: Submit two paper copies of each submittal unless otherwise indicated. Architect will not return copies.
4. Certificates and Certifications Submittals: Provide a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.

   a. Provide a digital signature with digital certificate on electronically submitted certificates and certifications where indicated.
   b. Provide a notarized statement on original paper copy certificates and certifications where indicated.

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 published 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 catalog cuts.

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

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

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

5. Submit Product Data before or concurrent with Samples.
6. Submit Product Data in the following format:

a. PDF electronic file or five paper copies of Product Data unless otherwise indicated. Architect will return three copies.

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: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:

a. Identification of products.
b. Schedules.
c. Compliance with specified standards.
d. Notation of coordination requirements.
e. Notation of dimensions established by field measurement.
f. Relationship and attachment to adjoining construction clearly indicated.
g. Seal and signature of professional engineer if specified.

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

a. PDF electronic file.

D. Coordination Drawing Submittals: Comply with requirements specified in Section 013100 "Project Management and Coordination."

E. Contractor's Construction Schedule: Comply with requirements specified in Section 013200 "Construction Progress Documentation."

F. Application for Payment and Schedule of Values: Comply with requirements specified in Section 012900 "Payment Procedures."

G. Test and Inspection Reports and Schedule of Tests and Inspections Submittals: Comply with requirements specified in Section 014000 "Quality Requirements."

H. Closeout Submittals and Maintenance Material Submittals: Comply with requirements specified in Section 017700 "Closeout Procedures."

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

J. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.

K. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.

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

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

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

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

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

B. Project Closeout and Maintenance Material Submittals: See requirements in Section 017700 "Closeout Procedures."

3.2 ARCHITECT'S ACTION

A. Action Submittals: Architect will review each submittal, make marks to indicate corrections or revisions required, and return it. Architect will provide a list of comments with action items identified.

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

C. Submittals not required by the Contract Documents may be returned by the Architect without action.

END OF SECTION 013300

SECTION 014000 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

B. Testing and 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-assurance and -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 other quality-assurance and -control procedures that facilitate compliance with the Contract Document requirements.
3. Requirements for Contractor to provide quality-assurance and -control services required by Architect, Owner, Commissioning Authority, or authorities having jurisdiction are not limited by provisions of this Section.
4. Specific test and inspection requirements are not specified in this Section.

1.3 DEFINITIONS

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

B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by Architect.

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

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

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

1.4 CONFLICTING REQUIREMENTS

A. Referenced Standards: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Architect for a decision before proceeding.

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

1.5 INFORMATIONAL SUBMITTALS

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

B. Qualification Data: For Contractor's quality-control personnel.

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

1. Seismic-force-resisting system, designated seismic system, or component listed in the designated seismic system quality-assurance plan prepared by Architect.

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

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

1.6 CONTRACTOR'S QUALITY-CONTROL PLAN

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

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

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

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

D. Testing and Inspection: In quality-control plan, include a comprehensive schedule of Work requiring testing or inspection, including the following:

1. Contractor-performed tests and inspections including subcontractor-performed tests and inspections. Include required tests and inspections and Contractor-elected tests and inspections.
2. Commissioning work to be performed by the Commissioning Authority.

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

1.7 REPORTS AND DOCUMENTS

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

1. Date of issue.
2. Project title and number.
3. Name, address, 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. Record of temperature and weather 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 Contractor performing test.

B. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:

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

C. 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.

1.8 QUALITY ASSURANCE

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

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

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. 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.

1.9 QUALITY CONTROL

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

1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
2. Where services are indicated as Contractor's responsibility, perform these quality-control services.
3. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
4. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.

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

C. Testing Agency Responsibilities: Cooperate with Architect, Commissioning Authority, and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.

1. Notify Architect, Commissioning Authority, and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
6. Do not perform any duties of Contractor.

D. 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.

E. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and -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, commissioning, and similar activities.

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

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

1.10 SPECIAL TESTS AND INSPECTIONS

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 Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 017300 "Execution."

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

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

END OF SECTION 014000

SECTION 015000 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.

B. Related Requirements:

1. Section 011000 "Summary" for work restrictions and limitations on utility interruptions.

1.3 USE CHARGES

A. General: Installation and removal of and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities to use temporary services and facilities without cost, including, but not limited to, Owner's construction forces, Architect, occupants of Project, testing agencies, and authorities having jurisdiction.

B. Water and Sewer Service from Existing System: Water from Owner's existing water system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.

C. Electric Power Service from Existing System: Electric power from Owner's existing system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.

1.4 INFORMATIONAL SUBMITTALS

A. Site Plan: Show temporary facilities, utility hookups, staging areas, and parking areas for construction personnel.

B. Fire-Safety Program: Show compliance with requirements of NFPA 241 and authorities having jurisdiction. Indicate Contractor personnel responsible for management of fire-prevention program.

C. Moisture-Protection Plan: Describe procedures and controls for protecting materials and construction from water absorption and damage.

1. Describe delivery, handling, and storage provisions for materials subject to water absorption or water damage.
2. Indicate procedures for discarding water-damaged materials, protocols for mitigating water intrusion into completed Work, and replacing water-damaged Work.
3. Indicate sequencing of work that requires water, such as sprayed fire-resistive materials, plastering, and terrazzo grinding, and describe plans for dealing with water from these operations. Show procedures for verifying that wet construction has dried sufficiently to permit installation of finish materials.

D. Dust- and HVAC-Control Plan: Submit coordination drawing and narrative that indicates the dust- and HVAC-control measures proposed for use, proposed locations, and proposed time frame for their operation. Identify further options if proposed measures are later determined to be inadequate. Include the following:

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

1.5 QUALITY ASSURANCE

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

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

C. Accessible Temporary Egress: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines, ICC/ANSI A117.1.

1.6 PROJECT CONDITIONS

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

PART 2 - PRODUCTS

2.1 MATERIALS

A. Portable Chain-Link Fencing: Minimum 2-inch (50-mm), 0.148-inch- (3.8-mm-) thick, galvanized-steel, chain-link fabric fencing; minimum 6 feet (1.8 m) high with galvanized-steel pipe posts; minimum 2-3/8-inch- (60-mm-) OD line posts and 2-7/8-inch- (73-mm-) OD corner and pull posts, with 1-5/8-inch- (42-mm-) OD top and bottom rails. Provide concrete bases for supporting posts.

B. Polyethylene Sheet: Reinforced, fire-resistive sheet, 10-mil (0.25-mm) minimum thickness, with flame-spread rating of 15 or less per ASTM E 84 and passing NFPA 701 Test Method 2.

C. Dust-Control Adhesive-Surface Walk-off Mats: Provide mats minimum 36 by 60 inches (914 by 1624 mm).

D. Insulation: Unfaced mineral-fiber blanket, manufactured from glass, slag wool, or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.

2.2 TEMPORARY FACILITIES

A. Field Offices, General: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading. Only provide if contractor believes it is necessary for his work.

B. Use Field Office: Of sufficient size to accommodate needs of construction personnel office activities and to accommodate Project meetings specified in other Division 01 Sections. Keep office clean and orderly. Furnish and equip offices as necessary for Contractor's work:

C. Storage and Fabrication Sheds: Storage and fabrication sheds are not allowed on this project site.

D. Outdoor Storage: Contractor can store materials outdoors on parking lot. Maximum storage area available is 20 ft by 40 ft. Provide temporary fence around storage area.

2.3 EQUIPMENT

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

B. HVAC Equipment: Unless Owner authorizes use of permanent HVAC system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.

1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.

2. Heating Units: Listed and labeled for type of fuel being consumed, by a qualified testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.
3. Permanent HVAC System: If Owner authorizes use of permanent HVAC system for temporary use during construction, provide filter with MERV of 8 at each return-air grille in system and remove at end of construction and clean HVAC system as required in Section 017700 "Closeout Procedures".

C. Air-Filtration Units: Primary and secondary HEPA-filter-equipped portable units with four-stage filtration. Provide single switch for emergency shutoff. Configure to run continuously.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.

1. Locate facilities to limit site disturbance as specified in Section 011000 "Summary."

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

3.2 TEMPORARY UTILITY INSTALLATION

A. General: Install temporary service or connect to existing service.

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

B. Water Service: Connect to Owner's existing water service facilities. Clean and maintain water service facilities in a condition acceptable to Owner. At Substantial Completion, restore these facilities to condition existing before initial use.

C. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.

1. Toilets: Use of Owner's existing toilet facilities will be permitted, as long as facilities are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore these facilities to condition existing before initial use.

D. Heating: Provide temporary heating required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low

temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.

E. Isolation of Work Areas in Occupied Facilities: Prevent dust, fumes, and odors from entering occupied areas.

1. Prior to commencing work, isolate the HVAC system in area where work is to be performed according to coordination drawings.

   a. Disconnect supply and return ductwork in work area from HVAC systems servicing occupied areas.
   b. Maintain negative air pressure within work area using HEPA-equipped air-filtration units, starting with commencement of temporary partition construction, and continuing until removal of temporary partitions is complete.

2. Maintain dust partitions during the Work. Use vacuum collection attachments on dust-producing equipment. Isolate limited work within occupied areas using portable dust-containment devices.
3. Perform daily construction cleanup and final cleanup using approved, HEPA-filter-equipped vacuum equipment.

F. Ventilation: Provide temporary ventilation required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce ambient condition required and minimize energy consumption.

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

H. Electric Power Service: Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations.
1. Connect temporary service to Owner's existing power source, as directed by Owner.

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

1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.
2. Install lighting for Project identification sign.

J. Provide superintendent with cellular telephone. No telephone service will be provided at the site.

3.3 SUPPORT FACILITIES INSTALLATION

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

B. Project Signs: Provide Project signs as indicated. Unauthorized signs are not permitted.

1. Identification Signs: Provide Project identification signs as indicated on Drawings.
2. Temporary Signs: Provide other signs as indicated and as required to inform public and individuals seeking entrance to Project.

a. Provide temporary, directional signs for construction personnel and visitors.

3. Maintain and touchup signs so they are legible at all times.

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

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

E. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.

1. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.

F. Existing Elevator Use: Use of Owner's existing elevators is not allowed.

G. Existing Stair Usage: Use of Owner's existing stairs will be permitted, provided stairs are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore stairs to condition existing before initial use.

1. Provide protective coverings, barriers, devices, signs, or other procedures to protect stairs and to maintain means of egress. If stairs become damaged, restore damaged areas so no evidence remains of correction work.

3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION

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

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

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

C. Tree and Plant Protection: Protect tree root systems from damage, flooding, and erosion.

D. Security Enclosure and Lockup: Install temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security. Lock entrances at end of each work day.

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

F. Temporary Egress: Maintain temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction.

G. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.

1. Where heating or cooling is needed and permanent enclosure is incomplete, insulate temporary enclosures.

H. Temporary Partitions: Provide floor-to-ceiling dustproof partitions to limit dust and dirt migration and to separate areas occupied by Owner from fumes and noise.

1. Construct dustproof partitions with gypsum wallboard with joints taped on occupied side, and fire-retardant-treated plywood on construction operations side.
2. Construct dustproof partitions with two layers of 6-mil polyethylene sheet on each side. Cover floor with two layers of 6-mil polyethylene sheet, extending sheets 18 inches up the sidewalls. Overlap and tape full length of joints. Cover floor with fire-retardant-treated plywood.

    a. Construct vestibule and airlock at each entrance through temporary partition with not less than 48 inches between doors. Maintain water-dampened foot mats in vestibule.

3. Where fire-resistance-rated temporary partitions are indicated or are required by authorities having jurisdiction, construct partitions according to the rated assemblies.
4. Insulate partitions to control noise transmission to occupied areas.
5. Seal joints and perimeter. Equip partitions with gasketed dustproof doors and security locks where openings are required.
6. Protect air-handling equipment.
7. Provide walk-off mats at each entrance through temporary partition.

I. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241; manage fire-prevention program.

1. Prohibit smoking in construction areas.
2. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of authorities having jurisdiction.
3. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.

4. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign stating that hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

3.5 OPERATION, TERMINATION, AND REMOVAL

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

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

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

C. Operate Project-identification-sign lighting daily from dusk until 12:00 midnight.

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

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

1. Materials and facilities that constitute temporary facilities are property of Contractor. Owner reserves right to take possession of Project identification signs.
2. Remove temporary roads and paved areas not intended for or acceptable for integration into permanent construction. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at temporary entrances, as required by authorities having jurisdiction.
3. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 017700 "Closeout Procedures."

END OF SECTION 015000

SECTION 017300 - EXECUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1. Construction layout.
2. Installation of the Work.
3. Cutting and patching.
4. Progress cleaning.
5. Starting and adjusting.
6. Protection of installed construction.
7. Correction of the Work.

B. Related Requirements:

1. Section 011000 "Summary" for limits on use of Project site.
2. Section 013300 "Submittal Procedures" for submitting surveys.
3. Section 017700 "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, and final cleaning.
4. Section 024119 "Selective Demolition" for demolition and removal of selected portions of the building.
5. Section 078413 "Penetration Firestopping" for patching penetrations in fire-rated construction.

1.3 DEFINITIONS

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

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

1.4 QUALITY ASSURANCE

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

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

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

3. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety.

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

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

PART 2 - PRODUCTS

2.1 MATERIALS

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

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

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

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

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

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

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

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

3.2 PREPARATION

A. 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.

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

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

3.3 CONSTRUCTION LAYOUT

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

3.4 INSTALLATION

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

1. Make vertical work plumb and make horizontal work level.
2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.

B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.

C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.

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

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

F. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.

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

H. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions.

1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.
2. Allow for building movement, including thermal expansion and contraction.
3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

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

3.5 CUTTING AND PATCHING

A. Cutting and Patching, General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.

1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.

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

C. Temporary Support: Provide temporary support of work to be cut.

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

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

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

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

1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
3. Concrete: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.

4. 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.
5. Proceed with patching after construction operations requiring cutting are complete.

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

1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will minimize evidence of patching and refinishing.

a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
b. Restore damaged pipe covering to its original condition.

3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.

a. Where patching occurs in a painted surface, prepare substrate and apply primer and intermediate paint coats appropriate for substrate over the patch, and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.

4. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition and ensures thermal and moisture integrity of building enclosure.

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

3.6 PROGRESS CLEANING

A. General: Clean Project site and work areas daily, including common areas. 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 waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F (27 deg C).

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

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

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

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

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

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

D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.

E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.

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

G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways.

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.

3.7 STARTING AND ADJUSTING

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

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

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

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

3.8 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.

END OF SECTION 017300

SECTION 017700 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1. Substantial Completion procedures.
2. Final completion procedures.
3. Warranties.
4. Final cleaning.
5. Repair of the Work.

1.3 ACTION SUBMITTALS

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

B. Certified List of Incomplete Items: Final submittal at Final Completion.

1.4 CLOSEOUT SUBMITTALS

A. Certificates of Release: From authorities having jurisdiction.

1.5 MAINTENANCE MATERIAL SUBMITTALS

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

1.6 SUBSTANTIAL COMPLETION PROCEDURES

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

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

1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
2. Submit closeout submittals specified in other Division 01 Sections, including project record documents, operation and maintenance manuals, final completion construction photographic documentation, damage or settlement surveys, property surveys, and similar final record information.
3. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
4. Submit maintenance material submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Architect. Label with manufacturer's name and model number where applicable.

    a. Schedule of Maintenance Material Items: Prepare and submit schedule of maintenance material submittal items, including name and quantity of each item and name and number of related Specification Section. Obtain Architect's signature for receipt of submittals.

5. Submit test/adjust/balance records.

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

1. Complete startup and testing of systems and equipment.
2. Perform preventive maintenance on equipment used prior to Substantial Completion.
3. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems.
4. Advise Owner of changeover in cooling and other utilities.
5. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
6. Complete final cleaning requirements, including touchup painting.
7. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.

D. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of 10 days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect 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, 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.

1.7 FINAL COMPLETION PROCEDURES

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

1. Submit a final Application for Payment according to Section 012900 "Payment Procedures."
2. Certified List of Incomplete Items: Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect. Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.

B. Inspection: Submit a written request for final inspection to determine acceptance a minimum of 10 days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect 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.

1.8 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

A. Organization 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 items applying to each space by major element, including categories for floors, equipment, and building systems.
2. Include the following information at the top of each page:

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

3. Submit list of incomplete items in the following format:

   a. PDF electronic file. Architect will return annotated file.

1.9 SUBMITTAL OF PROJECT WARRANTIES

A. Time of Submittal: 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, or when delay in submittal of warranties might limit Owner's rights under warranty.

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

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

1. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch (215-by-280-mm) 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.
4. Warranty Electronic File: Scan warranties and bonds and assemble complete warranty and bond submittal package into a single indexed electronic PDF file with links enabling navigation to each item. Provide bookmarked table of contents at beginning of document.

D. Provide additional copies of each warranty to include in operation and maintenance manuals.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 FINAL CLEANING

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

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

1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:

a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
c. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
d. Remove tools, construction equipment, machinery, and surplus material from Project site.
e. Remove snow and ice to provide safe access to building.
f. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
g. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
h. Sweep concrete floors broom clean in unoccupied spaces.
i. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean according to manufacturer's recommendations if visible soil or stains remain.
j. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Polish mirrors and glass, taking care not to scratch surfaces.
k. Remove labels that are not permanent.
l. Wipe surfaces of mechanical and electrical equipment and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
m. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
n. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency.
o. Leave Project clean and ready for occupancy.

3.2 REPAIR OF THE WORK

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

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

1. Remove and replace chipped, scratched, and broken glass, reflective surfaces, and other damaged transparent materials.

2. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that that already show evidence of repair or restoration.

    a. Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification.

3. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.
4. Replace burned-out bulbs, bulbs noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.

END OF SECTION 017700

SECTION 019113 - GENERAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. OPR and BoD documentation are included by reference for information only.

1.2 SUMMARY

A. Section includes general requirements that apply to implementation of commissioning without regard to specific systems, assemblies, or components.

B. Related Sections:

1. Section 230800 "Commissioning of HVAC" for commissioning process activities for HVAC&R systems, assemblies, equipment, and components.

1.3 DEFINITIONS

A. BoD: Basis of Design. A document that records concepts, calculations, decisions, and product selections used to meet the OPR 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.

B. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.

C. CxA: Commissioning Authority.

D. OPR: Owner's Project Requirements. A document that details the functional requirements of a project and the expectations of how it will be used and operated. These include Project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information.

E. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.4 COMMISSIONING TEAM

A. Members Appointed by Contractor(s): Individuals, each having the authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated action. 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.

B. Members Appointed by Owner:

1. CxA: The designated person, company, or entity that 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.

1.5 OWNER'S RESPONSIBILITIES

A. Provide the OPR documentation to the CxA for information and use.

B. Assign operation and maintenance personnel and schedule them to participate in commissioning team activities including, but not limited to, the following:

1. Coordination meetings.
2. Training in operation and maintenance of systems, subsystems, and equipment.
3. Testing meetings.
4. Demonstration of operation of systems, subsystems, and equipment.

C. Provide the BoD documentation, prepared by Architect and approved by Owner, to the CxA for use in developing the commissioning plan, systems manual, and operation and maintenance training plan.

1.6 EACH CONTRACTOR'S RESPONSIBILITIES

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

1. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.
2. Cooperate with the CxA for resolution of issues recorded in the Issues Log.
3. Attend commissioning team meetings held on a biweekly basis.
4. Integrate and coordinate commissioning process activities with construction schedule.
5. Review and accept construction checklists provided by the CxA.

6. Complete paper construction checklists as Work is completed and provide to the Commissioning Authority when completed.
7. Review and accept commissioning process test procedures provided by the Commissioning Authority.
8. Complete commissioning process test procedures.

B. Each Contractor shall assign representatives with expertise and authority to act on behalf of the Contractor and schedule them to participate in and perform commissioning team activities including, but not limited to, the following:

1. Participate in design- and construction-phase coordination meetings.
2. Participate in maintenance orientation and inspection.
3. Participate in operation and maintenance training sessions.
4. Participate in final review at acceptance meeting.
5. Certify that Work is complete and systems are operational according to the Contact Documents, including calibration of instrumentation and controls.
6. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.
7. Review and approve final commissioning documentation.

C. Subcontractors shall assign representatives with expertise and authority to act on behalf of subcontractors and schedule them to participate in and perform commissioning team activities including, but not limited to, the following:

1. Particpate in design- and construction-phase coordination meetings.
2. Participate in maintenance orientation and inspection.
3. Participate in procedures meeting for testing.
4. Participate in final review at acceptance meeting.
5. Gather and submit operation and maintenance data for systems, subsystems, and equipment to the CxA, as specified in Division 1 Section “Operation and Maintenance Data.”

1.7 CxA'S RESPONSIBILITIES

A. Organize and lead the commissioning team.

B. Prepare a construction-phase commissioning plan. Include design changes and scheduled commissioning activities coordinated with overall Project schedule.

C. Convene commissioning team meetings.

D. Provide Project-specific construction checklists and commissioning process test procedures.

E. Verify the execution of commissioning process activities using random sampling. The sampling rate may vary from 1 to 100 percent. Verification will include, but is not limited to, equipment submittals, construction checklists, training, operating and maintenance data, tests, and test reports to verify compliance with the OPR. When a random sample does not meet the requirement, the CxA will report the failure in the Issues Log. Review and comment on

submittals from Contractor for compliance with the OPR, BoD, Contract Documents, and construction-phase commissioning plan. Review and comment on performance expectations of systems and equipment and interfaces between systems relating to the OPR and BoD.

F. Prepare and maintain the Issues Log.

G. Prepare and maintain completed construction checklist log.

H. Witness systems, assemblies, equipment, and component startup.

I. Compile test data, inspection reports, and certificates; include them in the systems manual and commissioning process report.

J. Observe and inspect construction and report progress and deficiencies. In addition to compliance with the OPR, BoD, and Contract Documents, inspect systems and equipment installation for adequate accessibility for maintenance and component replacement or repair.

K. Prepare Project-specific test and inspection procedures and checklists.

L. Schedule, direct, witness, and document tests, inspections, and systems start-up.

M. Compile test data, inspection reports, and certificates and include them in the systems manual and commissioning report.

N. Certify date of acceptance and startup for each item of equipment for start of warranty periods.

O. Review Project Record Documents for accuracy.

P. Review and comment on operation and maintenance documentation and systems manual outline for compliance with the OPR, BoD, and Contract Documents.

Q. Prepare commissioning report.

R. Assemble the final commissioning documentation, including the commissioning report and Project Record Documents.

1.8 COMMISSIONING DOCUMENTATION

A. Index of Commissioning Documents: CxA shall prepare an index to include storage location of each document.

B. OPR: A written document, prepared by Owner, which details the functional requirements of Project and expectations of how it will be used and operated. This document includes project and design goals, measurable performance criteria, budgets, schedules, success criteria, and supporting information.

C. BoD Document: A document, prepared by Architect and Consultants, that records concepts, calculations, decisions, and product selections used to meet the OPR 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. Commissioning Plan: A document, prepared by CxA, that outlines the allocation of resources, and documentation requirements of the commissioning process, and shall include, but is not limited to the following:

1. Identification of items that must be completed before the next operation can proceed.
2. Description of responsibilities of commissioning team members.
3. Description of observations to be made.
4. Identification of installed systems, subsystems, and equipment, including design changes that occurred during the construction phase.

E. Test Checklists: CxA shall develop test checklists for each system, subsystem, or equipment including interfaces and interlocks, and include a separate entry, with space for comments, for each item to be tested. Prepare separate checklists for each mode of operation and provide space to indicate whether the mode under test responded as required. Provide space for testing personnel to sign off on each checklist. Specific checklist content requirements are specified in Division 1 Section "HVAC Commissioning Requirements." Each checklist, regardless of system, subsystem, or equipment being tested, shall include, but not be limited to, the following:

1. Name and identification code of tested item.
2. Time and date of test.
3. Indication of whether the record is for a first test or retest following correction of a problem or issue.
4. Dated signatures of the person performing the test and names of the witness, if applicable.
5. Deficiencies.

F. Test and Inspection Reports: CxA shall record test data, observations, and measurements on test checklists. Photographs, forms, and other means appropriate for the application shall be included with data. CxA shall compile test and inspection reports and test and inspection certificates and include them in systems manual and commissioning report.

G. Correction Action Documents: Retest systems and equipment requiring corrective action and document retest results at an additional fee.

H. Issues Log: CxA shall prepare and maintain an issues log that describes design, installation, and performance issues that are at variance with the OPR, BoD, and Contract Documents. Identify and track issues as sthey are encountered, documenting the status of unresolved and resolved issues.

I. Commissioning Report: CxA shall document results of the commissioning process including unresolved issues and performance of systems, subsystems, and equipment. The commissioning report shall indicate whether systems, subsystems, and equipment have been completed and are performing according to the OPR, BoD, and Contract Documents.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCOPE OF WORK

A. General Items Included:

1. Assist in OPR Creation:

   a. Verify that it meets customer requirements.
   b. Verify that OPR's communication is sufficient to be understood by the design team.
   c. Advise owner on the possible methods to enforce OPR.

2. Compare OPR to BOD:

   a. Verify that CD's meet the intent and requirements of the OPR and BoD.

3. Compare CD's to OPR and BOD:

   a. Verify that CD's meet the intent and requirements of the OPR and BoD.

4. Review Submittals and O&M's:

   a. Identify what the CD's require as far as contractor performance and equipment.
   b. Verify what is submitted meets the intent and requirements of the CD's OPR & BoD.
   c. Verify what equipment or contractor performances were actually provided and verify that it meets the intent and requirements of the CD's OPR and BoD primarily and matches the submittals secondarily.
   d. Verify O&M is complete and accurate.

5. Construction POR's:

   a. Cx Agent to provide three (3) construction phase site visits and project observation reports. Additional site visits to be subject to fee.

6. Post Construction POR's:

   a. Cx Agent to provide (3) post construction phase site visits and project observation reports. Additional site visits to be subject to fee.

7. Installation Checklists:

   a. Installation and startup checklists to be provided to the owner by the Cx Agent and be distributed to the construction team.
   b. Installation and startup checklists to be completed by contractor and returned to the owner. Post-Construction phase visits to commence only after these are received by the Cx Agent.
   c. Cx Agent to review installation and startup checklists, prior to functional testing.

8. Startup Technician Reports:

   a. Cx Agent to review manufacturer's equipment start-up checklists prior to functional testing.

9. Testing and Balancing Reports:

   a. Cx Agent to review completed Test and Balance Reports prior to functional testing.

10. Function Tests:

    a. To include but not limited to:

       1) Current, speed, RPM, voltage, pressure, flow and temperature readings.
       2) Verify T&B contractor's accuracy.
       3) Verify vendor's performance claims.
       4) Report equipment's actual performance and efficiency.
       5) Verify controls are working as needed for a successful project.

11. Summary:

    a. Cx Agent to provide a summary of the completed project.

B. Required Hours of Assistance by Contractors:

1. Sixteen (16) hours of assistance required from mechanical contractor to assist the owner's designated representative (Cx Agent).
2. Sixteen (16) hours of assistance required from controls contractor to assist the owner's designated representative (Cx Agent).
3. Four (4) hours of assistance required from test and balance contractor to assist the owner's designated representative (Cx Agent).
4. Four (4) hours of assistance required from general contractor to assist the owner's designated representative (Cx Agent).

C. Financial Compensation for Work Completed by Cx Agent:

1. Multiple submittal reviews due to:
2. Multiple O&M reviews due to:
3. Multiple CD reviews due to:
4. Multiple CD reviews due to
5. Multiple OPR creation meetings due to:
6. Multiple OPR vs. BoD reviews due to:
7. Excessive construction POR's due to:
8. Excessive post construction POR's due to:

D. Cx Agent's Required Qualifications are the following:

[x]Engineering Degree
[ ]P.E.
[ ]LEED AP
[ ]ASHRAE Certification
[x]Mechanical design experience
[x]Controls Experience
[ ]Other certification
[x]Cx experience

END OF SECTION 019113

SECTION 024119 - SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

B. Related Requirements:

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

1.3 DEFINITIONS

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

B. Remove and Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to Owner.

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

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

1.4 MATERIALS OWNERSHIP

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

1.5 PREINSTALLATION MEETINGS

A. Predemolition Conference: Conduct conference at Project site.

1. Inspect and discuss condition of construction to be selectively demolished.
2. Review 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.
5. Review areas where existing construction is to remain and requires protection.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For refrigerant recovery technician.

B. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered. Contractor to sell recovered refrigerant and credit this sum to Owner. Provide owner receipts from sales of refrigerant in order to document credit amount.

C. Warranties: Documentation indicated that existing warranties are still in effect after completion of selective demolition.

1.7 QUALITY ASSURANCE

A. Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved certification program.

1.8 FIELD CONDITIONS

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

B. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

C. 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 suspected hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.

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

E. 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.

PART 2 - PRODUCTS

2.1 PEFORMANCE REQUIREMENTS

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

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

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

C. 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.

3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

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

1. Comply with requirements for existing services/systems interruptions specified in Section 011000 "Summary."

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

1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
2. If services/systems are required to be removed or relocated, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
3. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated to be removed.

    a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
    b. Equipment to Be Removed: Disconnect and cap services and remove equipment.
    c. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
    d. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
    e. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.

C. Refrigerant: Remove refrigerant from mechanical equipment to be selectively demolished according to 40 CFR 82 and regulations of authorities having jurisdiction.

3.3 SELECTIVE DEMOLITION, GENERAL

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:

1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, 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 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.

B. 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.

3.4 DISPOSAL OF DEMOLISHED MATERIALS

A. General: Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, remove demolished materials from Project site.

1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.

B. Burning: Do not burn demolished materials.

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

3.5 CLEANING

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

END OF SECTION 024119

SECTION 078413 - PENETRATION FIRESTOPPING

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. Penetrations in fire-resistance-rated walls.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: A firm that has been approved by FM Global according to FM Global 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."

B. Installer Qualifications: A firm experienced in installing penetration firestopping similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its penetration firestopping products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

C. Fire-Test-Response Characteristics: Penetration firestopping shall comply with the following requirements:

1. Penetration firestopping tests are performed by a qualified testing agency acceptable to authorities having jurisdiction.
2. Penetration firestopping is identical to those tested per testing standard referenced in "Penetration Firestopping" Article. Provide rated systems complying with the following requirements:

a. Penetration firestopping products bear classification marking of qualified testing and inspecting agency.
b. Classification markings on penetration firestopping correspond to designations listed by the following:

1) UL in its "Fire Resistance Directory."
2) Intertek ETL SEMKO in its "Directory of Listed Building Products."
3) FM Global in its "Building Materials Approval Guide."

1.4 PROJECT CONDITIONS

A. Environmental Limitations: Do not install penetration firestopping when ambient or substrate temperatures are outside limits permitted by penetration firestopping manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.

B. Install and cure penetration firestopping per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

1.5 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping is installed according to specified requirements.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. A/D Fire Protection Systems Inc.
2. Grace Construction Products.
3. Hilti, Inc.
4. Johns Manville.
5. Nelson Firestop Products.
6. NUCO Inc.
7. Passive Fire Protection Partners.
8. RectorSeal Corporation.
9. Specified Technologies Inc.
10. 3M Fire Protection Products.
11. Tremco, Inc.; Tremco Fire Protection Systems Group.
12. USG Corporation.

2.2 PENETRATION FIRESTOPPING

A. Provide penetration firestopping that is produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.

B. Penetrations in Fire-Resistance-Rated Walls: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.

1. F-Rating: Not less than the fire-resistance rating of constructions penetrated.

C. VOC Content: Penetration firestopping sealants and sealant primers shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Sealants: 250 g/L.
2. Sealant Primers for Nonporous Substrates: 250 g/L.
3. Sealant Primers for Porous Substrates: 775 g/L.

D. Low-Emitting Materials: Penetration firestopping sealants and sealant primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping manufacturer and approved by qualified testing and inspecting agency for firestopping indicated.

1. Permanent forming/damming/backing materials, including the following:

a. Slag-wool-fiber or rock-wool-fiber insulation.
b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
c. Fire-rated form board.
d. Fillers for sealants.

2. Temporary forming materials.
3. Substrate primers.
4. Collars.
5. Steel sleeves.

2.3 FILL MATERIALS

A. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.

B. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.

C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.

D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized-steel sheet.

E. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.

F. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.

G. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.

H. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.

I. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

J. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces, and nonsag formulation for openings in vertical and sloped surfaces, unless indicated firestopping limits use of nonsag grade for both opening conditions.

2.4 MIXING

A. For those products requiring mixing before application, comply with penetration firestopping manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.

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

3.2 PREPARATION

A. Surface Cleaning: Clean out openings immediately before installing penetration firestopping to comply with manufacturer's written instructions and with the following requirements:

1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping.
2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Priming: Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking Tape: Use masking tape to prevent penetration firestopping from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing firestopping's seal with substrates.

3.3 INSTALLATION

A. General: Install penetration firestopping to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestopping.

C. Install fill materials for firestopping by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 CLEANING AND PROTECTION

A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping manufacturers and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping is without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping and install new materials to produce systems complying with specified requirements.

END OF SECTION 078413

SECTION 221410 - PLUMBING PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Water Piping.

B. Soil, Waste and Vent Piping.

C. Compressed Air Piping.

D. Testing.

1.2 PRODUCTS INSTALLED BUT NOT FURNISHED IN THIS SECTION

A. Motorized ball valves for in-line solids separator systems specified in Section 236400 - Refrigeration.

1.3 RELATED REQUIREMENTS

A. The General Conditions, Supplementary Conditions and Division 1, General Requirements apply to this Section, and Contractor shall review and adhere to all requirements of these documents.

B. Section 230500 - Basic Mechanical Requirements.

1.4 RELATED SECTIONS

A. Section 230529 - Basic Mechanical Materials and Methods.

B. Section 230540 - Mechanical Sound and Vibration Control.

C. Section 230548 - Mechanical Seismic Control.

D. Section 230700 - Mechanical Insulation.

E. Section 221411 - Disinfecting Water Supply System.

F. Section 221430 - Plumbing Specialties.

G. Section 224440 – Plumbing Fixtures.

H. Section 224460 - Special Plumbing Equipment Systems.

1.5 SUBMITTALS

A. Submit Product Data for the following items under provisions of the General Conditions of the Contract:

1. Water Piping, Fittings, and Joints.

PART 2 - PRODUCTS

2.1 WATER PIPE, TUBE, FITTINGS AND JOINTS

A. Interior Tube Supported by Hangers and Clamps:

1. Provide ASTM B88 Type L hard drawn copper tube for all water distribution piping inside building/structure, with wrought copper fittings and couplers up to 6", cast brass or bronze fittings and couplers for sizes 6" and larger. Joints shall be 95-5 Class SnSb solder or Victaulic CTS roll-grooved couplers and fittings for 3” and larger tube.

2.2 SOIL DRAIN WASTE, VENT AND STORM PIPE FITTINGS AND JOINTS

A. General:

1. Cast iron pipe centrifugally cast service weight (SV) soil pipe with cast iron drainage fittings conforming to ASTM A 74. Joint materials and systems may be hub and spigot with neoprene gaskets and lubricant conforming to ASA-021 and ASTM C-564 SV pattern. Gaskets shall be equal to U.S. Pipe Company Veri-tite conforming to ASTM-C564 and/or CISPI HSN75 and be certified in writing to the Engineer that the following criteria has been met, thru testing by a recognized independent testing laboratory. Cast iron hubless pipe and fittings conforming to ASTM A 888 or CISPI 301. Hubless couplings shall conform to ASTM C 1277 for standard and ASTM C 1540 for heavy duty or CISPI 310.

   Criteria: Sizes 2" thru 6" shall withstand 15 psig hydrostatic pressure for 10 minutes with <u>unrestrained</u> joints, and no leakage, and using restrained joints must be able to withstand 25 psig air pressure and 40 psig hydrostatic pressure with no leakage. Offset joints shall withstand 1056 pounds of horizontal force without joint separation or detectable leakage.

B. Buried Pipe:

1. Provide SV hub and spigot cast iron pipe and fittings to 5'-0" beyond building excavation line, continue past this point with SV cast iron or XS vitrified clay to termination points with hub and spigot joints. At Contractor's option and where approved by local jurisdiction, No-Hub standard weight cast iron pipe with either M-G couplings or heavy-duty stainless steel shielded couplings may be used in lieu of hub and spigot with Ty-Seal neoprene gaskets. The heavy-duty shielded couplings shall comply with ASTM C1540, with ASTM C564 neoprene gaskets, minimum 0.008" stainless steel shields with transverse corrugations across longitudinal corrugations, standard 304 stainless steel clamps and 305 stainless steel screws. Entire assembly shall be suitable for direct burial, be corrosion resistant, and accommodate pipe deflection.

C. Interior Pipe Supported By Hangers and Clamps:

1. Provide hubless cast iron pipe using hubless cast iron soil pipe couplings certified to withstand a minimum of 50 psi internal pressure. Where stack pressures may theoretically exceed 50 psi, use clamp all or heavy-duty couplings with restrained joints horizontal and vertical up to 80 psig. For pressures above 80 psi, use Schedule 40 ASTM A-120 galvanized steel pipe with threaded cast iron drainage fittings. Roll grooved schedule 40 pipe with Victaulic Style 77M galvanized couplers may be used on horizontal and vertical stacks and mains. Use Teflon tape or compound for all threaded joint make-up.
2. Sump pump discharge from the pump to the point the waste stream flows continuously via gravity shall be Schedule 40 galvanized steel pipe with NPT threaded joints and fittings.
3. Copper Waste, Vent and Soil Pipe and Fittings shall be prohibited on this project.

2.3 COMPRESSED AIR

A. Provide Type L Copper tubing and wrought copper fittings with "95-5" Class Sn Sb, soldered joints or Schedule 40 black steel piping with welded joints. Screwed joints may be used on piping under 4" diameter. Press fittings shall conform to material requirements of ASME B16.18 or ASME B16.22 and performance criteria of IAPMO PS 117.

PART 3 - EXECUTION

3.1 WATER TUBE, FITTINGS AND JOINTS

A. General:

1. All copper tube and fittings shall be reamed and buffed prior to soldering or brazing.

2. The use of lead solder of any class, for joint make-up or back-up for finishing is prohibited.
3. Refer and conform to the Copper Development Association instructions for proper preparation and actual installation practice for all soldered and brazed joints.

4. Support water tube in accordance with Section 230529.
5. Pull tee (T-drill) fittings are forbidden.

3.2 CLEANING

A. Remove temporary coverings and protection of adjacent work areas.

B. Repair or replace damaged installed products.

C. Clean installed products in accordance with manufacturer's instructions prior to owner's acceptance.

D. Remove construction debris from project site and legally dispose of debris.

3.3 PROTECTION

A. Protect installed work from damage due to subsequent construction activity on the site.

3.4 SOIL, DRAIN, WASTE, VENT AND STORM PIPE FITTINGS AND JOINTS

A. General:

1. Provide bedding, restraints and hangers as appropriate and in accordance with manufacturers recommendations based upon type of pipe, fittings, joints, and bury depth using final finished grading as the basis.
2. Piping shall be run true, plumb, and straight, with all restraints and hangers adjusted to carry their proportional load and locked to prevent pipe "wag" misalignment, movement or shear.
3. Provide anchors for piping risers on every floor using riser clamps, wall brackets, knee brackets, and foot blocks for all vertical piping over 20 feet straight height.
4. Furnish and install all soil, waste and vent piping for the complete sanitary system in accordance with jurisdictional code requirements.
5. All soil and waste piping shall be run at the following minimum slope unless otherwise indicated on drawings.

Slope of Horizontal Drainage Pipe	
Size (In.)	Min. Slope (In./Ft.)
2-1/2 or less	1/4
3 to 6	1/8
8 or larger	1/16

6. Bushings in soil waste or vent piping shall be prohibited. Tapped spigots or tees shall be used when changing from cast iron pipe to steel waste or vent piping, and for appropriate cleanout plugs.
7. Vertical Piping: All vertical soil and vent stacks shall be supported with riser clamps at each floor slab. When soil stacks over two stories in height terminate at the bottom on slab fill or native soil, provide stack base elbows set on 24" x 24" x 8" thick minimum poured reinforced concrete pads set directly on undisturbed native soil or fill compacted to same density as undisturbed earth.
8. Horizontal Piping (suspended):

    a. Supports - Horizontal piping shall be supported at sufficiently close intervals to keep it in alignment and prevent sagging.
    b. Cast iron soil pipe - Where joints occur, suspended cast iron soil pipe shall be supported at not more than five (5) foot intervals; except that pipe exceeding five (5) feet in length, may be supported at not more than ten (10) foot intervals. Supports shall be adequate to maintain alignment and prevent sagging and shall be placed within eighteen (18) inches of the hub or joint. Hubless or compression gasket joints must be supported at least at every other joint except that when the developed length between supports exceeds four (4) feet, they shall be provided at each joint. Supports shall also be provided at each horizontal branch connection. Supports shall be placed on or immediately adjacent to the coupling. Suspended lines shall be suitably braced to prevent horizontal movement.
    c. Threaded pipe - Threaded pipe (IPS), shall be supported in accordance with Section 230529.
    d. Rigid support sway bracing shall be provided at changes in direction greater than 45 degrees for pipe sizes 4 inches and larger.
    e. For pipe sizes greater than 4 inches, axial restraints shall be provided for drain pipes at all changes in direction and at all changes in diameter greater than two pipe sizes.

9. The waste connections between fixtures and their respective collection and venting systems shall consist of galvanized steel nipples and cast iron drainage fittings.
10. All interior waste, soil, and vent piping up to 1-1/2" shall consist of galvanized steel with cast iron drainage fittings, all piping 1-1/2" and over shall consist of S.V. cast iron soil pipe and fittings.
11. All pipe and fittings shall have affixed thereon the CISPI grade mark of identification.
12. All vents shall be installed through the roof of at least the minimum size as required by jurisdictional code and shall be cast iron.
13. All vents protruding through the roof shall be not less than 2" size and extended to not less than 12 inches above the finished roof. Vents through built-up roofing shall be flashed with 24" x 24" x 4 lb. sheet lead. The flashing shall extend to top of vent and the edges turned down into a cast iron vent pipe. Single ply rubberized roofing systems shall be flashed around vent with top edge of roofing clamped to vent pipe and sealed with compatible sealant.

14. All vents shall be located in accordance with jurisdictional code and in no case less than two (2) feet from roof edge or parapet, or wall line of an "on the roof structure". Vent terminations shall not occur within twenty-five (25) feet of any outside air intake.
15. Provide all expansion joints, braces, earthquake restraints as required by the contract documents (Section 230548) and jurisdictional authority.

3.5 PROHIBITED PIPE ROUTING

A. Plumbing piping, regardless of contents (water, sewer, vent, etc.) shall not be routed through or above the following locations:

1. Electrical panel rooms
2. Electrical switch gear rooms
3. Electrical transformer rooms
4. Elevator shafts
5. Elevator equipment rooms
6. Data Centers
7. File Server Rooms / MDF / IDF

B. Should there be a conflict with the plans and the above paragraph, notify the Engineer immediately for corrective action prior to starting work.

3.6 COMPRESSED AIR

A. Provide compressed air piping pitched to low points at 1" per 40 ft (min.) with drain valve at all low points. All branch line takeoffs from CA main shall be made from top of main.

B. Provide filters and separators for all spray paint supply branches.

C. Provide lubricators and filters for all pneumatic hand tools requiring lubrication.

D. Provide ball valves for all main line and branch shut-offs.

E. Provide all gauges, accessories and connectors required to match new or existing system and components.

B. Provide quick disconnect fittings compatible with owner's equipment at each branch line termination. Terminations shall be at 4 ft. A.F.F. unless noted otherwise.

3.7 TESTING

A. Schedule of Testing:

Service	Allowable Test Methods H_2O	CA	N_2	V	Minimum Test Pressure (psig)	Minimum Test Period (minutes)	Allowable Pressure Variance (psig)
1. Potable Water Pipe Valves & Fittings	X	 X			125 100	60 60	-0- +1/2
2. Sanitary, Storm & Acid Waste and Vent System:							
*Stack Height:							
0-23 FT.	X				10	30	-0-
24-34 FT.	X				15	30	-0-
35-46 FT.	X				20	20	-0-
47-57 FT.	X				25	20	-0-
58-69 FT.	X				30	10	-0-
70-80 FT.	X				35	10	-0-
81-92 FT.	X				40	10	-0-
93-103 FT.	X				45	10	-0-
Over 104 FT.	X				50	10	-0-
3. Compressed Air:							
Single Stage Compressor		X	X		100	30	+ 1/2
Two Stage Compressor		X	X		200	30	+ 1/2

B. Testing connections for hydrostatic tests shall be made at the base of the system, CA, N2 and vacuum testing can be made from connections anywhere in the system tested.

C. In the event that tests fail, use a standard soap and brush inspection using "Trouble Bubble" Liquid high density soap as manufactured by Jersey Meter Co., Patterson N.J. Formula ST-1. After source of failure is discovered, correct and retest system. Repeat procedure until system sustains required testing successfully.

D. Testing contractor shall give at least 16 working hours notice to the General Contractor/Construction Manager so that arrangements for witnessing tests can be made. The General Contractor/Construction Manager shall witness and SIGN the required test form.

E. All joints, valves, fittings and piping accessory items shall be exposed to view during tests whether pipe is above or below ground. "Closed in" or "Buried" piping shall be re-exposed during testing.

F. Proper restraining of piping and test plugs shall be accomplished prior to test.

END OF SECTION 221410

SECTION 221411 - DISINFECTING WATER SUPPLY SYSTEM

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Disinfection of Domestic Water Supply System.

1.2 RELATED WORK

A. Requirements: Provide Disinfecting Water Supply System in accordance with the Contract Documents.

B. Section 230500 - Basic Mechanical Requirements.

C. Section 221410 - Plumbing Piping.

1.3 DEFINITIONS

A. Disinfectant residual means the quantity of disinfectant in treated water.

B. pH factor means the measure of alkalinity and acidity in water.

C. ppm means parts per million.

1.4 CONTRACTOR'S QUALIFICATIONS

A. Water Treatment Contractor: At least three years experience performing work specified herein.

B. Bacteriological Laboratory: Certified by Serving Water Board or District and be in compliance with the State and U.S. Safe Drinking Water Act.

1.5 REGULATORY AGENCY REQUIREMENTS

A. Comply with requirements of Local and State Regulations.

1.6 SUBMITTALS

A. Submit for review and acceptance the following items under provisions of the General Conditions of the Contract:

1. Water treatment contractor's evidence of experience.
2. Bacteriological laboratory's evidence of certification.

B. Submit printed data for the following items under provisions of Operating and Maintenance Data paragraph in Section 230500:

1. Disinfection Report:

a. Include the following:

Date issued.

Project name and location.

Treatment Contractor's name, address, and phone number.

Type and form of disinfectant used.

Time and date of disinfectant injection start.

Time and date of disinfectant injection completion.

Test locations.

Initial and 24 hour disinfectant residuals in ppm for each outlet tested.

Time and date of flushing start.

Time and date of flushing completion.

Disinfectant residual after flushing in ppm for each outlet tested.

2. Bacteriological Report:

a. Include the following:

Date issued.

Project name and location.

Laboratory's name, certification number, address and phone number.

Time and date of water sample collection.

Name of person collecting samples.

Test locations.

Time and date of laboratory test start.

Coliform bacteria test results for each Outlet tested. Certification that water conforms or fails to conform to bacterial standards of State and Federal Safe Drinking Water Act.

Bacteriologist's signature.

1.7 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Protect against damage and discoloration.

B. Maintain caution labels on hazardous materials.

C. Maintain storage room dry and with temperatures as uniform as possible between 60 deg.F and 80 deg.F.

D. Do not store Caustic Soda directly on floor colder than 55 deg.F.

1.8 PROTECTING WORK OF OTHER TRADES

A. Provide necessary signs, barricades, and notices to prevent any person from accidentally consuming water or disturbing system being treated.

B. Protect against damage and discoloration caused by work of this Section.

PART 2 - PRODUCTS

2.1 DISINFECTANT

A. Free chlorine; liquid, powder, tablet, or gas.

2.2 ALKALI

A. Caustic Soda or Soda Ash.

2.3 ACID

A. Hydrochloric type.

PART 3 - EXECUTION

3.1 EXISTING CONDITIONS

A. Prior to starting work, verify that Domestic Water System is completed, flushed and clean.

B. Prior to starting work, notify Construction Manager/General Contractor of any defects requiring correction.

C. Do not start work until conditions are satisfactory.

3.2 PREPARATION OF WATER FOR TREATMENT

A. Verify pH factor of water to be treated.

B. If pH factor is less than 7.4, introduce sufficient alkali during disinfectant injection to produce 7.4 to 7.6 pH level.

C. If pH factor is greater than 7.6, introduce sufficient acid during disinfectant injection to lower pH to 7.4 to 7.6 level.

3.3 SYSTEM TREATMENT

A. Inject disinfectant throughout system to obtain 50 to 80 ppm residual.

B. Starting at outlet closest to water sources, bleed water from each outlet until water produces odor of disinfectant. Repeat process at each outlet throughout system.

C. Test for disinfectant residual at each of the following locations:

1. Ends of piping runs.
2. Remote outlets. (Ends of each multiple fixture branch line)
3. Tanks and domestic water heaters.
4. At least 15% of outlets on each floor as directed by Architect/Engineer.

D. Maintain disinfectant in system for 24 hours.

E. If resultant disinfectant residual test is less than 25 ppm, repeat System Treatment.

3.4 FLUSHING

A. Flush disinfectant from entire system; permit no more than residual rate of supplied incoming water.

3.5 BACTERIOLOGICAL TEST

A. Instruct Bacteriological Laboratory to take water samples no sooner than 24 hours after flushing system.

B. Take water samples at each of the following locations:

1. Where water enters system.
2. Ends of piping runs.
3. Remote outlets.
4. Tanks.
5. At least 10% of outlets on each floor other than those used for testing disinfectant residual, where directed by Architect/Engineer, but in no case less than 2 outlets per floor.

C. Analyze Water Samples in accordance with Standard Methods for the examination of Water & Waste Water, published by American Water Works Assoc., 6666 W. Quincy Ave., Denver, CO 80235.

D. If Bacteriological Test proves water quality to be unacceptable, repeat System Treatment.

3.6 PRODUCT CLEANING & REPAIRING

A. Including work of other trades, clean, repair and touch-up, or replace when directed, products which have been soiled, discolored, or damaged by work of this Section.

B. Remove debris from Project Site upon work completion or sooner, if directed.

END OF SECTION 221411

SECTION 230500 - BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Basic requirements common to the work in general of Division 23 and other Divisions and Sections of the Specification where referenced.

B. Provide, unless specified otherwise, all labor, materials and equipment necessary for completely finished and operational mechanical systems described and specified under other Sections of this Division 23.

C. Provide all minor incidental items such as offsets, fittings, and accessories required as part of the work even though not specified or indicated.

D. Inspection: Inspect work preceding or interfacing with work of Division 23 and report any known or observed defects that affect the Work to the Construction Manager/General Contractor. Do not proceed with the work until defects are corrected.

E. Existing Utilities: Are indicated as accurately as possible on the Drawings. Close openings and repair damage in acceptable manner to utilities encountered. This Contractor shall be responsible for field surveying all aspects of existing conditions prior to bid date. Change orders will not be issued for a failure to review existing conditions which affect Division 23000 work.

1.2 RELATED WORK

A. Requirements: Provide Basic Requirements in accordance with the Contract Documents.

1.3 UTILITIES, EXTENSIONS, CONNECTIONS AND FEES FOR WATER AND SEWER

A. Provide all building services are existing, no connections to off-site utilities are required.

1.4 REFERENCES

A. General:

1. For products or workmanship specified by association, trade, or Federal Standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.
2. The date of the standard is that in effect at the date of the Contract Documents, except when a specific date is specified.

3. When required by individual Specification sections, obtain copy of standard. Maintain copy at job site during work until substantial completion.

B. Schedule of Referenced Organizations: The following is a list of the acronyms of organizations referenced in these Specifications:

ADC	Air Diffusion Council 1000 E. Woodfield Rd. Schaumburg, IL 60173 www.flexibleduct.org
AGA	American Gas Association 400 No. Capitol St. N.W. Washington, DC 20001 www.aga.org
AMCA	Air Movement and Control Association 30 West University Drive Arlington Heights, IL 60004 www.amca.org
ANSI	American National Standards Institute 1819 L Street N.W. Washington, DC 20036 www.ansi.org
ARI	Air Conditioning and Refrigeration Institute 4301 No. Fairfax Drive. Arlington, VA 22203 www.ari.org
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers 1791 Tullie Circle, N.E. Atlanta, GA 30329 www.ashrae.org
ASME	American Society of Mechanical Engineers Three Park Avenue New York, NY 10016 www.asme.org
ASPE	American Society of Plumbing Engineers 8614 W. Catalpa Ave. Chicago, IL 60656 www.aspe.org

ASSE	American Society of Sanitary Engineering 901 Canterbury Westlake, OH 44145 www.asse-plumbing.org
ASTM	American Society for Testing and Materials 100 Barr Harbor Dr. West Conshohoeken, PA 19428 www.astm.org
AWS	American Welding Society 550 N.W. LeJeune Rd. Miami, FL 33126 www.aws.org
AWWA	American Water Works Association 6666 West Quincy Avenue Denver, CO 80235 www.awwa.org
CDA	Copper Development Association 260 Madison Avenue New York, NY 10016 www.copper.org
CISPI	Cast Iron Soil Pipe Institute 5959 Shallow Ford Rd., Suite 419 Chattanooga, TN 37421 www.cispi.org
CS	Commercial Standard of NBS (U.S. Dept. of Commerce, National Institute of Standards and Technology) Government Printing Office Washington, D.C. 20402
CTI	Cooling Technology Institute 530 Wells Fargo Drive Houston, TX 77090 www.cti.org
ICC	International Code Council 5203 Leesburg Pike, Suite 600 Falls Church, VA 22041 www.intlcode.org

IAPMO	International Association of Plumbing and Mechanical Officials 20001 E. Walnut Drive South Walnut, CA 91789 www.iapmo.org
NEBB	National Environmental Balancing Bureau 8575 Grovemont Circle Gaithersburg, MD 20877 www.nebb.org
NEC	National Electric Code (of NFPA)
NEMA	National Electric Manufacturer's Association 1300 N. 17th Street Rosslyn, VA 22209 www.nema.org
NFPA	National Fire Protection Association One Batterymarch Park P.O. Box 9101 Quincey, MA 02269 www.nfpa.org
NSF	NSF International 789 No. Dixboro Rd. Ann Arbor, MI 48113 www.nsf.gov
OSHA	Occupational Safety Health Administration (U.S. Dept. of Labor) Government Printing Office Washington, D.C. 20402 www.osha.gov
PDI	Plumbing and Drainage Institute 45 Brystal Drive South Easton, MA 02375 www.pdionline.org
SMACNA	Sheet Metal and Air Conditioning Contractor's National Association 4201 Lafayette Center Drive Chantilly, VA 20151 www.smacna.org

UL	Underwriters Laboratories, Inc. 333 Pfingston Rd. Northbrook, IL 60062 www.ul.com

1.5 DEFINITIONS

A. Specification Language Explanation: These Specifications are of abbreviated, simplified or streamlined type and include incomplete sentences. Omissions of words of phrases such as "the Contractor shall", "in conformity therewith", "shall be", "as noted on the drawings", "a", "the", are intentional. Supply when "NOTE" occurs on Drawings. Supply words "shall be" or "shall" by inference when colon is used with sentences or phrases. Supply words "on the Drawings" by inference when "as indicated" is used with sentences or phrases. Singular words will be interpreted as plural and plural words will be interpreted as singular where applicable and where full context of the Contract Documents so indicates.

B. Furnish: Except as otherwise defined in greater detail, term "furnish" is used to mean supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, etc., as applicable in each instance.

C. Install: Except as otherwise defined in greater detail, term "install" is used to describe operations at Project site including unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning and similar operations, as applicable in each instance.

D. Provide: Except as otherwise defined in greater detail, term "provide" means furnish and install, complete and ready for intended use, as applicable in each instance.

E. Indicated: The term "Indicated" is a cross-reference to graphics, notes or schedules on Drawings, to other paragraphs or schedules in the Specifications, and to similar means of recording requirements in contract documents. Where terms such as "shown", "noted", "scheduled", and "specified" are used in lieu of "indicated", it is for purpose of helping reader locate cross-reference, and no limitation of location is intended except as specifically noted.

F. General Contractor: The term "General Contractor" used in Division 23 and elsewhere in the Contract Documents means the party with whom the Owner has executed the Owner-Contractor Agreement.

G. Approved Equal: Except as otherwise defined in greater detail, term "approved equal" means that any materials, equipment, work procedures and techniques shall be either addressed on the drawing, specifications or addendum by manufacturer or by detailed material description. When brand names are referenced it implies that only the manufacturers listed are approved. All approved material, equipment, work procedures, and techniques will be noted in the specifications, drawings, or by addendum prior to bid date. Items not approved in this manner will not be considered.

1.6 QUALITY ASSURANCE

A. Quality Control:

1. Materials and apparatus required for the work to be new and of first-class quality; to be furnished, delivered, erected, connected and finished in every detail; and to be so selected and arranged so as to fit properly into the building spaces. Where no specific kind or quality of material is given, a first-class standard article shall be furnished.
2. Furnish the services of an experienced superintendent, who will be constantly in charge of the installation of the work, together with all skilled workmen, fitters, metal workers, certified welders, plumbers, millwrights, sprinkler fitters, drain layers, helpers, and labor required to unload, transfer, erect, connect, adjust, start, operate and test for each system.
3. Unless otherwise specifically indicated, equipment and materials to be installed in accordance with the recommendations of the manufacturer. This includes the performance of tests as recommended by the manufacturer.

B. Proof of Performance:

1. Division 23 Contractor shall provide proof of performance certification of all Mechanical Equipment and Systems to demonstrate that all Mechanical Equipment and Systems are operating to the intent of the design. This proof of performance shall include, but shall not be limited to, actual demonstration of all temperature/pressure control loops, operation of all heating/cooling equipment and other required tests upon request by the Engineer or Owner. A signed certificate from the piping, sheet metal, control, and balancing subcontractors stating that they have personally checked the operation of all equipment and control loops and that everything under their subcontract is operating as specified. These certificates shall be furnished to the 230593 Contractor for inclusion in the Operation and Maintenance Manual.

1.7 REGULATORY REQUIREMENTS

A. Execute work per Underwriters, Public Utility, Local and State Codes, Ordinances and applicable regulations. Obtain and pay for required permits, inspections, and certificates. Notify Architect of items not meeting said requirements.

B. Comply with editions of all applicable codes, ordinances and regulations in effect at the time of bid opening including but not necessarily limited to the following:

International Mechanical Code
International Plumbing Code
State Department of Health Requirements
State Energy Code
National Fire Protection Association Standards
International Fire Code
International Building Code
National Electrical Code NFPA-70
State Boiler Code
Jurisdictional County Health Department
Jurisdictional City Wastewater Management Division or District
Jurisdictional City Water Department
Jurisdictional Water Conservation Standards

C. If discrepancies occur between the Contract Documents and any applicable codes, ordinances, acts, or standards, the most stringent requirements shall apply.

D. Where hourly fire ratings are indicated or required, provide components and assemblies meeting requirements of the IBC, and listed by Underwriters Laboratories, Inc.

1.8 SUBMITTALS

A. Submit Samples, Shop Drawings and Product Data as required by various Sections of Division 23 in accordance with The General Conditions of the Contract. The Contractor agrees that these Submittals processed by the Engineer are not Change Orders; that the purpose of these Submittals by the Contractor is to demonstrate to the Engineer that the Contractor understands the design concept, that he demonstrates his understanding by indicating which equipment and material he intends to furnish and install and by detailing the fabrication and installation methods he intends to use. Contractor further agrees that if deviations, discrepancies, or conflicts between these Submittals and the Contract Documents in the form of design drawings and specifications are discovered either prior to or after these Submittals are processed by the Engineer, the Design Drawings and Specifications shall control and shall be followed.

B. The submittals shall be submitted in a single package with all mechanical equipment for the project enclosed. The submittals shall be enclosed in a stiff back, 3-ring binder. All mechanical equipment shall be separated with tabbed index cards with an indexed legend provided in the front of the binder.

C. Test Reports: Submit certified test reports as required by various Sections of Division 23 showing compliance in accordance with General Conditions of the Contract. Signed copies shall be included in the Operation and Maintenance Manual.

D. Operating Instructions and Maintenance Data: Prepare and submit printed operating instructions and maintenance data in accordance with Operating and Maintenance Data paragraph in this Section.

E. Submittals will be reviewed and marked as follows:

1. No Exceptions Taken: No action required.
2. Make Corrections Noted: Correct the submittals per notes by engineer and submit new copies of submittal to contractor for project records. Do not resubmit to engineer.
3. Rejected: Equipment as submitted does not meet requirements of contract documents. Revise and/or clarify per comments and resubmit to engineer.
4. Submittal Not Requested: Submittal not required per specification. Submittal returned with no review.

F. Note that the submittal review process does not relieve Contractor from being ultimately responsible for ensuring that submitted items satisfy all requirements of the Contract Documents.

G. Site Condition and Coordination:

1. Before any ductwork is fabricated or equipment installed and before running and/or fabricating any lines of piping or ductwork, the Contractor shall provide Architect and Engineer ¼" scale drawings of all mechanical rooms and main access walkways, coordinated with all trades with submitted equipment and verify all other areas to assure himself that they can be run and installed as contemplated in cooperation with Contractors of other Divisions of the Work and the physical constraints of the Structural and Architectural Work and maintain access walkways are clear for maintenance.

1.9 PRODUCT OPTIONS AND SUBSTITUTIONS

A. Substitutions and Prior Approvals: Substitutions and prior approvals will be acceptable only when the proposed substitute has been submitted to the Engineer and approved through an addendum or change order. Request for prior approval shall be submitted a minimum of 10 calendar days prior to bid.

B. Some materials and equipment are specified by manufacturer and catalog numbers. The manufacturer and catalog numbers are used to establish a degree of quality and style for such equipment and material.

C. NOTE: When alternate or substitute materials and equipment are used Division 23 Contractor shall be responsible for engineering/redesign costs, space requirements, configurations, performance, changes in bases, supports, structural members and openings in structure, electrical changes and other apparatus and trades that may be affected by their use. Notification of General Contractor and other affected subcontractors shall be the responsibility of the Division 23 Contractor.

1.10 PROJECT RECORD DOCUMENTS

A. General: Comply with Division 1.

B. Job Site Documents: Maintain at the job site, one record copy of the following:

1. Drawings
2. Specifications
3. Addenda
4. Reviewed Shop Drawings
5. Field Test Records

Do not use record documents for construction purposes. Maintain documents in clean, dry legible condition, apart from documents used for construction.

C. Record Information: Label each document "Record Document". Mark information with red ink. Keep each record current. Do not permanently conceal any work until required information is recorded.

D. Record following information on Drawings:

1. Horizontal and vertical location of underground utilities to be dimensioned from column lines.
2. Dimensioned location of internal utilities and appurtenances concealed in construction.
3. Field changes of dimension and detail.
4. Changes by change order or field order.
5. Details not on original contract drawings.
6. Manufacturer, trade name, catalog number and supplier of each product and item of equipment actually installed shall be indicated on equipment schedules.

E. Record the following information on Specifications:

1. Changes by change order or field order.
2. Other matters not originally specified.

F. Shop Drawings: Maintain shop drawings as record documents recording changes made after review as specified for drawings above.

G. Submittal: At completion of project, deliver record documents to Owner's representative and transmit a copy of signed receipt from Owner to the Engineer.

1.11 OPERATING AND MAINTENANCE DATA

A. The "Operating and Maintenance Manual" (O & M) is a bound compilation of descriptive drawings and data which identify equipment installed at the project site and detail the procedures and parts required to maintain and repair the equipment. Copies of final reviewed submittals shall be included for all equipment items.

B. Five sets of bound manuals will be required for this project. These are to be submitted for approval to the Project Manager.

C. Organization of the manuals shall follow the recommendations in ASHRAE Guideline 4-1993.

D. Enclose the material in rigid 3-ring or metal post binders and submit to the Project Manager at the completion of the project. Binders shall be Buckram or metal post binders or prior approved equal with block lettering. Simple binders with slide-in cover sheets are not acceptable. Sheet size shall be 8-1/2" x 11" with expandable metal capacity as required for the project. The number of binders forming one O & M Manual shall be based on a maximum limit of 4 inches. The following information shall appear on the front cover and backbone:

1. "Operation and Maintenance Manual"
2. Project Name (and volume number if more than one volume)
3. DFCM Project number
4. Building name, number, and street address
5. “Weber State University”
6. * Architect's name
7. * Engineer's name
8. * General Contractor's name
9. * Mechanical Contractor's name

* Items "6" through "9" need not be printed on the backbone.

E. Pages are to be standard 8-1/2" x 11" sheets, or 11" x 17" folded to fit the 8-1/2" x 11" sizes.

F. The manual shall include the following:

1. Alphabetical list of all system components including the name, address, and 24-hour phone number of the company responsible for servicing each item during the first year's operation.
2. Operating instructions for complete system, including emergency procedures for fire or failure of major equipment and procedures for normal starting/operating/shutdown and long-term shutdown
3. Maintenance instructions, including valves, valve tag and other identified equipment lists, proper lubricants and lubricating instructions for each piece of equipment and necessary cleaning/replacing/adjusting schedules.
4. All test reports and proof of performance certificates.

5. Manufacturer's data and instruction sheets for each piece of equipment, marked to indicate the plan symbol, model, number, and options installed for each item of equipment furnished and installed on the project. These data sheet shall be accompanied by reviewed submittals that had no exceptions taken to them. Provide original printed material in each book, faxes are NOT acceptable. The serial numbers of each item of equipment installed are to be listed with the model numbers and plan symbols.

    a. Installation instructions.
    b. Drawings and specifications (final shop drawings).
    c. Complete parts lists, and a source of supply for each piece of equipment, marked with model, size, and plan symbol.
    d. A copy of the reviewed submittals for each piece of equipment, with any/all corrections identified during the submittal process made to the final submittal documents.
    e. Performance curves and capacity data, marked with model number, size, and plan code.
    f. Complete “as-builts” wiring and temperature control diagrams. (Shop drawings are not acceptable).
    g. Lubrication and other preventative maintenance data.
    h. Equipment warranties.
    i. The final balance report.

6. Include a Table of Contents and tabbed index dividers.

G. In addition to the maintenance manual, and keyed to it, the equipment shall be identified and tagged as specified on drawings. Insert a copy of the Equipment List or Equipment Schedules in manual.

1. Identify all starters, disconnect switches, and manually operated controls, except integral equipment switches. Label with permanently applied, legible markers corresponding to operating instructions in the "Maintenance Manual".
2. Tag all valves per requirements in Section 230529.
3. Provide a typed tag list or schedule laminated or mounted under plexiglass in the equipment room stating valve ID number, location, service or function of each tagged item, and normal valve position. Insert a copy of tag list in each "Maintenance Manual". Also provide one copy of the list in a plastic closure as manufactured by Seton Name Plant Company, New Haven, Conn; or approved equal. The plastic closure shall include two holes punched at the top, with a brass or nickel grommet in each hole, and an 8” long length of nickel plated bead chain run through the holes, allowing the list to be hung from a wall peg.
4. Provide a reduced scale drawing of each floor indicating the location of each manual and automatic valve in every HVAC and plumbing piping system and include valve position number and normal valve position (normally open/normally closed) as per Specification Section 230529. Mount all drawings under plexiglass or laminate and mount on equipment room wall.

H. Division 230593 Contractor shall be responsible for scheduling instructional meetings for maintenance personnel on the proper operation and maintenance of all mechanical systems, using the maintenance manual as a guide. These meetings must be scheduled through the Architect, Construction Manager/General Contractor and far enough in advance so that all necessary personnel can be adequately notified.

1. Submit training certificate to Owner's Representatives at end of training and have certificate signed to indicate adequate training has been received.

1.12 DELIVERY, STORAGE AND HANDLING

A. General: Deliver and store materials and equipment in manufacturer's unopened containers fully identified with manufacturer's name, trade name, type, class, grade, size and color. Note: Storage is not allowed outside the existing chiller room. Contractor is responsible for storing materials off-site.

B. Protection: Store materials and equipment off the ground and under cover, protected from damage. Maintain caution labels on hazardous materials.

C. Large Items: Make arrangements with other contractors on the job for introduction into the building of equipment too large to pass through finished openings.

D. Handling of Materials: Materials shall be handled, sorted and distributed using appropriate handling methods to protect all materials from damage. Dented, rusted, corroded or otherwise damaged materials shall be removed from the project site. Determination of materials deemed unusable or inappropriate for installation shall be made by the Architect/Engineer.

1.13 PROJECT CONDITIONS AND ASBESTOS HAZARD

A. Accessibility:

1. Division 23 Contractor shall be responsible for the sufficiency of the size of shafts and chases and the adequate clearance in double partitions and hung ceilings for proper installation of his work. He shall cooperate with Contractors of other Divisions of the Work whose work is in the same space and shall advise the Construction Manager/General Contractor of his requirements. Such spaces and clearances shall, however, be kept to the minimum size required.
2. Division 23 Contractor shall locate all equipment which must be serviced, operated, or maintained in fully accessible positions. Equipment shall include (but not be limited to) valves, shock absorbers, traps, cleanouts, motors, controllers, switchgear, filters, VAV boxes, control valves, balancing valves, and drain points. If required for better accessibility, furnish access doors for this purpose. Minor deviations from Drawings may be allowed to provide for better accessibility. Any changes shall be approved by the Architect/Construction Manager/General Contractor prior to making the change.

3. Division 23 Contractor shall provide the Construction Manager/General Contractor with the exact locations of access doors for each concealed valve, damper, or other device requiring service. Locations of these doors shall be submitted in sufficient time to be installed in the normal course of work.

B. Fabrication:

1. Before any ductwork is fabricated and before running and/or fabricating any lines of piping or ductwork, the Contractor shall assure himself that they can be run as contemplated in cooperation with Contractors of other Divisions of the Work and the physical constraints of the Structural and Architectural Work.

C. Freeze Protection:

1. Do not run lines in outside walls, or locations where freezing may occur. Piping next to outside walls shall be in furred spaces with insulation between the piping and the outside wall. Insulation of piping shall not be considered freeze protection.

D. Scaffolding, Rigging and Hoisting:

1. Provide all scaffolding, rigging, hoisting and services necessary for erection and delivery into the premises of any equipment and apparatus furnished; remove same from premises when no longer required.

E. If Contractor during the course of work observes or suspects the existence of asbestos in the structure or building, Contractor shall promptly notify Owner and Architect/Engineer. Owner shall consult with Architect/Engineer regarding removal or encapsulation of the asbestos material and Contractor shall not perform any work pertinent to the asbestos material prior to receipt of special instructions from Owner through the Architect/Engineer.

1.14 COORDINATION

A. General: Coordinate and order the progress of mechanical work to conform to the progress of the work of the other trades. Complete the entire installation as soon as the condition of the building will permit.

B. Coordination with Electrical Work: Section 230529.

C. Utility Interruptions: Coordinate mechanical utility interruptions with the Owner and the Utility Company. Plan work so that duration of the interruption is kept to a minimum.

D. Cutting and Patching: Section 230529.

E. Drawings and Specifications: The Mechanical Drawings indicate the general design and arrangement of lines, equipment, systems, etc. Information shown is diagrammatic in character and does not necessarily indicate every required offset, fitting, etc. Do not scale the Drawings for dimensions. Take dimensions, measurements, locations, levels, etc., from the Architectural Drawings and equipment to be furnished.

F. Each Division 23 subcontractor shall coordinate with other contractors to make certain that any of his equipment, piping or ductwork which is mounted on isolators or flexibly connected does not become "grounded" by another contractors work (e.g. walls, ceiling, etc.).

G. Discrepancies: Examine Drawings and Specifications for other parts of the work, and if any discrepancies occur between the plans for the work of this Division and the plans for the work of others, report such discrepancies to the Construction Manager/General Contractor and obtain written instructions for any changes necessary.

H. Order of Precedence: The precedence of mechanical construction documents are as follows:

1. Addenda and modifications to the Drawings and Specifications take precedence over the original Drawings and Specifications.
2. Should there be a conflict within the Specifications or within Drawings of the same scale, the more stringent or higher quality requirements shall apply.
3. In the Drawings, the precedence shall be Drawings of larger scale over those of smaller scale, figured dimensions over scaled dimensions and noted materials over graphic indications.
4. Should there be a conflict in dimensions or locations between Mechanical Drawings and Architectural Drawings, the Architectural Drawings shall have precedence.

1.15 START-UP PROCEDURES

A. Before start-up, each piece of equipment comprising a part of the system shall be checked for proper lubrication, drive rotation, belt tension, proper control sequence, and any other condition which may cause damage to equipment or endanger personnel.

B. Insure that all control systems are fully operational in automatic mode. Individually test each control loop to make certain it is operating as intended and is communicating properly with other devices.

C. If systems are not to continue in use following the start-up procedures, steps should be taken to insure against accidental operation or operation by unauthorized personnel. Provide padlocks on disconnect switches where applicable.

D. Factory personnel shall be notified as appropriate to start systems requiring their services.

E. Notify engineer and commissioning agent at least 2 weeks prior to the scheduled start-up date of all major mechanical equipment and systems.

1.16 SCHEDULE OF TESTING

A. Provide testing in accordance with the General Conditions of the Contract.

B. A schedule of testing shall be drawn up by the Division 23 Contractor in such a manner that it will show areas tested, test pressure, length of test, date, time and signature of testing personnel.

C. All testing must be performed in the presence of the Architect's/Construction Manager's/General Contractor's representative; his signature for verification of the test must appear on the schedule.

D. All testing must be performed in accord with the procedures set forth in Division 23 and other Sections of the Specifications where referenced. At completion of testing, the completed schedule shall then be submitted in triplicate to the Architect and a copy shall be forwarded to the 230593 Contractor for inclusion in Operation and Maintenance Manual.

E. Make all specified tests on piping, ductwork and related systems as specified in this specification.

F. Make sure operational and performance tests are made on seasonal equipment.

G. Complete all tests required by Code Authorities, such as smoke detection, life safety, fire protection and health codes.

H. After test runs have been completed and systems have been demonstrated to be satisfactory and ready for permanent operation, all permanent pipeline strainers and filters shall be cleaned, air filters cleaned or replaced, settings on pressure relief valves properly adjusted, valve and pump packings properly adjusted, belt tensions adjusted, drive guards secured in place, lubrication checked and replenished if required.

1.17 COMMISSIONING

A. This project will be commissioned by a Commissioning Agent. Contractor shall assist commissioning agent as required in other specification sections.

1.18 CLEANING AND FINISHING

A. Provide cleaning in accordance with the General Conditions of the Contract and Division 1.

B. Cleaning shall include but not be limited to removing grease, dirt, dust, stains, labels, fingerprints and other foreign materials from sight-exposed piping, ductwork, equipment, fixtures and other such items installed under Division 23 of the work. If finishes have been damaged, refinish to original condition and leave everything in proper working order and of intended appearance.

C. Section 232113 Contractor shall be responsible to certify that all HVAC Piping Systems have been cleaned in accordance with Section 232500 - HVAC Water Treatment whether actually done by the Section 232113 Contractor or by the 232500 Contractor.

1.19 WARRANTIES

A. Warranty: Provide a written warranty to the Owner covering the entire mechanical work to be free from defective materials, equipment and workmanship for a period of one year after Date of Acceptance. During this period provide labor and materials as required to repair or replace defects. Provide certificates for such items of equipment which have warranties in excess of one year. Submit to the Construction Manager/General Contractor for delivery to the Architect. Include a copy of all warranties in the Operation and Maintenance Manual.

B. This warranty will be superseded by the terms of any specific equipment warranties or warranty modifications resulting from use of equipment for construction heat or ventilation.

C. All refrigeration compressors shall have a (4) four year extended warranty from the manufacturer of the equipment in addition to the standard one-year warranty.

1.20 PROJECT CLOSEOUT

A. Project Observation Reports:

At or near the completion of the construction phase of this project, the Engineer will generate one or more Project Observation Reports for the owner. These reports will list the items of construction observed by the Engineer which are not in compliance with the Contract Documents.

The Mechanical Contractor and/or subcontractors shall certify completion of each listed item in writing and forward copies to the Architect, Engineer and General Contractor. The Engineer will not recommend the payment of retainage until this compliance certification has been received.

Each item on the Project Observation Report shall have a signature/date in the margin of the report indicating completion of that item.

1.21 CERTIFICATES AND KEYS

A. Certificates: Upon completion of the work, deliver to the Construction Manager/General Contractor one copy of Certificate of Final Inspection.

B. Keys: Upon completion of work, submit keys for mechanical equipment, panels, etc. to the Construction Manager/General Contractor.

END OF SECTION 230500

SECTION 230529 - BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED WORK

A. The General Conditions, Supplementary Conditions and Division 1, General Requirements apply to this Section, and Contractor shall review and adhere to all requirements of these documents.

1.2 SYSTEM DESCRIPTION

A. The work includes, but is not limited to the following:

Materials and methods common to the work in general of Division 23 and other Divisions and Sections of the Specifications where referenced.

1.3 QUALITY ASSURANCE

A. Welder Qualifications: Welding shall be performed by an ASME Certified welder with current certificate in accordance with ANSI B31.1 for shop and project site welding of piping work. Welder Qualifications:

1. Each welder shall have passed a qualification test within the past 6 months.
2. The test shall be in accordance with the ASME Boiler and Pressure Vessel Code, Section IX, "Welding Qualifications", ASME Section VIII, and ANSI 313.
3. The test report shall certify that the welder is qualified to weld the material to be used at the job site.
4. The Contractor shall submit three copies of each welder's qualification test report to the Project Manager for approval prior to commencing the work. No welder shall be used on the project until so certified.

1.4 REFERENCES

A. Reference Standards: Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations of the following:

1. For electrical equipment and products, comply with applicable National Electrical Manufacturers Association (NEMA) Standards, and refer to NEMA Standards for definitions of terminology herein.
2. Comply with National Electrical Code (NEC) NFPA-70 for electrical installation requirements.

3. Certified Pipe Welding Bureau (NCPWB) and American National Standards Institute (ANSI) Code Numbers B31.2, & B31.9 as applicable for welding requirements.
4. Comply with American National Standards Institute (ANSI A13) for identification of piping systems.
5. Comply with American National Standards Institute (ANSIB31.1) Code for Pressure Piping.
6. State of Utah, Division of Facilities Construction and Management Design Criteria.
7. Weber State University Design Criteria.

1.5 SUBMITTALS

A. Shop Drawings: Submit Shop Drawings and Product Data for the following items in accordance with the General Conditions of the Contract:

1. Legend and color of piping and equipment identification Weber State University Campus Design and Construction Standards.
2. Freeze Protection Systems for Piping and Equipment (Heat Tracing).

B. Operating Instructions and Maintenance Data: Submit printed Operating Instructions and Maintenance Data for the following items in accordance with Operating and Maintenance Data Paragraph in Section 230500.

1. Motors.
2. Starters.

C. Certificates: Before proceeding with the Work, submit to the Architect/Construction Manager/General Contractor, two copies of Certification that the welding work will be done according to ANSI B31.1 by welders who have been tested and whose qualification test sheets are available, attesting to their ability to weld in accordance with the Standard Procedure Specifications as established by the National Certified Pipe Welding Bureau.

PART 2 - PRODUCTS

2.1 MOTORS

A. General: Furnish motors necessary to operate mechanical equipment.

B. Motor Characteristics: Comply with the following requirements:

1. Variable Speed Drive Compatibility: All motors which are powered through a variable frequency drive shall conform to NEMA MG-1, Part 31 for inverter duty and shall be capable of continuous operation at 20% of nominal speed and shall meet the requirements of the Variable Frequency Drive specification in Section 230810 or Division 26 as applicable.
2. Altitude Deration: Motors to be furnished to maintain specified rated service factor at altitude of project.
3. NEMA Temperature Rating: Rated for 40 deg.C environment for continuous duty at full load, Class B motor temperature rise. Motors for use with variable frequency drives shall be Class F insulated.
4. Starting Capability: Provide each motor capable of making starts as frequently as indicated by the automatic control system.
5. Phases and Current Characteristics: Provide squirrel-cage induction polyphase motors for 3/4 horsepower and larger, and provide capacitor-start single-phase motors for 1/2 horsepower and smaller. One-sixth horsepower and smaller may, at equipment manufacturer's option, be split-phase type. Coordinate current characteristics with power specified in Division 26 and with individual equipment requirements specified in other Sections of Division 23. Provide two separate windings on polyphase two speed motors. Do not purchase motors until power characteristics available at locations of motors have been confirmed, and until rotation directions have been confirmed.
6. Power Factor: All motors rated greater than 1000 watts shall have a Power Factor of not less than 95% under rated load conditions. The 95% PF may be obtained by design of the motor or by providing a capacitor. Capacitors, if provided to obtain the 95% PF, must be switched with the motor. If the motor draws less than 1000 watts at full load, it is excluded from the 95% power factor requirement.
7. Service Factor: 1.15 for polyphase motors and 1.35 for single-phase motors. Motors shall be selected such that the brake horsepower requirement is not within the service factor at design load.
8. Efficiency: All motors shall be premium efficiency type in accordance with the current State Energy Code, except where a higher efficiency is noted on drawings.
9. Motor Construction: Provide Design "B" motors for general purpose continuous duty and Design "C" motors where required for high starting torque such as the low speed motor on fans with a two-motor drive arrangement. Small motors that are part of packaged equipment may be manufacturer's standard motors meeting Energy Code requirements for efficiency.

    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 the motor, provide bearings designed to resist the thrust loading. Refer to individual sections of Division 23 for fractional horsepower light-duty motorized equipment where sleeve-type bearings are permitted.

b. Enclosure Type: Except as otherwise indicated, provide open drip-proof motors for indoor use where satisfactorily housed 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.

c. Overload Protection: Provide built-in thermal overload protection for each leg of each phase and, where indicated, provide internal sensing device suitable for signaling and stopping the motor at the starter. Thermal overload protectors shall be sized to accommodate the altitude of installation.

d. Name Plate: Provide metal nameplate on each motor, indicating full identification of manufacturer, ratings, characteristics, construction, NEMA efficiency, power factor, special features and similar information.

e. Motor Connections: Provide conduit connection boxes.

f. Motors shall not exceed 80dbA rating when running their full speed and power range.

2.2 STARTERS

A. Note that some starters are furnished and installed under Division 26. Review electrical plans before bidding.

B. General: Furnish starters and contactors necessary to operate mechanical equipment motors. **Starter manufacturer shall be the same brand for ALL motors furnished under Division 23.** Approved manufacturers shall be those listed in Division 26 or this specification.

C. Motor Starter Characteristics: Comply with NEMA standards and NEC. Furnish Type I general purpose enclosures with padlock ears, and with frames and supports for mounting on wall, floor or panel as required. Furnish the type and size of starter recommended by the motor manufacturer and equipment manufacturer for the applicable protection and start-up condition; refer to individual equipment sections for basic load requirements. All starters shall be by the same manufacturer. Only manufacturers approved by Division 26000 will be accepted. All starters shall comply with Division 26000 requirements.

D. Manual Control:

1. Furnish maintained-contact push buttons and pilot lights, properly arranged for single-speed or multi-speed operation as indicated.
2. Furnish manual switch and pilot light for motors 1/3 horsepower and smaller, except where interlock or automatic operation is indicated.

E. Automatic Control:

1. Furnish magnetic starters for motors 1/2 horsepower and larger and for smaller motors where interlock or automatic operation is indicated. Include the following:

a. Maximum number of auxiliary contacts available: three or more.
b. "Hand-Off-Automatic" switches in starter cover.
c. Interlocks, pneumatic switches and similar devices as required for coordination with the control requirement specified in Section 230900-Electronic Controls.
d. Built-in 120 volt control circuit transformer, fused from line side, where service exceeds 240 volts.

1) Control circuit conductors to be protected in accord with the National Electrical Code.

e. Trip-free thermal overload relays, each phase.
f. Externally operated manual reset except on refrigeration compressors which shall have automatic reset. Automatic reset shall be limited to three attempts. If motor fails to start after three attempts, manual reset shall be required.
g. Undervoltage release or protection.
h. Phase failure/phase reversal protection on all legs.

F. Weather Protection: Provide weather-proof mounting of magnetic starters for equipment outside of the building.

2.3 VALVES

A. General:

1. Provide valves as specified herein and as indicated on the Drawings complete with accessories and attachments as required and appropriate for the pressure/temperature of system.
2. Supply valves for proper pressure ratings determined by the system working pressures at point of use and of proper types for systems and functions indicated.
3. Steam and Condensate System Isolation Valves: Use steam rated ball valves on pipe sizes 2” and smaller. Use gate valves on pipes larger than 2”. Use globe valves on manual bypass lines.
4. Provide like type valves of one manufacturer only unless specified otherwise.
5. Plainly and permanently mark valves with manufacturer's name or trademark, pressure rating, both Cold Working Pressure (CWP) and Steam Working Pressure (SWP), as applicable and flow direction when required to prevent improper installation.

6. Mark valves requiring approval by Underwriter's Laboratories (UL) or Factory Mutual Engineering Division (FM) with appropriate markings cast into the valve body.
7. Provide extended necks as appropriate for insulation.

B. Manufacturers:

1. The following manufacturers are acceptable providing the product to be considered is equivalent in every respect to the nomenclature provided by the specified make and model.

   a. Bronze Valves: Powell, Milwaukee, Crane, Hammond, Nibco.
   b. Iron Body Valves: Powell, Milwaukee, Traverse City, Kennedy, Iowa, American, Nibco.
   c. U.L., F.M. Approved or Listed Valves: Nibco, Demco, Pratt, Kennedy, Mission, Milwaukee, Hammond.
   d. Ball Valves: Hammond, Watts, Jamesbury, Worcester, Milwaukee, Apollo, Powell, Dynaquip, Nibco, Spirax Sarco.
   e. Butterfly Valves: Milwaukee, Hammond, Centerline, DeZurik, Fisher, Victaulic, Keystone, Posi-Seal, TEC, Flowseal, Nibco, IFC.
   f. Lubricated Plug Valves: Homestead, Nordstrom, Powell.
   g. Non-Lubricated Eccentric Plug Valves: DeZurik.
   h. Stop and Drain and Drain Valves: Milwaukee, Hammond, Prier, Nibco or United Brass.
   i. Gas Cock: Peter Healy or Crane.
   j. Check Valves: Nibco, IFC, DFT.

C. Valve Schedule:

1. Standard Bronze Valves - 150 SWP/300 CWP, per ASTM B61/B62. No brass materials will be accepted.

   a. Check, Gate, and globe with union bonnet and rising stem.
   b. Sizes 1/8 through 2 inches.
   c. Schedule:

Plan Code:	G.V.	GL.V.	C.V.	L.C.V.
Valve Type:	Gate	Globe	Swing	Lift
Make:	Nibco	Nibco	Nibco	Crane
Straight Threaded:	T-134	T-235Y	T-433Y	365.5
Straight Soldered:	S-134	S-235Y	S-433Y	--
Angle Threaded:	--	T-335Y	--	--
Angle Soldered:	--	--	--	--

2. Standard Bronze Valves - 300 SWP/600 CWP, per ASTM B61/B62, no brass materials will be accepted.

a. Gate, globe and check.
b. Sizes 1/8 through 2 inches.
c. Schedule:

Plan Code	G.V.	GL.V.	C.V.	L.C.V.
Valve Type:	Gate	Globe	Swing	Lift
Make:	Nibco	Nibco	Nibco	Crane
Straight Threaded:	T-134	T-235Y	T-433Y	365.5
Straight Soldered:	S-134	S-235Y	S-433Y	--
Angle Threaded:	--	T-335Y	--	--
Angle Soldered:	--	--	--	--

3. Standard Iron Body Valves - 125 SWP/200 CWP.

a. Gate, globe and check.
b. Sizes 2-1/2 through 12 inches.
c. Schedule:

Plan Code:	G.V.	OS&Y	GL.V.	C.V.	W.C.V.	N.S.C.V.
Valve Type:	Gate	Gate	Globe	Swing	Weighted	Non Slam
Make:	Nibco	Nibco	Nibco	Nibco	Nibco	Crane
Straight Threaded:	T-619	T-617-0	T-718B	T-918Y	T-918YBLW	--
Straight Flanged:	F-619	F-617-0	F-718B	F-918Y	F-918YBLW	23
Angle Threaded:	----	----	T-818B		----	----
Angle Threaded:	----	----	F-818B	----	----	----

4. Standard Iron Body Valves - 150 SWP/300 CWP.

a. Gate, globe and check.
b. Sizes 2 through 12 inches.
c. Schedule:

Plan Code:	G.V.	OS&Y	GL.V.	C.V.	N.S.C.V.
Valve Type:	Gate	Gate	Globe	Swing	Non Slam
Make:	Nibco	Nibco	Nibco	Nibco	Crane (Chapman)
Straight Threaded:	T-669	T-667-0	--	--	--
Straight Flanged:	F-669	F-667-0	F-768B	F-968B	223
Angle Threaded:	--	--	--	--	--
Angle Flanged:	--	--	F-868B	--	

5. Standard Iron Body Valves - 250 SWP/500 CWP.

a. Gate, globe and check.
b. Sizes 2 through 12 inches.
c. Schedule:

Plan Code:	G.V.	OS&Y	GL.V.	C.V.	N.S.C.V.
Valve Type:	Gate	Gate	Globe	Swing	Non Slam
Make:	Nibco	Nibco	Nibco	Nibco	Crane
Straight Threaded:	T-669	T-667-0	--	--	--
Straight Flanged:	F-669	F-667-0	F-768B	F-968B	223
Angle Threaded:	--	--	--	--	--
Angle Flanged:	--	--	F-868B	--	--

6. UL and FM Approved Valves.

a. Gate, check and butterfly.
b. Sizes all.
c. Schedule:

Plan Code:	OS&Y	C.V.	W.V.C.	BF.V	D.V.
Valve Type:	Gate	Swing	Wafer	BTFY	Drain
Make:	Nibco	Nibco	Nibco	Demco	Nibco
Straight Threaded:	T-104-0	T-413W	--	--	T-211Y
Straight Flanged:	F-607-0	F-908-W	--	--	--
Wafer:	--	--	W-900-W	NE-H	--

7. UL and FM Approved Valves - 175 Pound Water.

a. Post indicator with indicator post.
b. Sizes 4 through 12 inches.
c. Schedule:

Plan Code:	P.I.V.	P.I.V.B.F.
Valve Type:	Gate	BTFY
Make:	Nibco	Demco
Straight Flanged:	F-609	NE-H (Wafer)
Mechanical Joint:	M-609	--
Indicator Post Vertical:	NIP-1	Stem extension and gear operator with post indicator U.L. Listed only.
Indicator Post through Wall:	NIP-2	--

8. Underground Valves - 175 Pound Water, American Water Works Association (AWWA).

a. Gate valves with service boxes.

b. Sizes (see schedule).
c. Schedule:

Plan Code:	GV & SB	GV & SB
Size/Inches:	3/4 thru 2	2 thru 16
Valve Type:	Oriseal	Gate
Make:	Mueller	Mueller
Model:	H-15201	A-2380-22 or 2380-18
Service Box:	H-10396-86	H-10357
Base:	H-10396-7-8-9 or H-10400	No. 6 Oval
Key:	Stationary rod attached.	A-24610 Furnish one each box.

9. Ball Valve:

a. Blowout proof stem.
b. Full port type with appropriate seals and seat, as specified.
c. Bronze bodies per ASTM B61/B62 or ASTM B-584. No brass material will be accepted.
d. Stainless steel bodies per ASTM A-351, Grade CF3M.
e. Schedule:

Plan Code:	B.V.	B.V.	H.V.	S.B.V.
Service:	Balancing	In line control and isolation	Refrigeration	Steam and Steam Condensate
Pressure:	150 SWP/300 CWP	150 SWP/300 CWP	500 CWP	150 SWP
Sizes/Inches:	1/4 thru 2-1/2	1/4 thru 3"	3/8" thru 2 1/8"	½” thru 2”
Make:	Nibco	Nibco	Nibco	Nibco
Straight Threaded:	T-580-70-66	T-585-70-66	--	T-595-Y-S6R-66
Straight Solder End:	S580-70	S585-70	S595-Y-66	--
Actuator:	Lever with memory stop	Lever	Lever	Lever
Port:	Standard	Full	Full	full

* Steam ball valve includes a three-piece body, seals rated for steam operating temperatures up to 400°F.

10. Butterfly Valves:

a. Schedule; standard 150 psi with 150 psi ANSI companion flanges for use where system pressures cannot exceed 200 psig shut off (static) pressure.

Plan Code:	BFV		
Style:	Semi-lug wafer body		
Pressure Rating ANSI Class:	150 minimum		
Body:	Cast Iron		
Disc:	Aluminum Bronze		
Stem:	316 Stainless	18-8 Stainless	17-4 PH Stainless
Seat:	EPDM (-40 deg.F to 250 deg.F)		
Actuator:	2" thru 5" Infinite position lever with memory stop. 6" thru 24" Self-locking worm gear with adjustable limit stops, and position indicator. Provide chain wheel and chain where indicated by contract documents.		
Make:	Keystone		
Size:	2"-12"	14"-20"	24-36
Model:	228	122	AR1

b. Schedule: High performance 300 psi with 300 psi ANSI companion flanges for use where system pressures are more than 200 psig but cannot exceed 700 psig shut-off (static) pressure.

Plan Code:	BFV	
Style:	Lug	
Pressure Rating ANSI Class:	300 minimum	
Body:	Carbon steel ASTM A-216	
Disc:	316 stainless steel ASTM A-216	
Stem:	Stainless steel ASTM A564 Type 630 (17-4PH)	
Seat:	Virgin TFE	
Actuator:	3" and 4": Rachet handle with lock. 6 and over: Worm gear with lock.	
Make:	Flowseal (Mark Controls Corp.)	
Size:	3" and 4"	6" and over
Model:	XX-3L-121TTH-L	XX-3L-121TTH-2

11. Stop Check Valve:

a. Schedule:

Plan Code:	S.C.V.
Pressure:	250 SWP/500 CWP
Size/Inches:	2-1/2 thru 10"
Make:	Crane
Straight Flanged:	28E
Angle Flanged:	30E

12. Eccentric Plug Valve:

a. Schedule:

Plan Code:	E.P.V.	E.P.V.
Pressure:	175 lb. CWP	175 lb. CWP
Size/Inches:	1/2 thru 3	4 thru 8
Make:	DeZurik	DeZurik
Model:	400	100
Actuator:	483-487	159 w/Memory Stop
Ends:	Threaded	Flanged

13. Gas Valves:

a. Gas cock and lubricated plug.
b. Schedule:

Plan Code:	G.C.K.	L.P.V.	L.P.V.	G.B.V.
Pressure:	100 PSI Air	200 lb. CWP	200 lb. CWP	250 PSI LP-Gas
Size/Inches:	1/2 thru 1	1/2 thru 3	4 thru 12	1/4" thru 3"
Make:	Peter Healy	Walworth	Walworth	Apollo
Model:	1500-F	1700	1707-F	80-100
Actuator:	None	E-2	Wrench as required	1/4 turn
Ends:	Threaded	Threaded	Flanged	Threaded

14. Specialty Valves:

a. Petcock, stop and drain, drain, needle.
b. Schedule:

Plan Code:	PTK	S&D.V.	D.V.	N.V.
Type:	Petcock	Gate	Ball	Needle
Pressure:	250 LB.	125 LB.	125 LB.	200 LB.
Size/Inches:	1/8	1/2 and ¾	3/4	1/8 thru 3/4
Make:	Powell	Nibco	Apollo	Jenkins
Model:	922	76 or 726	78-104	743G
Ends:	Threaded	Threaded or Soldered	Threaded and Hose End Adaptor	Threaded

2.4 PIPE HANGERS, SUPPORTS, AND ACCESSORIES PROTECTION

A. General:

1. Provide hangers, rods, clamps, brackets, attachments, inserts, bracing, nuts, coach screws, eye bolts, clips, plates, and washers as required for appropriate installation for building structure provided.
2. All hangers and accessories shall be manufactured by one manufacturer for compatibility of all components.
3. All hangers, attachments, and accessories shall be provided with a certified manufacturers safety factor of five (5).
4. All hangers, attachments and accessories shall comply with the following:

   a. Safety factor of 5 (actual load vs. ultimate load).
   b. National Fire Protection Association (NFPA) (except as amended by provisions of this Specification for minimums) and as applicable.
   c. Factory Mutual Engineering Division (FM) as applicable.
   d. Manufacturers Standardization Society (MSS).

5. Support and positioning of piping shall be by means of engineered methods that comply with IAPMO PS 42-96.

B. Material:

1. Hangers in contact with steel, iron, cast or ductile iron shall be hot dipped galvanized or cold galvanized with "Galvilite by ZRC" cold galvanized compound only to a thickness of not less than 3.0 mil (.003 inches). "Galvilite by ZRC Worldwide, Marshfield, MA. Tel: (800) 831-3275, www.zrcworldwide.com" or equal.

2. Hangers in contact with copper piping shall be copper clad or provided with heavy density felt (20 oz.) pad permanently attached to the hanger and placed so as to prevent direct contact between pipe and hanger. Felt shall be mildew and moisture rot-proof. Heavy polyvinyl chloride coating on hanger, 5 mil thickness minimum will be acceptable in lieu of felt.
3. Hangers in contact with "plastic" or "glass" piping shall be galvanized in accordance with Sub-paragraph B-1, above and padded in accordance with Sub-paragraph B-2, above.
4. Hangers for insulated piping shall be provided on all piping of this size with insulation shields or insulation saddles* as applicable and appropriate and in accordance with the following schedule:

Nominal Pipe or Tubing Size	Shield Length	Shield Gauge Thickness	Material
½" thru 3"	12"	18	Galvanized
4"	12"	16	Galvanized
5"	15"	16	Galvanized
6"	18"	16	Galvanized
8"	24"	--	B-line (B3160-3165)
over 8"	36"	--	B-line (B3160-3165)

* Insulation inserts between piping and shield shall be furnished by 230700 Contractor for appropriate pipe size and insulation thickness for all insulated piping requiring a vapor barrier.

5. Provide swivel ring hangers similar and equivalent to B-Line B-3170, 3170CT, and 3170C for pipe sizes 1/2" thru 8".
6. Clevis type hangers may, at the Contractors option, be provided when similar and equivalent to B-Line B-3100, and 3100C.
7. Roller type hangers shall be used on all steam piping 4" and larger and when appropriate shall be equivalent to B-Line B-3110 black steel with cast iron roller. Provide insulation saddles for all roll-type hangers, B-Line B3160-3165. Calcium silicate inserts, in conjunction with insulation saddles shall be provided on all steam piping.
8. Beam and bar joist clamps shall be appropriate for attachment locations, top beam, bottom beam, etc., and provided with retainer rods, clips or straps as required.
9. Hanger spacing and minimum rod sizes shall be based on the applicable Mechanical and Plumbing Codes for the type of piping installed.
10. Riser clamps shall be provided on all vertical risers at each floor and shall conform to materials and protective coatings or pads as specified in Paragraph B of this Article 2.05. Clamps shall be similar and equivalent to B-Line B-3131 and B-3148.
11. Provide concrete inserts where required in flat slab construction similar and equivalent to B-Line B-22-1 Series 2000 lbs. per foot load capacity and spaced

per hanger spacing schedule (sub-paragraph B-9 above) provide all accessories and nuts required.

12. Trapeze hangers shall be constructed of channel similar and equivalent to B-Line Series B-11 thru B-72 as appropriate complete with pipe clamps, nuts, rollers etc., as required. Channel to bear 5 times actual weight of all piping on trapeze system with minimum deflection. (.01 inch maximum). At a minimum, install pipe clamps on every other trapeze hanger, and where required to comply with seismic restraint design.
13. Wall brackets shall be fabricated "knee" brackets conforming to requirements of sub-paragraph B-12 above and made up with B-Line Series B-11 thru B-72 channel. Angle clips may be used in wood joist construction when similar and equivalent to B-Line B-3060 or 3061.
14. Hangers attached to wood construction shall be attached by use of eye bolts, coach screws or lag bolts when load bearing ratings maintain a safety factory of 5.
15. All other means of support i.e., special construction, pipe stands, earthquake bracing, sway bracing, etc., shall be provided as required and in conformance with jurisdictional authority and these Contract Documents, submit all special or required support and bracing systems for review by the Architect/Engineer prior to installing any item.
16. All vertical refrigeration suction and hot gas, and all steam piping shall be provided with insulation shields and calcium silicate inserts at each support location.
17. All piping systems exposed to motorized traffic shall be fully protected by installation of concrete-filled pipe bollards. Bollards shall be cleaned and painted as directed by the Owner.
18. For plenum applications use pipe supports that meet ASMT E-84 25/50 standards.

C. Acceptable Manufacturers:

1. Manufacturers acceptable to this Specification are as follows, all other manufacturers must submit for acceptance.

    a. B-Line
    b. Fee & Mason
    c. Grinnell
    d. Hubbard Enterprises/HOLDRITE
    e. P.H.D.
    f. Michigan
    g. Tolco

2.5 IDENTIFICATION MATERIALS FOR PIPING AND EQUIPMENT

A. Materials for identification shall be as follows:

1. Metal Tags: Round brass discs, minimum 1-1/2" diameter with edges ground smooth. Each tag shall be punched and provided with brass chains for installation.
2. Engraved Nameplates: Fabricate from plastic sheet stock of sufficient thickness to allow engraved lettering in contrasting color. Attach nameplates to equipment with screws.

3. Pressure Sensitive Markers: Brady Type 350 flexible vinyl film identification markers and tape, with legend, size and color coding per ANSI A13.1. or approved equal.

Insulation or Pipe Diameter	Length of Color Field	Size of Letters
3/4" to 1-1/4"	8"	1/2"
1-1/2" to 2"	8"	3/4"
2-1/2" to 6"	12"	1-1/4"
8" to 10"	24"	2-1/2"
over 10"	32"	3-1/2"
Ductwork and Equipment	NA	2-1/2"

2.6 FREEZE PROTECTION SYSTEMS FOR PIPING AND EQUIPMENT (HEAT TRACING)

A. General:

1. Provide freeze protection for all water, sewer, sumps, tanks, pumps, equipment drains, etc., where piping and equipment are subject to ambient temperatures of less than 35 deg.F, and as indicated on Contract Drawings.
2. Approved Manufacturers: Raychem, Thermon, Heat Trace Solutions.
3. Freeze protection shall consist of electrical self regulating semi-conductive "core" heat cable complete with all accessories including but not limited to an adjustable thermostat sensing the pipe or vessel contents temperature in lieu of ambient sensing, and contactors to enable power to the heat cable when temperature is below thermostat setpoint.

4. The self-regulating heater shall consist of two (2) 16 AWG tinned-copper bus wires embedded in parallel in a self-regulating polymer core that varies its power output to respond to temperature all along its length, allowing the heater to be crossed over itself without overheating, to be used directly on plastic pipe, and to be cut to length in the field. The heater shall be covered by a radiation cross-linked modified polyolefin dielectric jacket.

   (Optional: For installation on plastic piping, the heater shall be applied using aluminum tape (AT180). To provide a good ground path where none exists and to enhance the heater's ruggedness, the heater shall have an outer braid of tinned-copper and an outer jacket of modified polyolefin (-CR).

5. In order to provide energy conservation and to prevent overheating, the heater shall have a self-regulating factor of at least 90 percent. The self-regulation factor is defined as the percentage reduction, without thermostatic control, of the heater output going from 40°F pipe temperature operation to 150°F pipe temperature operation.
6. The heater shall operate on line voltages of either 120 or 208-277 volts without the use of transformers.
7. Heater shall operate from a circuit breaker for each tracing circuit.
8. The heat tracing shall maintain minimum "contents" temperature of 40 deg.F at ambient temperature of -20 deg.F when enclosed within a minimum of 1" fiberglass insulation on piping and vessels and pumps, no insulation required on sumps, etc., unless otherwise indicated.
9. Installation:

   a. Apply the heater linearly on the pipe after piping has been successfully pressure tested. Secure the heater to piping with cable ties or fiberglass tape.
   b. Apply "electric traced" signs to the outside of the thermal insulation.

10. Tests:

    After installation and before and after installing the thermal insulation, subject to testing using a 2500 VDC megger. Minimum insulation resistance should be 20 to 1000 megaohms regardless of length.

B. Manufacturers:

1. Manufacturer:	Raychem
2. Product:	Chemelex
3. Trade Name:	XL-Trace
4. Pipe Size:	4” & Larger
5. Product No.:	8XL-2-CR
6. Voltage:	277V
7. Max Circuit Length:	350 Ft.
8. Thermal Rating:	8 Watts/Ft.
9. Connection:	RAYCLIC-PL
10. Splice Kit & Tee Kit:	RAYCLIC-T
11. End Seal Kit:	RAYCLIC-S
12. Thermostat:	RAYCLIC-E
13. Glass Cloth Adhesive Tape:	GT-66

C. Responsibilities:

1. Heat trace including all accessories shall be furnished as part of the Work included in Division 23. Installation of cable on pipe including splices, strapping and bulb placement shall be by Division 23 Contractor.
2. Installation of power wiring including breakers and mounting thermostat enclosure shall be part of the Work included in Division 26.
3. Work under Division 23 includes coordination of material quantity and delivery, tracing installation, and insulation of piping after heat trace has been installed, inspected and tested.

2.7 DIELECTRIC PIPE FITTINGS AND ISOLATORS

A. Manufacturer: Epco Sales Inc., Victaulic.

B. Schedule: (complete unions)

Model:	FX	GX
Sizes:	½" thru 2"	2" thru 12"
Maximum Pressure:	250 psi	175 psi
Maximum Temp.:	210 deg. F	210 deg. F
Epconite Gasket:	#2	#2
Ends:	FPT x Solder	FPT x Solder
Type:	Union	Flanged Union

C. Schedule: (companion flanges)

Model:	X	W	H
Sizes:	1-1/2" - 10"	1-1/2" - 12"	1-1/2" - 12"
Maximum Pressure:	175 psi	175 psi	175 psi
Maximum Temp.:	210 deg. F	210 deg. F	210 deg. F
Epconite Isolators:	#2	#2	#2
End Style:	Solder (Brass)	Weld neck	Iron Pipe Thread
Type:	Companion	Companion	Companion
Face Gasket:	Same as Isolators		

D. Dielectric fittings shall conform to ASA B16.8, and shall be plated as applicable a minimum of .0005" and have no flow restriction when assembled.

2.8 SOLVENTS FOR PLASTIC PIPING

A. Solvents for plastic piping joints shall be certified to meet SCAQMD Rule 1168/316A. This includes but is not limited to PVC, CPVC, and ABS piping, all grades and sizes.

2.9 EQUIPMENT DRAINS AND OVERFLOWS

A. Steel Pipe: ASTM A53, Schedule 40 galvanized.

1. Fittings: Galvanized cast iron, or ANSI/ASTM B16.3 malleable iron.
1. Joints: Screwed, or grooved mechanical couplings.

B. Copper Tubing: ASTM B88, Type M, hard drawn.

1. Fittings: ANSI/ASME B16.23 cast brass, or ANSI/ASME B16.29 solder wrought copper.
2. Joints: ASTM B32, solder, Grade 95TA.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. General: Unless otherwise specifically indicated on Drawings or in Specifications, install equipment and materials in accordance with recommendations of manufacturer, including performance of tests as manufacturer recommends.

B. Protection:

1. Close ends of pipe and ductwork during construction and cover equipment to prevent entry of foreign material. Protect insulation against dirt, water, chemical or mechanical damage before, during and after installation. Cover floor drains and protect fixtures and equipment against damage during concrete pours and mechanical work.

C. Quiet Operation and Vibration:

1. All work shall operate in accordance with Section 230540 - Mechanical Sound and Vibration Control under all conditions of load.
2. Sound or vibration conditions not in accordance with Section 230540 and considered objectionable shall be corrected in a manner approved by the Architect under the Work of Division 23.

3.2 WELDING

A. Joints between sections of pipe, between pipe and fittings, shall be fusion welded. Use only certified welders. Strength of finished welded joints to be equal to strength of pipe. Width of finished weld to be at least 2-1/2 times the thickness of the part joined. Thickness of weld to be at least 25% greater than the thickness of pipe or fittings. Finished welded joints to present neat and workmanlike appearance.

B. Make no direct welded connections to valves, strainers, apparatus, and related equipment. Make connections to flanged valves, and flanged equipment with welded pipe connection flanges.

C. Radii of weld ells to be 1-1/2 times nominal diameter of fittings. Fittings used for all branch connections, whether full-size or reducing, to have interior surfaces smoothly contoured. Wall thickness of welded fittings equal to adjacent piping.

3.3 ELECTRIC WIRING

A. Furnish equipment requiring electrical connections to operate properly and to deliver full capacity at electrical service available.

B. All control wiring to be in accordance with manufacturer's recommendations; all wiring shall be color coded to facilitate checking.

C. Unless otherwise indicated, all mechanical equipment motors, starters, and controls shall be furnished, set in place, and wired in accordance with the Electrical Equipment/Wiring Responsibility Matrix on the drawings. Contractor should note that the intent of this electric wiring matrix is to have the Division 23 Contractor responsible for coordinating all control wiring as outlined, whether or not specifically called for by the mechanical or electrical drawings and specifications. Mechanical Contractor shall comply with the applicable requirements of Division 26 for electrical work of this Division 23 which is not otherwise specified. No extras will be allowed for Contractor's failure to provide for these required items. The Division 23 Contractor shall also refer to the Division 26 specifications and plans for all power and control wiring and shall advise the Architect/Engineer of any discrepancies prior to bidding.

ELECTRICAL EQUIPMENT/WIRING RESPONSIBILITY MATRIX

Item	Furnished By*	Set By*	Power Wiring*	Control Wiring*
Equipment Motors	MC	MC	EC	MC
Motor Starters & Overload Heaters	MC – Except when shown on MCC	EC	EC	MC
Variable Frequency Drives (VFD's)	MC	EC	EC	MC
Fused & Unfused Disconnect Switches, Thermal Overload & Heaters	EC	EC	EC	--
Manual Switches & Speed Control Switches carrying full load currents.	MC	EC	EC	EC
Fire/Smoke and Smoke Dampers	MC	MC	EC – Requires emergency power circuit if air system served is on emergency power.	EC
Control Relays & Transformer (See Note 2)	MC	MC	EC	MC
Thermostats (Line Voltage)	MC	EC	EC	EC
Temperature Control Panels	MC	MC	EC	MC
Building Fire Alarm System Fire & Smoke Detectors, including Relays in Starters for Fan Shutdown.	EC	EC	EC	EC
DDC Interface to Fire Alarm System	MC	MC	EC	MC

Item	Furnished By*	Set By*	Power Wiring*	Control Wiring*
Electric Plumbing Fixtures, Sensor Faucets, Sensor Flush Valves, Electric Water Coolers, and required Transformers.	MC	MC	EC	MC
Motor & Solenoid Valves, Damper Motors, PE & EP Switches, Control Valves, Low Voltage Thermostats	MC	MC	MC	MC
Pushbutton Stations & Pilot Lights (manually operated switches not carrying load currents).	MC	MC	N/A	MC
Pushbutton Stations & Pilot Lights carrying fully load current.	MC	EC	EC	N/A
Temporary Heating Connections	MC	MC	EC	MC
HVAC Water Treatment Interlocks	MC	MC	EC	MC
Cooling Tower Level Control and Fan Vibration Switch	MC	MC	MC	MC

* MC = Mechanical Contractor under Division 23 of the work.
* FM = Mechanical Contractor under Section 212200 - FM-200 Fire Suppression System.
* FPC = Fire Protection Contractor.
* EC = Electrical Contractor under Division 26 of the work.
* MGES = Medical Gas Equipment Supplier (Section 226313).

D. All temperature control conduit and wiring shall be furnished and installed under Section 230900. All motorized damper and motorized valve wiring shall be furnished and installed under Section 230900.

3.4 SLEEVES, PLATES AND CLOSURES

A. Division 23 Contractor shall provide and locate pipe sleeves, and inserts required before new floors and walls are built or shall be responsible for the cost of cutting and patching required where sleeves and inserts were not installed or where incorrectly located.

B. Provide sleeves for mechanical piping passing through concrete floor slabs and through concrete, masonry, tile, and gypsum wall construction. Provide metal collars to close and protect openings.

C. Where pipes penetrate the floor slab of the cooling tower areaway, stop water by providing a Link-Seal device and pack spaces between the pipe or conduit and the sleeves or penetration walls and from the link seal to the surface of the areaway slab with Hornflex Thiokol L-32 Sealant and make water-tight. Provide a stainless steel escutcheon/collar securely fastened to structure, and apply a liquid/trowelled

waterproofing system from the pipe, across the escutcheon, and across the concrete slab to a point 12” beyond the edge of the escutcheon.

D. Where pipe motion due to expansion and contraction will occur, make sleeves of sufficient diameter to permit free movement of pipe. Where sleeves pass insulated pipes, the sleeves shall be large enough to pass the pipe only and the insulation shall be made to butt against the construction, except for pipes requiring insulation having a vapor barrier, in which case, the sleeves shall be large enough to pass the pipe and insulation. Check floor and wall construction finishes to determine proper length of sleeves for various locations, make actual lengths to suit the following:

1. Terminate sleeves flush with floors, walls, partitions, and ceilings.
2. Seal annular space around pipes watertight at floor penetrations.
2. In areas where pipes are concealed, as in chases, terminate sleeves flush with floor.
3. In all areas where pipes are exposed, extend sleeves 1/4" above finished floor, except in rooms having floor drains, where sleeves shall be extended 2" above floor and in Kitchens and Mechanical Equipment Rooms, where sleeves shall be extended 4" above floor.

E. Sleeves shall be constructed of 24 gauge galvanized sheet steel with lock seam joints for all sleeves set in concrete floor slabs terminating flush with the floor. All other sleeves shall be constructed of galvanized steel pipe unless otherwise indicated on the drawings. "Crete Sleeve" (plastic type) sleeves are acceptable for concrete construction as manufactured by Sperzel Division, Shamrock Industries or Willoughby Industries.

F. Fasten sleeves securely in floors and walls so that they will not become displaced when concrete is placed or when other construction is built around them.

G. Provide tight fitting floor and ceiling plates on pipes passing thru walls, ceilings, and floors. Nickel or chrome plated in finished areas, galvanized cast iron in unfinished areas. Provide wall and ceiling flanges for ducts in finished areas.

H. Provide all cutting, patching of holes, openings, notches. Obtain written approval for notching, boring, chipping, burning, drilling, welding to structural members in accordance with the General Conditions of the Contract <and paragraph 3.7 of this Section>.

I. Where pipe sleeves penetrate fire rated walls and floors, this contractor shall use fire safing to seal openings.

3.5 FOUNDATIONS, PADS AND CURBS

A. Provide dowels, anchor bolts, groutings, concrete foundations and pads for pumps, chillers, plumbing, heating and ventilating or air conditioning equipment.

B. Dimensions and exact locations for foundations and concrete curbs for mechanical equipment to be field verified and located accurately by Division 23 Contractor.

3.6 EXCAVATING AND BACKFILLING

A. Excavate for all mechanical equipment such as fuel tanks, ductwork, sump pumps, manholes and trenches for underground pipelines to required depths. Compact bottoms of excavations. Slope to obtain required grade. Remove rocks, trash and debris before installation of equipment and backfilling. Backfill by hand tamping earth under the haunch of the pipe to specified compaction. Backfill and compact in thin layers until top of pipe is covered. Complete backfill by methods required or directed for soil characteristics to comply with the Architectural section of these specifications.

B. Excavations near footings shall be such that, when nearing building footings, or bearing foundation walls, the excavation bottom shall not be nearer the footing than a normal 45 degree bearing line from edge of footing bottom to bottom of excavation. When it is necessary to perpendicularly cross under a continuous foundation wall, care shall be taken to insure that crossing is clear of the structural foundation and of minimal width.

C. Do not place backfill over pipe lines until lines are properly tested.

D. When trenching through specially tested areas, such as paving, asphalt, etc., Contractor shall be responsible for restoring the surface to its original condition, and in a manner approved by the Architect. Repair trenches where settlement occurs, and restore the surface for the period of one year after final acceptance of the project. All cutting of paving, asphalt, etc. shall be by saw cutting.

3.7 CUTTING AND PATCHING

A. Cutting in Existing Building:

1. The Contractor shall provide all required openings in the existing building to facilitate the passage of ductwork, piping, etc. thru existing floors, walls, and beams.

B. Patching in Existing Building:

1. The Contractor shall patch all existing walls and floors to match existing.

3.8 PIPE HANGERS/SUPPORTS

A. Use inserts, anchors, expansion bolts or other approved and acceptable means of attachment to concrete construction. Set inserts in advance of concrete installation, provide required reinforcement rod for all inserts carrying loading equivalent of one 4" pipe or more. All inserts shall be flush with face of slab or wall containing insert.

B. Provide flat square washers for rods thru metal decking with nut above washer, when acceptable and approved.

C. Cinch hangers to carry appropriate share of loading and slope piping without sags or "pocketing" as appropriate and required.

D. Rod offsets, or angle installation, plumber tape or wire will not be accepted. Hanger rods shall be true and plumb.

E. Piping shall not be hung from other piping or equipment items. Provide attachments to building structure only. Use trapeze, wall brackets, knee brackets, etc., where hanger rods cannot be attached within spacing plumb to structures.

F. Provide sway and earthquake bracing where required in accordance with Section 230548 - Mechanical Seismic Control.

3.9 INSTALLATION OF VALVES

A. General:

1. Provide valves as shown on Contract Documents and as required for pressure relief, balancing and/or control of flow.
2. Provide isolation valves for maintenance and service on each piece of equipment regardless of whether or not shown on Contract Drawings.
3. Provide isolation valves for all branch line take-offs that serve more than two items of fixtures or equipment.
4. Provide balancing valves for each leg of domestic hot water return piping of two branches or more, all heating/cooling water returns and/or supplies to equipment as shown on Contract Documents.
5. Provide access means for each valve or group of valves either by access panels or utilization of inherent access provided by building methods i.e., lift out ceiling construction or exposed valve installations in non critical areas such as janitors closets, storage rooms, etc.
6. Install all valves with valve bonnets or operating stems in vertical (upright) position when possible, valves may be installed with bonnets or stems not less than 35 degrees downward from vertical plane except valves on vertical piping may be 90 degrees from vertical plane. Swing type check valves shall be installed on horizontal piping no more than 45 degrees upward slope from horizontal plane, using lift checks on vertical piping. Lift check valves shall not be used on sewage or sump pump discharge piping.
7. Inspect and tighten all bonnet nuts, bolts, packing glands, lubricate all valves requiring lubrication, secure all hand wheels and identification plates, be responsible for all valves having manufacturers name, trade name, working pressure and size stamped or cast into the body of the valve. Perform all maintenance, repacking and inspection prior to installation of valve.

B. Proper Installation of Valves:

1. Provide valves in accordance with the following schedule unless specified otherwise in Contract Documents.

a. Dead-end shut off: Gate, ball, butterfly, plug, stop and drain.
b. Throttling: Ball, plug, globe, diaphragm, needle, butterfly (when using butterfly valves for throttling, additional valves must be provided for service shutoff.)
c. Backflow prevention: Check.
d. Water hammer prevention: Silent or pilot operated non slam check.
e. Gas piping: Lubricated plug (or ground joint cock up to 1" only), or UL-Listed ball valve.

C. Removal and Repair Provisions:

1. Provide all valves which are not accessible for repair without removal from piping with union connection immediately adjacent to valve outlet.

3.10 PAINTING

A. Surfaces of exposed equipment and materials to be thoroughly cleaned before painting.

B. Duct interiors visible through registers, grilles and diffusers shall be painted flat black.

C. Exposed gas piping to be cleaned, primed and painted 2 coats (grey).

D. Provide all other painting of mechanical equipment and piping.

3.11 IDENTIFICATION OF PIPING AND EQUIPMENT

A. General: Provide pipe identification, valve tags, stencils, or engraved nameplates to clearly identify the mechanical equipment, piping and controls of the various mechanical systems and direction of flow in piping.

B. Methods for identification shall be as follows:

1. Metal Tags: Stamp tags with letter prefixes to indicate service, followed by a number for location in system.
2. Engraved Nameplates: Attach nameplates with brass screws. Pressure-sensitive embossed labels are not acceptable. Nameplates shall bear the same identifying legend used on the Contract Documents.

Insulation or Pipe Diameter	Length of Color Field	Size of Letters
¾" to 1-1/4"	8"	1/2"
1-1/2" to 2"	8"	3/4"
2-1/2" to 6"	12"	1-1/4"
8" to 10"	24"	2-1/2"
over 10"	32"	3-1/2"
Ductwork and Equipment	NA	2-1/2"

4. Piping Legend and Color (Contractor shall obtain written approval of colors from Owner's representative prior to starting work.)

Legend	Background Color	Direction Arrow	Pressure
Chilled Water	Light Green	Arrow	
Tower Water	Light Green	Arrow	
Compressed Air	Light Blue		PSI
Domestic Cold Water	Light Green		
Domestic Hot Water	Yellow		
Sprinkler-Fire	Red		
Heating Water	Yellow	Arrow	
Refrigerant Liquid	Yellow	Arrow	
Refrigerant Suction	Yellow	Arrow	
Refrigerant Hot Gas	Yellow	Arrow	

5. Pressure Sensitive Markers: Apply pressure sensitive markers in accordance with manufacturer's recommendations with complete wrap around may be used at Contractor’s option. Marker adhesion will be tested for permanence. Any markers showing dog ears, bubbles, or other failings shall be replaced.
6. Semi-Rigid Plastic Identification Markers: Seton Setmark premolded (not pressure sensitive) identification markers may be used at Contractor's option on service piping which is accessible for maintenance operations (but not on piping in finished spaces). This type marker shall not be installed on bare pipe when surface temperature exceeds 180 deg.F unless a 1" thick insulation band is first provided under marker for protection from the hot pipe.

C. Identification of Piping: Identify all piping accessible for maintenance in crawl spaces, tunnels, above ceilings, and access spaces as well as exposed to view utilizing either pressure sensitive markers, or semi-rigid plastic markers, according to the following procedures:

1. Use an arrow marker for each pipe-content legend. The arrow shall always point away from the pipe legend and in the direction of flow: color and height of arrow to be same as content legend lettering.
2. If flow can be in both directions, use a double-headed arrow indication.
3. Apply pipe legend and arrow indication at every point of pipe entry or exit where line goes thru wall or ceiling cut.
4. Apply pipe legend and arrow indication within 3" of each valve to show proper identification of pipe contents and direction of flow.
5. The legend shall be applied to the pipe so that lettering is in the most legible position. For overhead piping, apply legend on the lower half of the pipe where view is unobstructed, so that legend can be read at a glance from floor level.
6. For pipes under 3/4" O.D., fasten brass tags securely at specified legend locations.
7. Legend on steam piping, condensate return, compressed air, medical air, gas, and vacuum systems shall include working pressure or vacuum.
8. Insulated piping equipped with electric heat trace shall additionally be labeled “Electric Traced” with label of same size and color as the pipe legend.

D. Valves: All valves, including but not limited to domestic hot and cold water, hot water recirculation, heating water, chilled water, condenser water, steam, steam condensate return, fire protection, gas, medical gas, vacuum and special service valves located inside the building, shall be tagged and identified as to type of service, location number, and normal valve position (normally open or normally closed). Tags on valves used for balancing purposes shall be marked with the letter ‘B’ in place of normal valve position.

E. Controls: All magnetic starters and relays, shall have nameplates or be stenciled to identify connecting or controlled equipment. All manual operating switches, fused disconnect switches and thermal over-load switches which have not been specified as furnished with indexed faceplates shall also have nameplates or be stenciled as to "connected" or "controlled" equipment. All automatic controls, control panels, zone valves, pressure electric, electric pressure switches, relays, and starters shall be clearly identified.

F. Pumps: All pumps shall be identified as to service and zones served. Base mounted pumps shall be stenciled or have system served nameplates. Brass tags secured by brass chains may be used on small in-line pumps.

G. Storage Tanks, Water Treatment Equipment and Heaters: All tanks and heaters shall be stenciled as to service. The connecting pipes to each shall be identified and the service temperature entering and leaving the tank or heater shall be indicated.

H. Fans: All supply and exhaust fans and air handling units and connecting ductwork supplying one or more areas from an equipment room or isolated crawl or furred space shall have nameplate or be stenciled as to plan code number, service and areas of zones served.

I. Air Conditioning Equipment: Air conditioning equipment such as chillers, pumps, condensers, or cooling towers shall be identified by stencils, or system nameplates.

J. Access Doors: Provide engraved nameplates or painted stencils to identify concealed valves, controls, dampers or other similar concealed mechanical equipment. Obtain Architect approval before installation on all access doors in finished areas.

K. Lift Out Ceilings: Provide engraved nameplates or black lettering on transparent adhesive labels on ceiling tee stem to identify concealed valves, controls dampers or similar concealed mechanical equipment which is directly above nameplate in ceiling space. Obtain Architect approval before installation.

L. Expansion tanks shall be labeled to indicate system served and precharge pressure.

3.12 DRIP PANS

A. Provide drip pans under all fluid conducting piping which runs over electric switchgear, busway, or electric motor starters, and under all point-of-use water heaters.

B. Pans: 18 gauge galvanized iron. Pans shall be two inch deep, with rolled top edges, and shall extend six inches each side of the pipe or group of pipes and six inches beyond the equipment below. Keep pans as close to the underside of the pipes as practicable. All seams shall be soldered, and pans shall be crossbraced as required to prevent sagging and warping.

C. Pitch each pan to a drain connection, and pipe a 1-1/2 inch or larger copper tube drain to discharge over nearest available open drain.

3.13 FIRE SAFING

A. Mechanical Contractor shall provide fire safing for his work as follows: Where fire rated separations are penetrated by pipes, conduit or ductwork, the annular space around the pipe, conduit or ductwork shall be filled with a U.L. Rated fire safing material. Refer to Division 7 for materials and application specifications.

3.14 FREEZE PROTECTION CABLE

A. Comply with National Electric Code Section 427 for installation.

B. Protect heater strips from damage before, during and after installation.

C. Provide waterproof insulation for all heat traced and heat maintained piping one inch thick minimum in accordance with Section 230700.

D. When installing do not twist buss wires together.

E. Test each circuit prior to and immediately after installation of thermal insulation using a megger under 500 volts D.C. Minimum insulation resistance reading shall be ten (10) megohms regardless of length, if less than ten (10) megohms investigate cause and replace damaged sections - do not repair!

F. Install heat cable on lower quadrant of pipe 45 degrees up from vertical, provide ties or fiberglass tape 12" on center max.

G. Install all accessories and kits per manufacturers' recommendations and standards. Careful attention to manufacturers' installation instructions as pertains to valves and equipment will be strictly adhered to and enforced.

3.15 DIELECTRIC PIPE FITTINGS AND ISOLATORS

A. Provide dielectric pipe fittings and isolators at all connections between dissimilar metals in the domestic water, HVAC and fire protection systems to control corrosion potential caused by galvanic or electrolytic action.

B. Typical locations for dielectric isolation are; water heaters, storage and pressure tanks, water conditioning equipment, pumps, changes in service piping materials, make-up connections to boilers and chilled water systems, valves, deaerators, flexible connectors and the like where materials of different electrode potential are joined.

C. Hangers for piping shall be isolated per Section 230529 when hanger and piping materials are dissimilar and subject to production of electrolysis or galvanic action.

D. Storage tanks shall be isolated from piping and tank stands by use of anti-electrolytic and galvanic isolators.

3.16 DRAIN LINES

A. Provide condensate drain lines from each cooling coil and evaporative media sump drain pan to drain or to termination indicated.

3.17 HEATING SYSTEM USED FOR TEMPORARY HEAT DURING CONSTRUCTION

A. Permanent heating system shall not be used until building is totally and permanently enclosed (no temporary barriers for weather protection), and source of heat supply is permanently installed.

B. Once the heating system has been placed into operation, it shall not be shut down except for moderate weather, and all heated areas shall be maintained at a minimum temperature of 50 deg. F 24 hours a day.

C. When any air-handling equipment is used for temporary heat, the filters (MERV 13) shall be installed and maintained. Before building acceptance by Owner, these units shall be thoroughly cleaned and new filters shall be installed. This is over and above the extra set of filters to be provided the Owner as called for in the specifications. Coils shall be cleaned if necessary, as determined by the Engineer. If project is LEED, provide additional MERV 8 filter over all return air grilles to prevent debris from entering. Tape around perimeter edge to seal to grille.

D. Any and all systems being used for temporary heat shall become the Contractor's responsibility to maintain, and be put into first class working order before acceptance by the Owner.

E. Any manufacturer's guarantees that start with the use of equipment for temporary heat shall be extended by the contracting firm holding the prime contract for construction, so that the Owner will have his one-year guarantee from date of acceptance.

3.18 EXISTING PIPES AND MECHANICAL EQUIPMENT TO BE REMOVED

A. Where existing mechanical equipment, fixtures and/or piping is to be removed and/or relocated, all piping shall be disconnected and capped. All existing piping and hangers not to remain in use shall be removed completely to an existing main that is to remain in use, and capped at the main. General Contractor shall do all cutting, patching, and restoring that may be required for the removal of this piping and equipment. Where it is not possible to remove branch piping not remaining in use, due to its being concealed in the structure, the Division 23 Contractor shall cap the piping concealed at both ends in these areas as approved by the Architect.

B. All mechanical equipment, fixtures, and piping to be removed and not re-used shall remain the property of the Division 23 Contractor and shall be recycled or disposed of. No demolition materials shall be left on the jobsite.

C. Evacuate refrigerant from chillers that are to be removed and return to WSU in their containers (containers furnished by WSU).

END OF SECTION 230529

SECTION 230540 - MECHANICAL SOUND AND VIBRATION CONTROL

PART 1 - GENERAL

1.1 RELATED WORK

A. Requirements: Provide Mechanical Sound and Vibration Control in accordance with the Contract Documents.

B. Related work specified in other Sections:

Section 230500 - Basic Mechanical Requirements
Section 230529 - Basic Mechanical Materials and Methods
Section 232113 - HVAC Piping & Specialties
Section 233300 - Ductwork and Accessories - Flexible Ductwork Connections

1.2 SYSTEM DESCRIPTION

A. The work includes, but is not limited to the following:

1. Support isolation for motor/driven mechanical equipment.
2. Fabricated bases for distribution of equipment loading to isolation units.
3. Isolation of pipes and ductwork.
4. Sound-linings.
5. Sound proofing of construction.
6. External sound proofing.

1.3 QUALITY ASSURANCE

A. The Division 23 Contractor shall be responsible for assuring that all the following sound pressure level criteria are met. Sound pressure level tests shall be carried out by the Section 230593 Contractor in compliance with the Section 230593 specifications.

B. Acoustical Criteria:

1. Noise levels due to equipment and ductwork to permit attaining sound pressure levels in all 8 octave bands in occupied spaces conforming to RC curves:

Mechanical Rooms ---------- RC-60-80

C. Mechanical Acoustical Performance:

1. Motor Acoustical Performance:

Motor drives for pumps when installed per Drawings and Specifications shall operate with noise levels not exceeding 90dbA.

Noise levels shall be determined in accordance with IEEE Standard #85 Test "Procedure for Air-Borne Noise Measurements on Rotating Electric Equipment.

2. Refrigeration Machine Cooler, Condenser, Compressor and Compressor Piping Acoustical Performance:

The maximum permissible noise levels under design operating conditions, when measured in accordance with the methods and qualifications specified herein shall not exceed 90 dbA.

1.4 SUBMITTALS

A. Shop Drawings: Submit Shop Drawings and Product Data for the following items in accordance with the General Conditions of the Contract.

1. Each type of isolator including spring diameters, deflections, compressed spring height and solid spring height.
2. Sound Lining.

B. Test Reports: Submit certified test reports showing compliance in accordance with General Conditions of the Contract of the following items:

1. Certification that sound lining meets erosion test method described in UL Publication No. 181.

PART 2 - PRODUCTS

2.1 PIPING AND EQUIPMENT ISOLATION

A. Manufacturer: Mason Industries, Inc., Vibro-Acoustics.

B. Other acceptable manufacturers offering equivalent products: Korfund, Amber/Booth Co., Vibration Mountings and Control Co., Kinetics.

C. Neoprene Mounting Pads (Specification Schedule Type 1)

1. Kinetics Noise Control Type NPD.
2. Minimum static deflection 0.04” for 0.22” thick pad.
3. Cross, double ribbed elastomer in-shear pads, capable of 60 or 120 PSI loading, depending on load density of equipment being isolated.

4. Material thickness as required to provide minimum deflections listed in table at end of the specification section.

D. Double Deflection Neoprene Mountings (Specification Schedule Type 2)

1. Mason Industries Type ND Mounting, Type DNR Rails.
2. Minimum static deflection 0.35 inch.
3. Bolt holes where required.
4. Steel rails above mountings to compensate for overhang where required.

E. Spring Isolator Mountings (Specification Schedule Type 3)

1. Mason Industries Type SLF.
2. Free-standing, laterally stable without housing, complete with 1/4 inch neoprene acoustical friction pads between base plate and support and with leveling bolts that must be rigidly bolted to equipment.
3. Spring diameters no less than 0.8 of the compressed height of the spring at rated load.
4. Springs with minimum additional travel to solid equal to 50 percent rated deflection.

F. Restrained Spring Isolator Mountings (Specification Schedule Type 4)

1. Mason Industries Type SLR.
2. Spring isolator mounting equal to Type SLF but with housing that includes vertical resilient limit stops to prevent spring extension when weight is removed from equipment.
3. Provide hot dipped galvanized mountings exposed to weather.

G. Vibration Hangers (Specification Schedule Type 6)

1. Mason Industries Type DNH.
2. Spring and double deflection neoprene element in series.
3. Neoprene element minimum deflection 0.35 inch.
4. Spring diameters no less than 0.8 of compressed height of spring at rated load.
5. Springs with minimum additional travel to solid equal to 50 percent rated deflection.

H. Integral Structural Steel Base (Specification Schedule Type B)

1. Mason Industries Type WF.
2. Rectangular for equipment other than "T" or "L" shaped pump bases.
3. Pump bases for split case pumps to include supports for suction and discharge base ells.
4. Beams for perimeter members minimum depth equal to one tenth of the longest dimension of the base. Depth need not exceed 14 inches if deflection and misalignment is kept within acceptable limits by manufacturer.
5. Provide height saving brackets to provide a clearance of one inch.

I. Steel Rail Base (Specification Schedule Type B)

1. Mason Industries Type ICS.
2. Steel members welded to height saving brackets to cradle machines having legs or bases that do not require a complete supplementary base.
3. Provide members sufficiently rigid to prevent strains in the equipment.

J. Flexible Butyl Hose Pipe Connectors (Up to 2")

1. Mason Industries Type RMM.
2. Flexible Butyl 150 lb. hose with brass screw type ends attached by expansion or swedging methods. Clamps are unacceptable.
3. Duty up to: 100 psi and 220 deg. F.
4. Hoses up to 1-1/4 inches shall be 12 inches in length and 1-1/2 inches to 2 inches shall be 18 inches in length.

K. Flexible Neoprene Sphere Pipe Connectors (2" to 12")

1. Mason Industries Type MFNC and Type MFTNC.
2. Neoprene single-sphere type with 150 lb. ASA steel floating flanges.
3. Duty up to: 150 psi and 230 deg. F.
4. Movement limits: minimal 3/8 inch axial compression, 1/4 inch axial elongation, 3/8 inch lateral movement and 15 deg. angular movement.

L. Braided Flexible Connectors

1. Manufacturer: Thermo Tech, Inc., Metraflex, Flex-Hose Co., Flexicraft Industries, Flex-Precision ltd.
2. Flexible connectors manufactured of 300 series stainless steel convoluted metal bellows and braid, 150 psig ASA drilled flanges. Maximum permanent offset from centerline = ¾”. Maximum intermittent offset from centerline = 3/8”.
3. Pressure test to be certified for 300 psi at 250 deg. F.

2.2 SOUND LININGS

A. Acceptable Manufacturer: Johns Manville Permacote, Linacoustic and Spiracoustic.

B. Other acceptable manufacturers offering equivalent products: Knauf, CertainTeed ToughGuard R.

C. Product: Fibrous glass, acrylic surface coating, stenciled NFPA, conforming to ASTM C1071, ASTM G21 and ASTM G22.

D. Minimum thickness: As indicated in Part 3 of this specification.

E. Sound Absorption Coefficient for 1" thickness per the following:

Frequency (cps)	=	125	250	500	1000	2000	4000	NRC
Coefficient	=	0.09	0.29	0.65	0.78	0.83	0.80	0.70

F. Flamespread: Maximum 25.

G. Fuel contributed and smoke developed: Maximum 50.

H. Suitable for duct velocity of 5000 fpm. Lining shall meet erosion test method described in UL Publication No. 181.

I. Dynamic loss coefficient: Maximum 1.2.

J. Thermal conductivity 0.25 Btu/hr/deg F/in. @ 75°F mean temperature.

2.3 ADHESIVE AND SEALER

A. Acceptable Products: Adhesive, Benjamin Foster "81-99", or accepted equal, Sealer, Benjamin Foster "82-07" or accepted equal.

B. In conformance with NFPA 90A.

C. Flamespread: Maximum 25.

D. Fuel contributed and smoke developed: Maximum 50.

2.4 NON-HARDENING CAULKING

A. Acceptable Products: Tremco "Polybutene", Schuller or accepted equal.

B. Guaranteed to be permanently elastic.

2.5 VIBRATION DAMPING COMPOUND

A. Acceptable Manufacturers: Soundcoat GP-1 Vibration Damping Compound, Korfund Dynamics Corporation Vibro-damp 80A, Kinetics, Vibro-Acoustics.

B. Non-burning.

C. Compound shall effectively damp vibrations for a broad frequency range between 10 Hz to 20 kHz.

D. Decay rate Geiger plate 45 dB/sec. at 72 deg. F.

2.6 EXTERNAL SOUND BARRIER INSULATION

A. Acceptable Manufacturers: Kinetics Noise Control, Vibro-Acoustics.

B. Model: KNM 100 ALQ-1.

C. Sound barrier shall be a barrier/decoupling layer composite consisting of 1.0 lb. per ft^2 mass barrier bonded to 1" fiberglass batting, non-woven porous scrim-coated glass cloth, quilted together to encapsulate the glass fibers. Provide with barrier tape for sealing joints.

D. Sound Transmission Loss:

1. Transmission loss when attached to outside of piping shall be as per the following table:

Band No.	Band Center Freq. (Hz)	Transmission Loss (dB)
1	125	13
2	250	16
3	500	24
4	1000	33
5	2000	43
6	4000	49
-	STC	28

E. Flamespread: Maximum 25.

F. Fuel contributed and smoke developed: Maximum 50.

2.7 EXTERNAL SOUND BARRIER INSULATION (PIPING)

A. Acceptable Manufacturers: Kinetics Noise Control, Vibro-Acoustics.

B. Model: KNM 100 ALQ-1.

C. Sound barrier shall be a barrier/decoupling layer composite consisting of 1.0 lb. per ft^2 mass barrier bonded to 1" fiberglass batting, non-woven porous scrim-coated glass cloth, quilted together to encapsulate the glass fibers. Provide with barrier tape for sealing joints.

D. Sound Transmission Loss:

1. Transmission loss when attached to outside of piping shall be as per the following table:

Band No.	Band Center Freq. (Hz)	Transmission Loss (dB)
1	125	13
2	250	16
3	500	24
4	1000	33
5	2000	43
6	4000	49
-	STC	28

E. Flamespread: Maximum 25.

F. Fuel contributed and smoke developed: Maximum 50.

2.8 EXTERNAL SOUND BARRIER INSULATION (SHEET METAL)

A. Acceptable Manufacturers: Kinetics Noise Control, Vibro-Acoustics.

B. Model: KNM 100 ALQ-1.

C. Sound barrier shall be a barrier/decoupling layer composite consisting of 1.0 lb. per ft^2 mass barrier bonded to 1" fiberglass batting, non-woven porous scrim-coated glass cloth, quilted together to encapsulate the glass fibers. Provide with barrier tape for sealing joints.

D. Sound Transmission Loss:

1. Transmission loss when attached to outside of piping shall be as per the following table:

Band No.	Band Center Freq. (Hz)	Transmission Loss (dB)
1	125	13
2	250	16
3	500	24
4	1000	33
5	2000	43
6	4000	49
-	STC	28

E. Flamespread: Maximum 25.

F. Fuel contributed and smoke developed: Maximum 50.

PART 3 - EXECUTION

3.2 GENERAL - PIPING AND EQUIPMENT ISOLATION

A. Unless otherwise noted on the Equipment Mounting Schedule, provide mechanical equipment mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure. Vibration isolators to be selected in accordance with the weight distribution so as to produce reasonable uniform deflection. Deflections to be as noted on the Equipment Mounting Schedule included at the end of this section.

B. Coordinate work with other trades to avoid rigid contact with the building. Inform other trades following the isolation work, to avoid any contact which would reduce the vibration isolation.

C. The installation or use of vibration isolators must not cause any change of position of equipment or piping which would result in stresses in piping connections or misalignment of shafts or bearings. In order to meet this objective, maintain equipment and piping in a rigid position during installation. Do not transfer the load to the isolator until the installation is complete and under full operational load.

D. Support the machine to be isolated with a structural steel frame.

E. Provide brackets to accommodate the isolator and provide a mechanical stop. The vertical position and size of the bracket to be recommended by the isolator manufacturer.

F. For restrained spring isolators, use housing as blocking during erection so that installed and operating heights can be the same. Maintain a minimum clearance of 1/2 inch around restraining bolts between housing and spring to avoid interference with spring action. Limit stops to be out of contact during normal operation.

3.3 HANGERS

A. Install type 2 or 3 vibration isolation piping hangers where indicated in Equipment Mounting Schedule at the end of this section and within 20 feet (measured along piping) upstream and downstream of all pumps 3 HP or larger.

B. Install the isolators with the isolator hanger box attached to or hung as close as possible to the structure.

C. Suspend the isolators from substantial structural members, not from slab diaphragm unless specifically accepted.

D. Align hanger rods to clear hanger box.

3.4 EQUIPMENT BASES

A. Provide minimum operating clearance between the equipment frame or rigid steel base frame and the housekeeping pad or floor of 1 inch. Provide minimum operating clearance between concrete inertia base and the housekeeping pad or floor of 1 inch.

3.5 FLEXIBLE PIPING CONNECTORS

A. Provide flexible connectors for equipment that is supported by or mounted on vibration isolators except when connected piping is made up with a Victaulic Flex coupling system. Connectors to be installed under Section 232113.

B. Hoses shall be installed on the equipment side of the shut-off valves and horizontally wherever possible.

C. Provide connectors at pump suction and discharge, and elsewhere as required to accommodate thermal expansion, vibration and misalignment.

D. Provide flexible connectors on all suction and discharge connections to all base mounted centrifugal pumps, vertical turbine pumps, air compressors, dryers, vacuum pumps or other equipment items producing vibration, shock, noise, or thermal motion of piping.

E. Provide 300 psi companion flanges for connector for threaded, welded, soldered, or brazed piping as appropriate.

F. Connectors to be aligned, centered, and shall not bear weight of pipe, fittings, or pipeline accessories such as valves. Piping shall be supported both sides of horizontal or vertical connectors.

3.6 PIPE FLOOR SUPPORTS

A. Provide type 3 mountings with a minimum static deflection of 1.5 inches on horizontal pipe floor supported at slab in equipment rooms above grade.

3.7 SOUND LININGS

A. Dimensions of lined ductwork are clear inside dimensions after lining has been installed.

B. Sound linings to be held in place with mechanical fasteners as per the latest SMACNA duct liner application standard, with joints and any tears to be coated with Benjamin Foster or accepted equal adhesive. The transverse joints to be coated prior to installation so that the ends of the liner are compressed together while the adhesive is still moist, forming a seal of the leading and trailing edge of each joint. Excess adhesive to be brushed to an even finish over the joint.

C. Provide continuous sheet metal edge protectors at entering and leaving edges of lined duct sections where adjacent to unlined duct sections.

D. Extent of 1” ductwork sound linings:

1. In all rectangular exhaust ducting.

3.8 SOUND PROOFING OF CONSTRUCTION

A. Required for opening between ductwork and piping and following construction:

1. Equipment room walls.
2. Floors, except in shafts.
3. Roofs, specifically inside roof curbs for mechanical equipment and where ductwork penetrates roof deck.

B. Sound proofing:

1. Fill openings with tightly packed fibrous glass blanket or board for full depth of penetration.
2. Caulk each side of opening with non-hardening, non-aging caulking compound.

3.9 EXTERNAL VIBRATION DAMPENING

A. For typical floor supply duct take-offs from main supply riser when required to meet specified sound levels, provide 1/8 inch thick duct exterior coating of vibration dampening compound. These treatments to be provided over the rectangular portion (flat sides) of the floor take-off ducts.

3.10 EQUIPMENT MOUNTING SCHEDULE

A. Manufacturer: Mason Industries, Inc., Kinetics, Vibro-Acoustics.

B. Schedule: See the following pages.

EQUIPMENT VIBRATION ISOLATION SCHEDULE			
EQUIPMENT TYPE	SLAB ON GRADE		
	BASE TYPE	ISOL TYPE	MIN. DEFL. (IN.)
REFRIGERATION EQUIPMENT			
A. Centrifugal Chillers	A	1	.75

EQUIPMENT VIBRATION ISOLATION SCHEDULE			
EQUIPMENT TYPE	SLAB ON GRADE		
	BASE TYPE	ISOL TYPE	MIN. DEFL. (IN.)
PUMPS			
A. Flexible Coupled			
1. 50 to 125 HP	A	1	.25
COOLING TOWERS, FLUID COOLERS & EVAPORATIVE CONDENSORS			
A. 301 to 500 RPM	(See Note 3)	Bolt to Support Beam	
B. 501 RPM & Over	(See Note 3)	Bolt to Support Beam	

EQUIPMENT VIBRATION ISOLATION SCHEDULE						
EQUIPMENT TYPE	SLAB ON GRADE			20 FT. FLOOR SPAN		
	BASE TYPE	ISOL TYPE	MIN. DEFL. (IN.)	BASE TYPE	ISOL TYPE	MIN DEFL. (IN.)
CENTRIFUGAL FANS & VENTILATION SETS						
A. Up to 22 in. Wheel dia.	A/B	2	.25	A/B	3	.75
B. 24 in. Wheel dia. & Over						
1. Up to 50 hp						
a. 301 to 500 RPM	B	3	1.5	B	3	1.5
b. 501 RPM & Over	B	3	.75	B	3	.75

EQUIPMENT VIBRATION ISOLATION SCHEDULE						
EQUIPMENT TYPE	SLAB ON GRADE			20 FT. FLOOR SPAN		
	BASE TYPE	ISOL TYPE	MIN. DEFL. (IN.)	BASE TYPE	ISOL TYPE	MIN DEFL. (IN.)

BASE TYPES:

A = NO BASE, ISOLATORS ATTACHED DIRECTLY TO EQUIPMENT
B = STRUCTURAL STEEL RAILS OR BASE
C = CONCRETE INERTIA BASE
D = CURB-MOUNTED BASE

ISOLATOR TYPES

1 = RUBBER OR GLASS FIBER PAD
2 = RUBBER FLOOR ISOLATOR OR HANGER
3 = SPRING FLOOR ISOLATOR OR HANGER
4 = RESTRAINED SPRING ISOLATOR
5 = SPRING AND RUBBER IN SERIES HANGER

NOTES:

1. CONTRACTOR SHALL PROVIDE VIBRATION ISOLATION AND CALCULATIONS STAMPED BY A LICENSED PROFESSIONAL ENGINEER.

2. TO AVOID ISOLATOR RESONANCE PROBLEMS, SELECT ISOLATOR DEFLECTION SO THAT NATURAL FREQUENCY IS 40% OR LESS THAN LOWEST OPERATING SPEED OF EQUIPMENT (SEE ASHRAE HVAC APPLICATIONS HANDBOOK, 1999 EDITION).

3. BOLT COOLING TOWER DIRECTLY TO SUPPORT I-BEAMS. NO VIBRATION ISOLATORS REQUIRED.

END OF SECTION 230540

SECTION 230548 - MECHANICAL SEISMIC CONTROL

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Anchorage and seismic restraint systems for all Division 23 isolated and non-isolated equipment, ductwork and piping systems.

B. Equipment/piping/ductwork to be isolated and/or seismically supported shall include but not be limited to the following:

1. Piping
2. Ductwork
3. Unit Heaters
4. Air Separators
5. Expansion Tanks
6. Cooling Tower
7. Hanging Exhaust Fans
8. Pumps
9. Chemical Treatment Stands
10. Chillers

1.2 RELATED WORK

A. Requirements: Provide Mechanical Seismic Control in accordance with the Contract Documents.

B. Section 230500 - Basic Mechanical Requirements.

C. Section 230529 - Basic Mechanical Materials and Methods.

D. Section 230540 - Mechanical Sound and Vibration Control.

1.3 REFERENCES

A. International Building Code, Current Edition in use by Jurisdictional Authority.

B. NFPA Bulletin 90A, Current Edition.

C. UL Standard 181.

D. SMACNA Seismic Restraint Manual: Guidelines for mechanical systems.

1.4 SYSTEM DESCRIPTION

A. The Division 23 Contractor shall be responsible for supplying and installing equipment, vibration isolators, flexible connections, rigid steel frames, anchors, inserts, hangers and attachments, supports, seismic snubbers and bracing to comply with the following:

1. Short period design spectral response acceleration coefficient S_{DS}= 1.2.
2. One-second period design spectral response acceleration coefficient S_{D1}= 0.78.
3. Site Class D.
4. Seismic Design Category D.

B. All components have an importance factor I_P of 1.0.

1.5 QUALITY ASSURANCE

A. All supports, hangers, bases, anchorage and bracing for all isolated equipment and non-isolated equipment shall be designed by a professional engineer licensed in the state where the project is located, employed by the restraint manufacturer, qualified with seismic experience in bracing for mechanical equipment. Shop drawings included with deferred submittal for earthquake bracing and anchors from the restraint manufacturer shall bear the Engineer's signed professional seal. All calculations/design work required for the seismic anchorage and restraint of all Division 23 equipment and systems shall be provided by a single firm.

B. The above qualified seismic engineer shall determine specific requirements for equipment anchorage and restraints, locations and sizes based on shop drawings for the mechanical equipment which have been submitted, reviewed and accepted by the Architect/Engineer for this project.

C. Seismic Engineer or the Engineer’s Representative shall field inspect final installation and certify that bracing and anchorage are in conformance with the Seismic Engineer’s design. A certificate of compliance bearing the Seismic Engineer’s signed Professional Engineer’s seal shall be submitted and shall be included in each copy of the Operation and Maintenance Manuals.

D. The Division 23 Contractor shall require all equipment suppliers to furnish equipment that meets the seismic code, with bases/skids/curbs designed to receive seismic bracing and/or anchorage. All isolated and non-isolated mechanical equipment bracing to be used in the project shall be designed from the equipment submittals and certified to be code-compliant by the equipment manufacturer for seismic description loads defined above, with direct anchorage capability.

1.6 SUBMITTALS

A. A single submittal shall be provided for all seismic anchorage and restraints for all Division 23 equipment and systems provided as part of this project. Individual submittals for specific systems will not be accepted.

B. Submit shop drawings, calculations, and printed data for the following items under provisions of the General Conditions of the Contract:

1. Complete engineering calculations and shop drawings for all seismic restraint requirements for all equipment as required by the IBC.
2. The professional seal of the engineer who is responsible for the design of the Seismic Restraint System.
3. Details for all seismic bracing.
4. Details for steel frames, concrete inertia bases, and housekeeping pads. Include dimensions, embed depths, dowelling details, and concrete reinforcing requirements.
5. Clearly outlined procedures for installing and adjusting the isolators, seismic bracing anchors, snubbers, cables, and bolt connections.
6. Floor plan noting the locations, size, and type of anchorage and restraint to be used.
7. Include confirmation that all calculations are based on the design criteria listed in Paragraph 1.4.A of this Section.
8. Certificate of Compliance.

PART 2 - PRODUCTS

2.1 RESTRAINT EQUIPMENT AND SYSTEMS

A. Acceptable Manufacturers and Suppliers for Non-Isolated Systems:

1. Mason Industries, Inc.
2. Korfund
3. Amber/Booth Company
4. Vibration Mountings and Control Company
5. Kinetics
6. International Seismic Application Technology
7. Tolco
8. Vibro Acoustics

B. Manufacture and design of restraints and anchors for isolated equipment shall be by the manufacturer of the vibration isolators furnished for the equipment in accordance with Section 230540.

2.2 SNUBBERS

A. Snubbers shall be all-directional and consist of interlocking steel members restrained by replaceable shock absorbent elastomeric materials a minimum of 3/4 inch thick.

B. Snubbers shall be manufactured with an air gap between hard and resilient material of not less than 1/8 inch or more than 1/4 inch.

C. Snubbers shall be Mason Industries Z - 1011 or accepted equivalent.

PART 3 - EXECUTION

3.1 DESIGN AND INSTALLATION

A. General:

1. All mechanical equipment, piping and ductwork shall be braced, anchored, snubbed or supported to withstand seismic disturbances in accordance with the criteria of this specification. Provide all engineering, labor, materials and equipment for protection against seismic disturbances as specified herein. The following mechanical components are exempt from seismic restraint requirements:

    a. Components in Seismic Design Categories A and B.
    b. Components in Seismic Design Category C that have an importance factor I_P of 1.0.
    c. Components that have an importance factor I_P of 1.0, that are mounted less than four feet above the floor, that weigh less than 400 pounds, and that have flexible ductwork, piping, and conduit connections.
    d. Components that have an importance factor I_P of 1.0, that weigh 20 pounds or less, and that have flexible ductwork, piping, and conduit connections.

2. Powder-actuated fasteners (shot pins) shall not be used for component anchorage in tension applications in Seismic Design Category D, E, or F.
3. Attachments and supports for mechanical equipment shall meet the following provisions:

    a. Attachments and supports transferring seismic loads shall be constructed of materials suitable for the application and designed and constructed in accordance with a nationally recognized structural code such as, when constructed of steel, AISC, Manual of Steel Construction (Ref. 9.8-1 or 9.8-2).
    b. Friction clips shall not be used for anchorage attachment.
    c. Expansion anchors shall not be used for mechanical equipment rated over 10 hp (7.45 kW). Exception: Undercut expansion anchors.

d. Drilled and grouted-in-place anchors for tensile load applications shall use either expansive cement or expansive epoxy grout.
e. Supports shall be specifically evaluated if weak-axis bending of light-gauge support steel is relied on for the seismic load path.
f. Components mounted on vibration isolation systems shall have a bumper restraint or snubber in each horizontal direction. The design force shall be taken as $2F_p$. The intent is to prevent excessive movement and to avoid fracture of support springs and any non-ductile components of the isolators.
g. Seismic supports shall be constructed so that support engagement is maintained.

B. Install ceiling mounted items in accordance with ASTM C 636.

1. Ceiling mounted air terminals or services weighing less than 20 pounds shall be positively attached to the ceiling suspension main runners or to cross runners with the same carrying capacity as the main runners.
2. Terminals or services weighing 20 pounds but not more than 56 pounds, in addition to the above, shall have two No. 12 gauge hangers connected from the terminal or service to the ceiling system hangers or to the structure above. These wires may be slack.
3. Terminals or services weighing more than 56 pounds shall be supported directly from the structure above by approved hangers.

C. Spring Isolated Equipment:

1. All vibration isolated equipment shall be mounted on rigid steel frames or concrete bases as described in the vibration control specifications unless the equipment manufacturer certified direct attachment capability. Each spring mounted base shall have a minimum of four all-directional seismic snubbers that are double acting and located as close to the vibration isolators as possible to facilitate attachment both to the base and the structure. Snubbers shall be installed with factory set clearances.

D. Non-Isolated Equipment:

1. The Division 230548 Contractor shall be responsible for thoroughly reviewing all drawings and specifications to determine all equipment to be restrained. This Contractor shall be responsible for certifying that non-isolated equipment is mounted and braced such that it adheres to the system description criteria in this specification section.

E. Piping:

1. Seismic braces for piping may be omitted when the distance from the bottom of the pipe to the supporting structure is 12" or less.

2. A rigid piping system shall not be braced to dissimilar parts of a building or two dissimilar building systems that may respond in a different mode during an earthquake. Examples: Wall and a roof; solid concrete wall and a metal deck with lightweight concrete fill.
3. Unbraced piping attached to in-line equipment shall be provided with adequate flexibility to accommodate differential displacements.
4. At the interface of adjacent structures or portions of the same structure that may move independently, utility lines shall be provided with adequate flexibility to accommodate the anticipated differential movement between the ground and the structure.
5. Provide large enough pipe sleeves through walls or floors to allow for anticipated differential movements.

F. Ductwork:

1. Seismic restraints are not required for HVAC ducts with importance factor I_P of 1.0, provided that either of the following conditions are met for the full length of each duct run:

   a. HVAC ducts are suspended from rod hangers and hangers are 12 inches or less in length from the point rod attaches to duct, to the point rod connects to the supporting structure. Rods must be secured to both top and bottom cross angles with locking nuts above and below angle iron.
   b. HVAC ducts have a cross-sectional area of less than 6 square feet.
   c. This exception is not valid if the top of ductwork is not secured to hanger rods to limit pendulum length to 12 inches.

2. Equipment items installed in-line with the duct systems with an operating weight greater than 75 pounds shall be supported and laterally braced independently of the duct system.

END OF SECTION 230548

SECTION 230593 - TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.1 RELATED WORK

A. The General Conditions, Supplementary Conditions and Division 1, General Requirements apply to this Section, and Contractor shall review and adhere to all requirements of these Documents.

B. Related work specified in other Sections:

Section 019113 – General Commissioning Requirements
Section 230500 - Basic Mechanical Requirements
Section 230800 – Commissioning of HVAC
Section 233300 – Ductwork and Accessories

1.2 SYSTEM DESCRIPTION

A. The work includes, but is not limited to the following:

1. Upon completion of the installation of all the plumbing, air and heating or cooling water systems, all necessary adjustments shall be made to provide capacities listed on the Drawings to properly balance these systems.
2. Submittals and written reports as specified.
3. Testing requirements as described in Specification Section 230500, paragraph 1.16.
4. Provide Owner training as described in Specification Section 230500.
5. Assist commissioning agent as required by specification sections 019113 and 230800.

1.3 QUALITY ASSURANCE

A. Work under this section shall be executed under the direct supervision of a Registered Professional Engineer having an established professional office in the State of Utah and having an experience record of not less than five (5) years in the mechanical contracting industry, engaged in testing, balancing and adjusting of air and hydronic mechanical systems for not less than two (2) years of that time, or, under the direct supervision of a qualified testing, adjusting and balancing supervisor, possessing certification from the National Environmental Balancing Bureau (NEBB) or from the Associated Air Balance Council (AABC).

B. Comply with the applicable procedures in the chapter on Testing, Adjusting and Balancing in the latest ASHRAE Edition of the NEBB, AABC, and SMACNA Test and Balance documents.

C. Calibration and maintenance of instruments shall be in accordance with manufacturer's standards and recommendations, and calibration histories for each instrument shall be available for examination.

D. Accuracy of measurements shall be in accordance with the applicable measurement means as listed in the latest edition of NEBB, AABC, and SMACNA Test and Balance documents.

E. Allowable Tolerances:

1. Tolerances of adjustment for air handling systems are plus or minus 10% for supply, return, and exhaust systems at air devices and plus 10%/minus 0% at all fans/source equipment from figures shown on drawings.
2. Tolerances of adjustment for hydronic systems, are plus or minus 10% of design conditions shown on drawings at terminal devices and equipment, and plus 10%/minus 0% at all pumps.

F. Final Testing, Adjusting and Balancing of all hydronic and air systems shall be performed by one of the 3 following testing, adjusting, and balancing subcontractors, no exceptions:

1. BTC Services, Inc.
2. Certified Testing & Balancing, Inc.
3. Payson Sheet Metal

G. Within 30 days after execution of the Owner-Contractor Agreement, transmit to Architect/Engineer the name of the organization proposed to perform the services.

1.4 SUBMITTALS

A. Procedure: Submit Qualifications, Documentation, Test Schedules and Reports in accordance with the General Conditions of the Contract:

B. Qualifications:

1. Submit three copies of documentation to confirm compliance with Quality Assurance provisions:

a. Organization supervisor and personnel training and qualifications.
b. Specimen copy of each of the report forms proposed for use.

C. Preliminary Report: At least fifteen days prior to starting field work, submit three copies of:

1. A set of report forms filled out as to the design flow values and the installed equipment pressure drops, and the required CFM for air terminals.

2. A complete list of instruments proposed to be used, organized in appropriate categories, with data-sheets for each. Show:

   a. Manufacturer and model number.
   b. Description and use when needed to further identify the instrument.
   c. Size of capacity range.
   d. Latest calibration date.

3. Architect/Engineer will review submittals for compliance with Contract Documents, and will return one set marked to indicate:

   a. Discrepancies noted between measured data and Contract Documents.
   b. Additional, or more accurate, instruments required.
   c. Requests for re-calibration of specific instruments.

D. Schedules:

1. Schedule tests to comply with project completion schedules.
2. Schedule testing and balancing of parts of the systems which are delayed due to seasonal, climatic, occupancy, or other conditions beyond control of the Contractor, as early as the proper conditions will allow, after consultation with Architect/Engineer.
3. Submit reports of delayed testing promptly after execution of those services.

E. Final Report: At least fifteen days prior to Contractor's request for final inspection, submit three copies of final reports, on applicable reporting forms, for review. Submit a fourth copy directly to the Engineer. Each individual final reporting form must bear the signature of the person who recorded data and that of the NEBB or AABC certified supervisor of the reporting organization. Identify instruments of all types which were used and last date of calibration of each. Report shall include:

1. A detailed letter to Engineer outlining all abnormal or notable conditions not covered in above data specifically identifying all locations where specified flow tolerances could not be met.
2. A set of reduced black and white or blueline prints with all air openings clearly marked to correspond with data sheets and with thermometer locations clearly marked.
3. Data sheets showing amount of air handled at each opening, instrument used, velocity readings, and manufacturer free area factor.
4. Equipment data sheets giving make, size and model, of fans, starters and motors with rated amps and service factors, and drives. Include pumps, supply fans, exhaust and recirculating fans.
5. Cooling equipment operating data including, water temperature entering and leaving chillers, and water flow and pressure drop through chillers.
6. Cooling tower operating data including measurements of hot water, cold water and wet-bulb temperatures, circulating water flow rate, fan RPM, fan power and wind velocity.
7. Equipment and operating data as required to show performance of pumps, heat exchangers, chillers, unit heaters, fans and temperature control devices.

8. Sound pressure levels showing readings in all 8 octave bands and plotted on RC(II) charts shall be submitted for the following:

   a. All sides of Chiller Rooms.
   b. All spaces exhibiting abnormally high or annoying noise levels.

1.5 PROJECT CONDITIONS

A. The following job conditions must be verified before any testing, adjusting or balancing of the environmental systems begin:

1. Installation of the designated system is complete and in full operation.
2. On hydronic systems, strainers shall be cleaned, temperature control valve operation shall be checked, pump rotation shall be checked, pressure reducing valves shall be adjusted, and other such conditions requiring correction.
3. Air systems shall be checked for dirty filters, filter leakage, equipment vibrations, damper operation, fan rotation, and other such conditions requiring correction.

PART 2 - PRODUCTS

- NOT USED –

PART 3 - EXECUTION

3.1 PROCEDURE

A. Confirm that project conditions have been verified and that necessary corrections have been made before proceeding with the Work.

B. The Test and Balance Contractor must proportion air/water flows in the system while introducing a minimum amount of resistance. All systems are to be proportionally balanced.

C. Hydronic Systems:

1. Using system flow meters and/or contact pyrometer, the balancing firm shall adjust the quantity of water or glycol solution handled by each pump and supplied to each chiller, heat exchanger, cooling tower, and such other primary source equipment to meet design requirements, and mark each balancing cock at final setting.
2. Assist the controls contractor with determining proper system differential setpoint to be used to modulate chilled water pump speed. Verify flow at each of the chilled water coils in the four main air handlers serving the events center. Main air handler chilled water flow to be 354 gpm. These existing systems include Griswold pressure-independent flow control valves, and the chilled water

system differential pressure setpoint must be adequate for these existing flow control valves to function correctly.

3. Assist the 230900 contractor with determining correct manual setpoint at condenser water pump VFDs to provide the design water flow rate at each chiller when one chiller is operating, and when two chillers are operating. System setpoints must be correct for any of the three new chillers operating as lead or lag chiller.

D. Air Systems:

1. The balancing firm shall adjust all dampers, diffusers, registers, belts and sheaves for the delivery and distribution of air quantities shown in the Contract Documents and shall mark each balancing device at final setting.
2. Adjust fan speeds and motor drives within drive limitations for required air volume, provide new sheaves as necessary, or adjustable bands on constant volume plenum fans, and notify Division 26 Contractor of any thermal overloads that need to be changed/replaced.
3. Exhaust and recirculation air systems shall be adjusted for air quantities shown on Drawings.
4. Report: After all adjustments are made, a detailed report shall be prepared by the balancing firm and submitted to the Architect for approval. Owner reserves the right to spot check the report prior to final acceptance.

END OF SECTION 230593

SECTION 230700 - MECHANICAL INSULATION

PART 1 - GENERAL

1.1 RELATED WORK

A. Requirements: Provide insulation in accordance with the Contract Documents.

B. Related work specified in other Sections:

Section 230500 - Basic Mechanical Requirements
Section 230529 - Basic Mechanical Materials and Methods
Section 230540 - Mechanical Sound and Vibration Control
Section 224450 - Plumbing Equipment
Section 232113 – HVAC Piping & Specialties
Section 236400 - Refrigeration

1.2 SYSTEM DESCRIPTION

A. The mechanical insulation work required by this Section shall include materials and methods as described herein and on the Drawings and as required by applicable energy codes.

B. The work includes, but is not limited to providing insulation on the following:

1. Plumbing Systems:

Domestic Cold Water, Industrial Water

2. Heating Systems:

Heating Water Supply and Return

3. Chilling Systems:

Chilled Water
Air Separators
Thermal Storage Tanks and Chilled Water Storage Tanks
Chilled Water Pump Bodies

4. Other Systems:

Cold Condensate Drains
Piping Exposed to Freezing with Heat Tracer <where noted on Drawings>.

1.3 QUALITY ASSURANCE

A. Qualifications: The firm executing the work of this Section shall have at least 3 years successful installation experience on projects with mechanical insulations similar in scope and nature to that required for this Project.

B. Requirements of Regulatory Agencies: All insulation shall be in accordance with Jurisdicational Building Code and State and Federal Energy Conservation Standards.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's specifications and installation instructions for each type of mechanical insulation in accordance with the General Conditions of the Contract. Include schedule showing manufacturer's product number, thickness and furnished accessories for each mechanical system requiring insulation.

B. Provide schedule of pipe sizes with insulation thickness at corresponding fluid temperatures.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials: Deliver insulation, coverings, adhesives, and coatings to site in containers with manufacturer's stamp or label affixed showing fire hazard ratings of products.

B. Storage of Materials: Protect insulation against dirt, water, chemical and mechanical damage. Do not install damaged insulation; remove from project site.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Acceptable manufacturers of insulation materials shall be as follows:

Certain-teed
Owens-Corning
Johns Manville
Armstrong
Knauf
Dow Chemical
3M/Thermal Ceramics (FireMaster)
Unifrax (Fyrewrap)
SpecSeal (Claymac)
Renler (Pyroscat FastR Wrap)
Gilsulate International, Inc. (Gilsulate 500XR Loose-Fill Insulation)

2.2 MATERIALS

A. Conductivity:

TYPE OF INSULATION	MAXIMUM THERMAL CONDUCTIVITY/INCH
Calcium Silicate	0.47 at 600 degrees Fahrenheit
Glass Fiber Pipe Insulation	0.25 at 75 degrees Fahrenheit
Glass Fiber Rigid Equipment Insulation	0.25 at 75 degrees Fahrenheit
Glass Fiber Rigid Duct Insulation	0.24 at 75 degrees Fahrenheit
Glass Fiber Blanket Duct Insulation	0.29 at 75 degrees Fahrenheit
Expanded Polystyrene	0.24 at 75 degrees Fahrenheit
Ceramic Fiber Grease Duct Wrap	0.25 at 70 degrees Fahrenheit
Polyisocyanurate Foam	0.19 at 75 degrees Fahrenheit
Granular Loose Fill	See below

B. Duct Board: Rigid glass fiber board with a minimum density of 1-1/2 pounds per cubic foot, a maximum thermal conductivity of 0.24 at 75 deg.F and complying with National Fire Protection Association Pamphlet 90A.

C. Duct Wrap: Blanket-type fiberglass insulation 1-1/2" thick, 0.75 pounds per cubic foot density.

D. Grease Duct Wrap: High-temperature ceramic fiber blanket, foil/scrim encapsulation, max-service temp. = 2300°F.

E. Vapor Barrier Coatings: To have a perm rating not more than 0.25 when tested in accordance with ASTM E96, procedure A.

F. Adhesives, Sealers, Facings and Vapor Barrier Coatings: To be compatible with materials to which applied, and shall not corrode, soften, or otherwise attack the pipe or insulation materials in either the wet or dry state. Use only adhesives, sealers, facings, and vapor barrier coatings as recommended by the manufacturer of insulation materials.

G. Chemicals for Treating Paper: Non-soluble.

H. Non-Collapsing Inserts: Calcium Silicate or Polyisocyanurate (Dow Trymer 2000). No Polystyrene inserts are allowed.

I. Granular, Loose-Fill Insulation: Inorganic, nontoxic, nonflammable, sodium potassium aluminum silicate with calcium carbonate filler. Include chemical treatment that renders insulation hydrophobic.

1. Thermal Conductivity (k-Value): 0.60 at 175 deg F and 0.65 at 300 deg F.

2. Application Temperature Range: 35 to 800 deg F.
3. Dry Density: 40 to 42 lb/cu. ft.
4. Strength: 12,000 lb/sq. ft.

2.3 PERFORMANCE CRITERIA

A. Insulation and accessory materials to meet the following criteria:

1. Insulation Materials: To be noncombustible as defined in National Fire Protection Association Pamphlet 220 and to be Underwriter's Laboratory listed.
2. Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread rating of 25 or less, and smoke-developed rating of 50 or less, as tested by ANSI/ASTM E 84 (NFPA 255) method.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Testing of piping and ductwork to be completed prior to application of insulation.

B. Apply insulation tightly over clean, dry surfaces with sections or edges firmly butted together.

C. Make insulation continuous through sleeves or openings in walls and floors.

D. Run sealed vapor barriers continuous throughout all cold surface insulation systems.

E. Avoid the use of staples on vapor barrier jackets. Seal all vapor barrier penetrations with white vapor barrier sealant.

F. Apply adhesives so as not to exceed the coverages recommended by the manufacturers.

G. Leave surfaces clean and ready for painting.

H. Do not insulate cleanouts, access openings or identification plates. Neatly bevel insulation and finishes up to the edges of such openings and stop with sheet metal rings.

I. Provide non-collapsing inserts between pipe and all shields/saddles on all insulated piping 2-1/2" and larger.

3.2 SPECIFIC INSTALLATION REQUIREMENTS

A. Minimum Pipe Insulation Schedule:

2009 International Energy Conservation Code

PIPE INSULATION THICKNESS IN INCHES*			
	Nominal Pipe Diameter		
Fluid	≤ 1.5”	> 1.5”	> 10”
Hot Water	1.0	2.0	2.0
Chilled Water/Glycol, Chilled Brine, Refrigerant,	1.0	1.5	2.0

*Based on insulation having a conductivity not exceeding 0.27 BTU per inch/h·ft^2·°F.

Exceptions:

1. Factory installed piping within HVAC equipment tested and rated in accordance with 2009 IECC referenced procedures.
2. Piping that conveys fluids that have a design operating temperature range between 55°F and 105°F, unless noted to be insulated on drawings or in specifications.
3. Piping that conveys fluids that have not been heated or cooled through the use of fossil fuels or electric power, unless noted to be insulated on drawings or in specifications.
4. Runout piping not exceeding 4 feet in length and 1 inch in diameter between the control valve and HVAC coil.

B. Plumbing System:

1. Domestic Cold Water:

   All piping and where freeze protection is required, one-half inch thick fiberglass pipe covering with all service jacket self-seal lap.

2. Fittings:

   Premolded PVC fitting covers with Fiberglass insert. PVC covers shall be rated for return air plenum use.

3. Valves:

   All systems: Oversized pipe covering of same material and thickness as adjacent pipe covering. Finish with six-ounce canvas and heavy coat of vapor barrier mastic coating.

C. Heating System:

1. Heating Water Supply and Return:

a. Fiberglass pipe covering with all-service jacket and self-seal lap.

b. Thicknesses per Minimum Pipe Insulation Schedule in Section 230700-3.2, A.

2. Fittings:

a. Premolded PVC fitting covers with Fiberglass insert.

3. Valves:

a. All systems: Oversized pipe covering of same material and thickness as adjacent pipe covering. Finish with six-ounce canvas or fiberglass reinforcing mesh and heavy coat of vapor barrier mastic coating.

D. Chilling System:

1. Fiberglass pipe covering with all service jacket self-seal lap.

2. Chilled water supply and return: Thicknesses per Chilled Water Piping System of Section 230700-3.2 A.

3. Fittings:

All systems: Premolded PVC fitting covers with fiberglass insert. Seal all fittings at end and throat.

4. Valves:

All systems: Oversized pipe covering of same material and thickness as adjacent pipe covering. Finish with six-ounce canvas or fiberglass reinforcing mesh and heavy coat of vapor barrier mastic coating.

5. Chilled Water Pump Bodies:

a. Chilled water pump bodies shall be insulated with 1-inch thick flexible expanded elastomeric insulation, install to allow for maintenance access to pump.

OR

b. Fabricate metal boxes lined with elastomeric insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism. Fabricate boxes from aluminum or stainless steel, at least 0.050 inch thick. Install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

OR

c. Apply a minimum coating thickness of 1/32" over all cold surfaces of the pump(s) with an anti-condensation coating to prevent sweating and dripping. Acceptable products: AQUABAN (chemicoat.com), or approved equal.

6. Cold Water Thermal Storage Tanks and Chilled Water Storage Tanks:

2" thick fiberglass board, foil faced or faced with Du-All pipe and tankwrap. Seal all joints with vapor barrier mastic. Finish with six-ounce canvas or fiberglass reinforcing mesh and fire retardant vapor barrier mastic.

E. Other Systems:

1. Piping Exposed to Freezing with Heat Tracer:

One-inch thick fiberglass pipe covering with all service jacket-self seal lap. Finish with 0.016-inch thick corrugated aluminum jacket and fitting covers for protection.

NOTE: Insulation shall be applied over heat tracer.

2. Piping Insulation Exposed to Rainfall:

Provide 0.016-inch thick corrugated aluminum jacket and fitting covers on all insulation exposed to rainfall. Install seam on bottom of horizontal and angled piping. Seal all joints weather-tight. Seal jacket seams with silicone sealant.

3. Condensate Drains Inside Buildings:

1/2" thickness fiberglass pipe covering with all service jacket self-seal lap.

END OF SECTION 230700

SECTION 230800 - COMMISSIONING OF HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes commissioning process requirements for HVAC&R systems, assemblies, and equipment.

B. Related Sections:

1. Section 019113 "General Commissioning Requirements" for general commissioning process requirements.

1.3 DEFINITIONS

A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.

B. CxA: Commissioning Authority.

C. HVAC&R: Heating, Ventilating, Air Conditioning, and Refrigeration.

D. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.4 INFORMATIONAL SUBMITTALS

A. Certificates of readiness.

B. Certificates of completion of installation, prestart, and startup activities.

1.5 ALLOWANCES

A. Labor, instrumentation, tools, and equipment costs for technicians for the performance of commissioning testing are covered by the "Schedule of Allowances" Article in Section 012100 "Allowances."

1.6 UNIT PRICES

A. Commissioning testing allowance may be adjusted up or down by the "List of Unit Prices" Article in Section 012200 "Unit Prices" when actual man-hours are computed at the end of commissioning testing.

1.7 CONTRACTOR'S RESPONSIBILITIES

A. Perform commissioning tests at the direction of the CxA.

B. Attend construction phase controls coordination meeting.

C. Attend testing, adjusting, and balancing review and coordination meeting.

D. Participate in HVAC&R systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.

E. Provide information requested by the CxA for final commissioning documentation.

F. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

1.8 CxA'S RESPONSIBILITIES

A. Provide Project-specific construction checklists and commissioning process test procedures for actual HVAC&R systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.

B. Direct commissioning testing.

C. Verify testing, adjusting, and balancing of Work are complete.

D. Provide test data, inspection reports, and certificates in Systems Manual.

1.9 COMMISSIONING DOCUMENTATION

A. Provide the following information to the CxA for inclusion in the commissioning plan:

1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for HVAC&R systems, assemblies, equipment, and components to be verified and tested.
4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.

5. Certificate of readiness certifying that HVAC&R systems, subsystems, equipment, and associated controls are ready for testing.
6. Test and inspection reports and certificates.
7. Corrective action documents.
8. Verification of testing, adjusting, and balancing reports.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TESTING PREPARATION

A. Certify that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

B. Certify that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.

C. Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.

D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

E. Inspect and verify the position of each device and interlock identified on checklists.

F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.

G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.2 Testing AND BALANCING VERIFICATION

A. Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.

B. Notify the CxA at least **10** days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work.

C. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC&R systems at the direction of the CxA.

1. The CxA will notify testing and balancing **Contractor 10** days in advance of the date of field verification. Notice will not include data points to be verified.
2. The testing and balancing **Contractor** shall use the same instruments (by model and serial number) that were used when original data were collected.
3. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.
4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

3.3 GENERAL TESTING REQUIREMENTS

A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.

B. Scope of HVAC&R testing shall include entire HVAC&R installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. Testing shall include measuring capacities and effectiveness of operational and control functions.

C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

D. The CxA along with the HVAC&R **Contractor**, testing and balancing **Contractor**, and HVAC&R Instrumentation and Control **Contractor** shall prepare detailed testing plans, procedures, and checklists for HVAC&R systems, subsystems, and equipment.

E. Tests will be performed using design conditions whenever possible.

F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

G. The CxA may direct that set points be altered when simulating conditions is not practical.

H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.

I. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.4 HVAC&R SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

A. Boiler Testing and Acceptance Procedures: Testing requirements are specified in HVAC boiler Sections. Provide submittals, test data, inspector record, and boiler certification to the CxA.

B. HVAC&R Instrumentation and Control System Testing: Field testing plans and testing requirements are specified in Section 230900 "Instrumentation and Control for HVAC" and Section 230993 "Sequence and Operations for HVAC Controls." Assist the CxA with preparation of testing plans.

C. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment requirements are specified in HVAC piping Sections. HVAC&R **Contractor** shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA. Plan shall include the following:

1. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.
2. Description of equipment for flushing operations.
3. Minimum flushing water velocity.
4. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.

D. Refrigeration System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of chillers, cooling towers, refrigerant compressors and condensers, heat pumps, and other refrigeration systems. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.

E. HVAC&R Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of air and hydronic distribution systems; and other distribution systems, including HVAC&R terminal equipment and unitary equipment.

F. Vibration and Sound Tests: Provide technicians, instrumentation, tools, and equipment to test performance of vibration isolation and seismic controls.

END OF SECTION 230800

SECTION 230810 - VARIABLE FREQUENCY DRIVE

PART 1 - GENERAL

1.1 WORK INCLUDED

A. The contractor shall furnish and install a complete Variable Frequency Drive and Energy Efficient motor system on the following equipment as described in this specification and as indicated on the drawings.

1. Cooling tower fans
2. Chilled water pumps
3. Condenser water pumps

B. The Variable Frequency Drive shall convert 480 volt, three phase, 60 Hz utility power to adjustable voltage and frequency, three phase, A-C power for stepless motor control from 6 to 60 Hz.

C. This contractor shall coordinate motor selection with Variable Frequency Drive.

D. Variable Frequency Drive Systems shall be compatible with any standard NEMA B or C design 3-phase induction motor. Variable Frequency Drive Systems shall be sized to insure the motor full load amps does not exceed the controller continuous RMS amps at project altitude (4500 ft.).

E. The VFD shall be interfaced to the building control system as specified in Section 230900.

F. VFD controls shall interface with the BACnet network specified under Section 230900 by means of a BACnet MS/TP interface. The VFD controls interface shall be BTL listed.

1.2 QUALITY ASSURANCE

A. The equipment supplied under this specification shall conform to the latest applicable codes and standards of the following:

1. NEC – (NFPA 70) – National Electric Code.
2. ANSI/NEMA ICS 6 – Enclosures for Industrial Controls and Systems.
3. NEMA AB1 – Molded Case Circuit Breakers.
4. NEMA ICS 2 – Industrial Control Devices, Controllers, and Assemblies.
5. IEEE Standard 519-1992 – Recommended Practices for Harmonic Control in Electrical Power Systems.
6. ANSI C37 – Standards for Circuit Breakers, Switchgear, Relays, Substations and Fuses.
7. ANSI C57 – Distribution, Power, and Regulating Transformers (includes Reactors).

8. UL 508C – Power Conversion Equipment.
9. NEMA ICS 3.1 – Safety Standards for Construction and Guide for Selection, Installation, and Operation of Variable Frequency Drive Systems.
10. FCC CFR 47 Part 15 subpart B.

B. The VFD's shall be UL listed for conformance to UL-508C. An equivalent safety labeling program by ETL or CSA documenting compliance with these industry standards will be acceptable.

C. The Division 23 Contractor shall coordinate and assume system responsibility and compatibility between the various approved suppliers' equipment and services required to meet these specifications.

D. The VFD system vendor shall provide a complete parts and labor warranty (including travel and shipping expenses) for one (1) year from the date of substantial completion. The warranty shall cover the entire VFD system including power devices, controllers, harmonics, mitigation devices, communications interface, etc. furnished as part of the system package.

E. The mechanical contractor shall coordinate the mounting location of the VFD with the electrical contractor to be certain that it is not mounted in the airstream of unfiltered exhaust air; i.e. in a parking garage application.

1.3 SUBMITTALS

A. Shop Drawings: Submit shop drawings and product data in accordance with Section 230500 – Basic Mechanical Requirements.

1. VFD: Product data sheets, functional descriptions, performance ratings, dimensions, conduit entry/exit locations, installation instructions, complete wiring diagrams for power, controls, etc.
2. Control System Interface: Furnish complete documentation of the controls system interface including bus specification, object list, wiring diagrams, XIF or configuration files, etc.
3. Derate calculation for installation altitude above 3300 ft. and ambient temperature above 40°C.

B. Operating Instructions and Maintenance Data: Submit printed operating instructions and maintenance data in accordance with Section 230500 – Basic Mechanical Requirements.

1. VFD: Operating and Maintenance instructions, programming instructions, spare parts lists, troubleshooting instructions.
2. Factory test reports.
3. Start-up and commissioning reports.
4. Power quality and harmonic test reports.

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. The following manufacturers are acceptable, submit alternates for prior approval in accordance with the General Conditions and Division 1 Requirements.

1. ABB
2. Graham/Danfoss
3. Mitsubishi

2.2 CONSTRUCTION, VARIABLE FREQUENCY DRIVE

A. The Variable Frequency Inverter(s) shall be PWM type using IGBTs, rated for the motor type, horsepower, and voltage as indicated on drawings.

B. The Inverter shall be altitude compensated and sized for the elevation at which the unit will be installed. The inverter shall operate in an ambient temperature of –10°C to 50°C humidity of 0-90% non-condensing.

C. The VFD system manufacturer shall integrate all components and equipment required to meet these specification features and functions as a single UL (or equivalent) labeled system. Vendors providing equipment requiring panel shop or job site modifications or additions that would not be valid under the original equipment manufacturer's (OEM's) safety labeling will not be acceptable.

D. Pre-integrated equipment shall include but not be limited to incoming line filters, rectifier units, inverter units, control circuitry, operator interfaces, protective equipment, and other accessories and auxiliary items necessary to meet the highest standards for the type of service specified herein.

E. All VFD system components shall be housed in a grounded, dead front, free-standing or wall mounted, NEMA 1 enclosure. The VFD system size shall not exceed the size allotments specified on the drawings nor shall any portion of the system exceed a height of 90 inches. Entry shall be provided for incoming line and load cables as required or as shown on the drawings.

F. VFD systems mounted indoors shall be properly ventilated and sized to operate continuously at the job site elevation in an ambient environment of 0°C to 40°C, 0-90% RH. VFD systems mounted outdoors shall include environment control provisions as required (or as shown on the plans) to operate in an ambient of –30°C to 50°C, 0-100% RH.

G. All components of the VFD system shall be selected to operate continuously without any system trip or damage based on the nominal power specifications and requirements shown on the drawings or schedules. The above conditions must be maintained under the following expected variations:

1. Plus or minus 10% voltage fluctuation.
2. Plus or minus 3% frequency variation (5% if served by a back-up generator).
3. Distorted voltage waveform with up to 7% total voltage harmonic distortion.

H. The VFD system shall employ voltage sag ride-through coordination under normal operating (average load) conditions to prevent nuisance trips with the following utility interruptions:

1. 0% voltage for 1 cycle.
2. 60% voltage for 10 cycles.
3. 87% voltage continuous.

I. The VFD system shall employ door mounted industrial control operator devices, programming unit, and other devices as required to meet all functional and feature requirements of this specification. Operator pilot lights or LEDs, switches and pushbuttons (if required) shall be industrial oil tight industry standard devices.

J. Control voltages shall be 120 volts or less supplied by machine tool type transformers employing both primary and secondary fusing.

K. The VFD system factory wiring shall be permanently marked with hot emboss stamping or an equivalent marking system. All devices shall be labeled and identified with correct setting selections. All component identification and wiring shall be documented in the operation and maintenance manual.

L. The VFD system shall be capable of starting and continuously driving the specified maximum motor load as identified on the drawings and schedules.

M. VFD’s driving variable torque loads shall be programmed to optimize load patterns which maximize system efficiency and minimize motor heating and stresses. VFD’s driving constant torque or other loads shall be programmed to optimize load patterns for system or process performance as required.

N. All VFD systems shall have an overload capacity of a minimum of 120% for one minute.

O. The VFD solid state converter and inverter power switching components and control shall be selected to achieve a 0.95 efficiency or better at full load and speed. Other auxiliary devices required on the drawings or in these specifications including filters, line reactors, cooling or heating devices etc. shall be of a design to optimize efficiency as intended under this specification.

P. The entire true system power factor (as measured at the input to the VFD system) shall be 0.95 or better across the operational speed and load range. Power factor that becomes leading under light load conditions (due to PF correction) is acceptable only if voltage rise is prevented from backfeeding to the rest of the system (meaning PF correction must act like a synchronous condenser). The voltage tolerance at the main VFD system input terminals shall not be compromised as a result of power factor correction techniques.

Q. Short circuit protection shall be provided to the VFD system through an externally operated, door interlocked fused disconnect, circuit breaker or motor circuit protector (MCP). VFD shall have a minimum short circuit rating of 65,00 amps RMS (100,000 amps RMS with DC bus reactor) without additional input fusing. The door interlocked handle must be capable of being locked off to meet NEC.

R. Overcurrent protection shall be provided in the VFD system through electronic motor overload (MOL) circuits with instantaneous trip, inverse time trip, and current limit functions. These shall be adjustable and optimized for the application.

S. In addition to the overcurrent protection above, the VFD system shall provide over and under voltage protection, over temperature protection, ground fault protection, and control or microprocessor fault protection. These protective circuits shall cause an orderly shutdown of the VFD, provide indication of the fault condition, and require a manual reset (except undervoltage) before restart. Undervoltage from a power loss shall be set to automatically restart after return to normal. The history of the previous three faults shall remain in memory for future review.

T. The VFD system customer terminations shall be clearly identified with terminal numbers and a permanent wiring diagram located in the VFD system enclosure. Coordinate all control work with Section 230900 Contractor.

U. VFD shall meet the requirements for Radio Frequency Interference as specified by FCC Regulations, Part 15, Subpart J, Class A devices.

2.3 FEATURES, VARIABLE FREQUENCY DRIVES

A. The following operator control and indication features shall be provided standard (unless shown differently on the drawings) as part of each VFD system:

1. Hand-Off-Auto (local start at VFD, remote start with contact closure).
2. Local-Remote speed control (local speed control at VFD, remote speed control through speed reference signal).
3. Frequency (speed) indication.
4. Motor voltage indication.
5. Motor current indication.
6. VFD run indication.
7. VFD fault and diagnostic indication.

B. The following customer connections and interface terminations shall be provided standard (unless shown differently on the drawings) as part of each VFD system:

1. VFD remote start/stop connection.
2. External safeties connection.
3. VFD run annunciation.
4. VFD fault annunciation.
5. VFD speed reference input connection (4-20mA or as shown on drawings).
6. Minimum of three (3) programmable digital inputs.
7. Minimum of two (2) 4-20mA input signals to integral controller.

C. The following parameter adjustments shall be available to tune the VFD system:

1. Minimum and maximum speeds.
2. Acceleration and declaration times.
3. Overcurrent trip point.
4. Current limit response to overload.
5. Maximum base motor voltage.
6. Input speed reference signal gain and bias.
7. Output speed reference signal gain and bias.
8. Critical frequency avoidance.
9. Multiple preset speed programming.
10. Integral PI controller programming.

D. The VFD shall be capable of starting into a rotating motor at any speed and rotation direction.

E. The VFD shall auto restart after a power failure.

F. For maintenance purposes, the VFD system shall be capable of starting, stopping, and running with stable operation with the motor completely disconnected (no load).

G. VFD shall include an integral locking disconnect.

H. VFD shall include an integral PI controller capable of closed loop control of motor speed based on external analog speed reference signals or programmed digital input signals.

2.4 FACTORY TEST, VARIABLE FREQUENCY DRIVE

A. Prior to shipping any equipment, the manufacturer shall individually test and certify each unit to document compliance. This certification report shall be submitted as part of the operation and maintenance manual and include the following minimum testing:

1. A visual inspection shall be made consisting of all system components, wiring connections, and safety mechanisms.

2. High pot testing shall be conducted on the completed VFD system including all accessory power components as a complete package. This test shall be conducted per UL 508C (two times the rated voltage plus 1000 volts AC for 60 seconds) using regularly calibrated high pot test equipment.
3. A system run test shall be conducted using an actual motor accelerated and decelerated through the entire speed range.
4. All control panel devices, including switches, pilot lamps, keypad and special control devices shall be functional tested.

2.5 POWER QUALITY

A. Provide DC link chokes and input reactors that will limit the total harmonic current distortion to no more than 20%. All devices must be factory installed inside the drive housing.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Field start-up service shall be provided by an authorized factory representative. The supplier shall provide warranty and authorized factory services including field start-up and training. The following adjustments and tests shall be performed as a minimum with certified copies included in the operation and maintenance manual:

1. Verify that the input voltage is within the manufacturer's specification tolerances.
2. Verify that the motor rotation is correct in all modes of operation.
3. Verify all operator devices, programming, and monitoring functions to be fully operational.
1. Verify operation of all field signal control connections.
2. Measure and record system output voltage and current at 50% and 100% speed. Tune the output voltage to correspond to motor nameplate rating at full speed. Check full load current measurements against nameplate data.
3. Make all parameter adjustments to tune and optimize the VFD system to the application. Record all configuration values as part of this report.
4. Conduct harmonic tests as identified in this specification. Measurements shall be recorded for each unit with the VFD system off, running at 50% speed, and running at full speed and load.

B. Owner training shall be provided for each model and type of VFD system provided. Training shall consist of both classroom and actual equipment hands-on training.

C. Installation shall be in accordance with manufacturer's printed instructions.

D. The mechanical contractor shall coordinate the mounting location of the VFD with the electrical contractor to be certain that it is not mounted in the airstream of unfiltered exhaust air; i.e. in a parking garage application. If no location is feasible to meet this location criteria, the VFD may be mounted inside a NEMA 3R enclosure in the dirty air location.

END OF SECTION 230810

SECTION 230900 - ELECTRONIC CONTROLS

PART 1 - GENERAL

1.1 RELATED WORK

A. The General Conditions, Supplementary Conditions and Division 1, General Requirements apply to this Section, and Contractor shall review and adhere to all requirements of these documents.

B. Related work specified in other Sections:

Section 019113 – General Commissioning Requirements
Section 230500 - Basic Mechanical Requirements
Section 230529 - Basic Mechanical Materials and Methods
Section 230540 - Mechanical Sound and Vibration Control
Section 230700 - Mechanical Insulation
Section 232113 - HVAC Piping and Specialties
Section 232123 - HVAC Pumps
Section 232500 - HVAC Water Treatment
Section 236400 – Refrigeration
Section 233400 - Air Handling Fans
Section 230810 - Variable Frequency Drives
Section 230593 - Testing, Adjusting and Balancing
Section 230800 – Commissioning of HVAC Systems
Division 260000 - Electrical

1.2 SYSTEM DESCRIPTION

A. Johnson Controls Inc. (JCI) corporate office is the only controls contractor allowed to provide the controls system for this project, and shall provide a Metasys BACnet system – no exceptions.

B. The work includes but is not limited to the following:

1. The energy management and control system (EMCS) shall be a electronic microprocessor-based networked direct digital control system. PID (Proportional, Integral, Derivative) or PI2 algorithms shall be applied on all control loop applications as called for hereinafter in the control sequences.
2. The system shall include all control devices, valves and automatic dampers, wire, conduit, hardware, software, the installation of all devices and wiring, all programming, etc., as specified and required and connected so as to perform all functions and operate according to the specified sequences. Provide all materials,

labor, and engineering as necessary to provide a complete and functioning system.

3. Provide an unconditional one-year parts and service warranty.

C. Integration and Interoperability: The DDC control system, including I/O nodes, distributed controllers, and application-specific controllers, network application engines, and network control engines shall be connected via a Local Area Network (LAN) utilizing the BACnet communications protocol defined by ASHRAE Standard 135-2004. The DDC system shall be able to exchange (read and write) data with foreign devices and systems connected to the LAN and supporting the BACnet standard. Remote access to the control system shall be as follows:

1. The Weber State University IT group will provide a single data node and IP address on the campus-wide Ethernet for use by the 230900 control system. The 230900 control system shall use this data node to communicate with the Owner's existing ADX server located at the facilities building. This data node shall also allow remote users to use Internet Explorer to connect to the control system user's interface from any computer connected to the campus-wide Ethernet through a user name and password protected interface. The system shall output system information to and receive input of commands from remote operators. Remote operators shall be able to view all setpoints, status information, and alarms; and change control setpoints, command status changes, and clear alarms. The 230900 controls contractor shall provide an Ethernet cable from their hardware to the Ethernet router used by the WSU IT group to provide access to the WSU Ethernet. Coordinate exact location to which Ethernet cable must be routed with WSU IT staff.

D. Existing Controls: The existing control system in the building consists of a combination of pneumatic and Johnson brand electronic controls. The BACnet control system being provided as part of this project will control all new equipment installed as part of this project, and shall interface with the existing controls as necessary to allow the existing system to signal a demand for cooling to the new chiller plant controls, and to allow the new and existing HVAC systems to be manually turned on and off. The 230900 contractor is responsible for maintaining in a fully functional condition any existing pneumatic and electronic controls required for proper operation of any existing HVAC equipment that is to remain. The 230900 contractor shall be responsible for demolition of any existing electronic controllers, pneumatic controllers, and associated wiring and pneumatic tubing/pipes serving HVAC equipment that is being removed, relocation of any existing controllers that are still required by existing equipment that is to remain, and for providing any new electronic controllers, pneumatics, pneumatic tubing, or wiring necessary to keep the existing controls system fully operational. Remove any controllers, wiring, or pneumatic tubing that is no longer needed as a result of the work provided as part of this project. Abandoning controllers, wiring, or pneumatic tubing that is no longer required is not acceptable. No existing controllers, devices, panels, or wiring shall be used for any new equipment being installed as part of this project.

E. System Architecture: The existing pneumatic and electrical controls that are left in place during this project will eventually be replaced by BACnet controls as part of a future

controls upgrade project that will take place at some point in the future after this chiller replacement project has been completed. The 230900 contractor shall configure the BACnet controls being installed as part of this project to be extended to serve the rest of the building as part of the future controls upgrade project. The 230900 contractor shall configure the control system architecture to include:

1) A primary JCI Network Automation Engine (NAE) that will serve as the single interface point between the WSU campus-wide Ethernet and the building-wide BACnet system. This NAE will provide the single point of communication out to the existing remote ADX and to remote users/operators. The intent is that the future controls upgrade for the rest of the building can also use this NAE for communication to the WSU campus-wide Etherenet.
2) Provide an Ethernet data bus that is dedicated to the HVAC systems in the Dee Events Center. This Ethernet data bus shall connect the NAE described in item 1 with any other NAE or Network Control Engine (NCE) installed in the remodeled chiller room or installed as part of the future controls upgrade project for the building. It will also allow for connection to the BACnet IP interface at the three chiller control panels.
3) Provide one or more NAEs or NCEs to serve the remodeled chiller room and all new HVAC equipment installed as part of this project. All data traffic between an individual NAE or NCE and all terminal unit controllers beneath it shall be carried by a BACnet data bus.

F. Commissioning: Assist the commissioning agent as required by the commissioning process described in specification sections 019113 and 230800.

1.3 QUALITY ASSURANCE

A. Manufacturing and Installation Qualifications:

1. The network operating system shall fully support the BACnet standard 135-2004 and BACnet MS/TP communication protocol. All BACnet controllers, sensors, and devices provided for the project must conform to any of the device profiles used by the BACnet Testing Laboratories. Profiles include: B-OWS, B-BC, B-AAC, B-ASC, B-SA, and B-SS. Non-BACnet devices (primarily sensors) allowed on the project are described in part 2 of this specification. Only those non-BACnet devices identified in this specification may be provided on this project.
2. All network tools shall be fully compatible with the network operating system.
3. All devices shall comply with the interoperability guidelines and use standard communication variables as defined by BACnet Standard 135-2004 and the BACnet Testing Laboratory.
4. All devices shall use standard configuration parameter types and a standard interface for configuration as defined by BACnet International and the BACnet Testing Laboratory.
7. All work shall be supervised by a controls specialist who has completed the BACnet network design, installation, and maintenance training program offered by the hardware manufacturer.

B. This work includes all material, equipment, and appurtenant accessories necessary for, or incidental to, the installation of a complete solid-state BACnet networked control system.

C. Regardless of the names JCI uses for their products being provided as part of this control system, it shall be a JCI Metasys BACnet system, and shall not use a manufacturer's proprietary data bus network - no exceptions.

1.4 SCOPE OF WORK

A. Provide a complete and functioning BACnet control system in accordance with this specification, the contract documents, attached sequences, and control schematics shown on drawings.

B. Modify the existing pneumatic/electric control system as necessary to keep it operational as existing mechanical equipment is removed from the chiller room and the cooling tower areaway.

C. The control system shall be designed such that mechanical equipment and subsystems will be able to operate under stand-alone control. In the event of a network communication failure, or loss of any other controller, the control system shall continue to independently operate under control of the preset schedules and sequences.

1.5 SUBMITTALS

A. Shop Drawings: Submit Shop Drawings and manufacturer's product data for the following items in accordance with the contract documents. All product data sheets shall be labeled with the device number and arranged under numbered tabs in the submittal book. Each device shall be listed in a device schedule or bill of materials with reference to the data sheet tab, device function or associated equipment, size, capacity, control range, and other pertinent information.

1. Sensors.
2. Controllers.
3. Automatic control valves and actuators; schedule, and wiring diagrams.
4. Thermostats.
5. Control diagrams and system control schematics. Indicate location of all devices, such as hydronic system differential pressure sensors, flow meters, BTU meters, flow switches, outside temperature sensors, duct temperature sensors, freezestats, refrigerant leak detection sensors, space differential pressure sensors.
6. Wiring diagrams, complete with all equipment and device tags, wire number or color, and wire termination point labels and locations. Include schematic or plan of network wiring.
7. Wiring media (including fiber optics) data sheets.
8. Routers, hubs, switches and similar network hardware.
9. Documentation of all software and hardware required to operate system on continuous basis.

10. Control Panels.
11. Control Dampers and Actuators.
12. I/O nodes.
13. Operator workstations, fixed and portable.
14. Submit detailed written operating sequences and a summary of programmed logic with setpoints, dead-bands, control ranges, throttling ranges, schedules and similar data to allow the engineer and owner to determine potential inconsistencies with the design intent. The submitted sequences shall include all necessary sequencing details, whether or not those details are identified in the contract documents. Merely copying control sequences from this specification is not acceptable.
15. Proposed graphic displays for user interface. Submit graphics in color. JCI shall use the same graphics blocks currently in use on the most recent BACnet control systems they have installed on the WSU campus.
16. The written sequences, setpoints, schedules, etc, as described in items 14 and 15 above shall be reviewed and accepted by the WSU maintenance and controls group prior to preparing and forwarding the finalized submittals. Please route all such pre-submittal documents through Chad Downs at WSU.

B. Operating Instructions and Maintenance Data: Submit printed Operating Instructions and Maintenance Data for all controls and instrumentation in accordance with Operating and Maintenance Data paragraph in Section 230500.

1. Include component data sheets keyed to parts lists indicating the location and service of each component.
2. Include detailed written operating sequences and a summary of programmed logic with setpoints, control ranges, schedules, device numbers and controller addresses keyed to the parts lists and wiring diagrams.
3. Include programming flow charts for programs and sequences installed.
4. Include installation and instruction manuals for all hardware and software for all controllers, host terminals, workstations, and portable operator's terminals.
5. Documentation of network variables, network node configurations, priority interrupts, node bindings, addressing structure, etc.
6. Provide floor plan drawings showing locations of all control devices, control panels, remote sensors, network wiring routes, and connection points for tenants and other future subsystems.
7. Provide instructions, forms, serial numbers, or other data as needed for the Owner to request reassignment of vendor license number from the software manufacturer for all network management software and engineering tools.

C. Certificate: Control system contractor shall submit a letter certifying completion of the control system in accordance with the Contract Documents.

D. Functional Demonstration: Contractor shall conduct a functional demonstration for the Engineer, Commissioning Agent, General Contractor, Construction Manager, Owner’s Representative, and other interested parties. Schedule demonstration after control system installation and equipment startup is complete. Demonstrate the full operating sequence

for each mechanical system and sub-systems. Demonstrate network communications with interfaced equipment and sub-systems.

E. Owner training: Contractor shall provide the following minimum training:

1. Minimum three days of 8-hour sessions of on-site training for Owner's personnel in the operation and maintenance of the controls system. Training shall be provided after the control system has been installed, started, tested, commissioned, demonstrated to the Engineer, and accepted by Engineer and Owner.
2. Minimum 5 days of training at out-of-state JCI Institute for one WSU technician. Include airfare, motel, 3 meals a day, and travel between motel and training facility. Include training on all BACnet controllers used on this project.
3. Minimum 8 hours of additional on-site training for Owner's personnel to review the operation and maintenance of the controls system and to answer any questions. Training shall be provided six months after system acceptance in order to give technicians time to become familiar with system to the point they can ask more in-depth questions specific to the programming and system architecture provided by JCI for this project.

1.6 WARRANTY

A. Provide a one year warranty for all hardware, software, and labor for the installed control system. See sub-section 3.5 of this specification for information on when the warranty period is to begin.

B. Contractor shall provide full service for the temperature control system for a period of one year after the control system has been found free of defects and accepted in writing by the owner, not the date of substantial completion. Service shall include, but not be limited to, calibration of all sensors and other control devices, adjustments to setpoints, and modifications to control sequences or programming as required/desired to fine-tune an/or finalize all control sequences.

PART 2 - PRODUCTS

2.1 SENSORS

A. Unless indicated otherwise below, temperature sensors shall be of the thermistor (NTC) or RTD type, commercial grade, minimum accuracy of ±0.36ºF. Sensors shall be available for room, duct, outdoor, or well mounting. Room type sensors shall be blank face without a temperature readout display, and shall not include a built-in setpoint adjustment and override button. Sensors shall be available in various ranges to properly suit the application. See item 4 below for heat pump thermostats/temperature sensors.

1. Sensors used in energy billing calculations shall be accurate to +/-0.10ºF over the application temperature range. Submit manufacturer's NIST-traceable calibration report.
2. Provide thermowells for all pipe-mounted sensors. The sensor and well shall be supplied as a complete assembly. Mount in threadolet with adequate access for repair or replacement. Thermowells shall be constructed of brass for chilled and heating water systems, and 316 stainless steel for steam and condenser water systems.
3. Outdoor temperature sensor (combination dry bulb and humidity) shall be Vaisala Model HMT-333 with optional solar radiation and precipitation shield (Model DTR502B). Sensor output shall include both dry bulb temperature and relative humidity (with integral microprocessor capable of calculating wet bulb and/or dewpoint temperature corrected for jobsite altitude). Sensor accuracy shall be within 1% (between 0 and 90% RH). The contractor shall adjust the atmospheric pressure setting in the microprocessor (utilizing the microprocessor's RS-232 port and a laptop computer with 'Hyper-terminal' software) as required to correct the device's output for the project altitude. Include a Vaisala HMK 15 RH sensor calibration kit for use by owner.

B. Pressure and differential pressure transmitters shall have an appropriate sensing range with a minimum accuracy of ±1% of full span. Analog output signal shall be appropriate for the receiving instrument.

C. BTU Meters: Dual-turbine insertion flow meters, all stainless steel construction, Onicon F-1200 series, with local display, matched insertion-type supply and return water temperature sensors, NIST calibrated BTU meter with BACnet MS/TP interface – Onicon System 10. Trend BTU consumption on weekly and monthly basis, and display instantaneous BTUH consumption on system graphics and on local display in chiller room.

D. Current switches shall be digital output type and shall have an adjustable setpoint capability (adjustable from 1 amp to 135 amps). Current sensors shall be Hawkeye Model H708 (manufactured by Veris Industries), or approved equal.

E. Refrigerant sensor shall be Sherlock Model 202 by Genesis International, Inc. Provide solid state sensor(s) suitable for sensing refrigerant R-134A. Sensor shall have an adjustable sensitivity range to allow for alarming at any refrigerant concentration from 100 to 800 ppm (initially set at 800 ppm). Sensor shall be configured to start the chiller room emergency exhaust fan whenever the refrigerant level exceeds 800 ppm (after a one minute time delay) and to stop the fan when the refrigerant level drops back down below 100 ppm. Sensor shall include a dry-contact to signal the 230900 system of an alarm status. Sensor shall be furnished with two optional remote audible/visible alarms (horn/strobes). Locate remote horn/strobes at the chiller room exit (one inside and one outside of chiller room exit) at 7'-6" above finished floor.

F. All transmitters shall have adjustable zero and span.

2.2 CONTROL VALVES

A. Control valves shall be modulating proportional type for equal percentage flow characteristics, unless otherwise indicated. Valve trim shall be suitable for chilled water, hot water, glycol, or steam service. Stainless steel valve stem assembly. Cast brass, screwed end for 1/2" through 2". Cast iron, flanged for 2-1/2" and larger. Select valves for 3 psi pressure drop at design flow, unless otherwise indicated. Valves shall be suitable for the system pressures and shall be capable of full close off at maximum system differential pressures.

1. Valves used for control of primary hot water and chilled water shall have a rangeability of at least 20 to 1. Valves shall be of the two-way or three-way type, as indicated for the application.
2. Bypass and equipment isolation control valves shall be full line size, ball or butterfly type, unless otherwise noted.

2.3 VALVE AND DAMPER ACTUATORS

A. Electric actuators for modulating or two-position control shall be direct coupled type. The drive motor shall be protected from overload at all angles of rotation. Where indicated, actuators shall be provided with spring return to the end position upon power interruption. Where indication of valve position is required in the control sequences, on the control diagrams on sheet M701, or on sheet M201, provide actuator with position indication potentiometer for connection to the 230900 system. Chiller room ventilation dampers to fail open. Actuator shall be available with adjustable end switches and have manual positioning capability. Thermally actuated valves are not allowed on this project. Install an actuator in each individual device that requires automatic actuation. Do not use linkage between devices to share a single actuator, with the exception of the three-way valves in the condenser water lines at each chiller.

2.4 CONTROL DAMPERS

A. Motorized control dampers furnished by the Control Contractor shall be factory built units with minimum 16 gauge galvanized steel blades, 1/2" axles, and oillite or cycoloy bearings. Frames shall be hat channel design, 0.125" minimum thickness with corner braces to assure squareness. Mixing dampers shall be parallel blade with blade direction oriented to assist mixing of air streams. Volume dampers shall be opposed blade. Outside air and relief air dampers shall be low leakage type with edge seals. Leakage shall not exceed 10 cfm/sq. ft. at 4" W.C. Maximum blade width shall not exceed 8". Dampers shall be not more than 42" in length between bearings. Damper sections shall be not more than 72" high. Dampers shall be Ruskin model CD60 (no substitutions), except where other models are specifically noted.

2.5 EQUIPMENT CONTROLLERS

A. Select BACnet controllers having the inputs, outputs, and control functions required to implement the sequences indicated. Controllers shall have non-volatile memory for storage of control programs, configuration, setpoints, time schedules, and historical log data. All data shall be retained in the event of power failure.

1. Terminal unit controllers and actuators to be field installed by the 230900 contractor. Any NEMA rated enclosures required for installation of any controllers in a return air plenum are the responsibility of the 230900 contractor.

2.6 INPUT/OUTPUT NODES

A. Select BACnet hardware having the inputs and outputs required to connect discrete data and control points to the BACnet network where indicated. Provide BACnet Testing Laboratory listed products.

2.8 Network Automation Engines and Network Control Engines

A. Provide NAE or NCE at each connection point between the BACnet network and the dedicated HVAC Ethernet backbone that serves only this building. The main NAE for the building shall provide network management functions, database management, and web server functions, and shall provide communication management between the HVAC Ethernet and the campus-wide Ethernet.

B. Software for NAE shall support all BACnet and TCP/IP communications on the controls network and shall support interactive access through the internet. The software package shall include all necessary network management tools and software plug-ins to support the design, configuration, installation, and maintenance of the BACnet network.

C. All software shall be the property of the Owner, and shall not require annual maintenance or licensing fees of any kind required to be paid by the Owner at any time during the ongoing use of the installed system and software.

D. Provide battery-powered UPS for the main NAE to allow at least 30 minutes of continuous operation during main power failure.

E. Provide firewall protection and virus protection software to protect the main NAE. Confirm desired/compatible software with the WSU representative prior to issuing submittals. In the event that no server is specified/required, provide a separate stand-alone firewall device by Cisco, or approved equal.

2.9 SPARE CONTROLLER CAPACITY

A. All controllers, except application specific controllers for fan coils and VAV boxes, shall be furnished with a minimum of 1 spare digital input, 1 spare digital output, 1 spare analog input, and 1 spare analog output. These controllers shall also have a minimum of 20% spare memory capacity to allow for additional programming of the spare points.

2.10 CONTROL NETWORK

A. Building-dedicated HVAC Ethernet Backbone. Minimum 100 Mbps Ethernet LAN.

B. Connection between building master NAE and WSU Router that provides data node to the campus-wide Ethernet: Minimum 100 Mbps Ethernet LAN (confirm with WSU IT group).

C. BACnet Field Bus. Minimum 76.8 kbpsMS/TP - RS485 BACnet field bus.

D. The factory controls on the three McQuay chillers furnished by WSU for this project each include a BACnet IP interface for communication with the 230900 control system. Provide the necessary data bus and hardware to enable data transfer through these interfaces. All other BACnet controllers and interfaces to be BACnet MS/TP.

2.11 OPERATOR WORKSTATION

A. No operator workstation is required for this system. Owner's personnel will connect to the system through data ports on the controls hardware being provided by the 230900 contractor as part of this project, or through the campus-wide WSU Ethernet.

2.12 ADDITOINAL HARDWARE AND SOFTWARE

A. Extend the security/password system currently in use for Metasys control systems on campus and at the existing ADX to protect the controls system being installed as part of this project. Review all user names, passwords, and levels of security with WSU, and obtain their approval before beginning any work on the security/password system.

B. Control system graphics are to be stored at the existing ADX.

C. Graphics shall include an operating schedule for occupied and unoccupied periods for the building. Additionally, operating schedules for each individual temperature control zone shall be capable of being modified individually for after-hours functions.

The Temperature Control Contractor shall program holidays into the controls software for the five years following the date of the installation as directed by the owner.

D. All temperature setpoints and all other setpoints identified as adjustable in the written control sequence shall be adjustable from the appropriate graphic display(s). Setpoints listed in the

contract documents are for initial set-up and trial of system operations. Control system shop drawings shall utilize the same (or similar) written sequences with all setpoints, throttling ranges, and differentials identified. As-built drawings shall include this same information with final setpoints resulting from start-up, testing, and adjustment.

E. Monitored points and alarms for each system shall be shown on the displays with full color graphics and real-time data as listed below. Where indicated, graphic displays shall be dynamic (animated). All graphic displays shall be submitted to the WSU maintenance/controls group for review and approval prior to commencing any programming. Screen resolution shall be confirmed with the WSU maintenance and controls group (in writing) prior to development of graphic displays.

F. All temperatures shall be displayed with zero decimal places. All valve and damper positions shall be displayed as percent open and shall be displayed with zero decimal places.

G. All setpoints which are identified as “adjustable” in the written control sequences shall be adjustable via the associated graphic displays (including deadband between heating and cooling space temperature setpoint).

H. All occupied mode and unoccupied mode room temperature setpoints shall have an adjustable deadband (adjustable from the associated graphic display). The adjustable global setpoint deadband shall be programmed such that it adjusts the deadband for all available room setpoints (global, remote, and local setpoints).

I. All displays for dynamic equipment shall depict motion (as a minimum dynamic displays shall include rotating fan wheels, rotating pump impellers, rotating compressors, etc).

J. All setpoints adjustable from the graphic displays shall be programmed with the deadband on one side of the setpoint (not split evenly across the setpoint) unless otherwise specified.

K. All inputs and outputs shall be programmed with the capability to override the device commands/positions via the associated graphic display (applies to all valves, dampers, fans, pumps, etc.).

L. Each variable frequency drive shall be programmed to display command status, input speed, output speed, amps, alarm/failure status, and additional points identified in the control sequences.

M. Outside air temperature sensors which are capable of sensing both temperature and humidity shall be programmed to display dry bulb temperature, wet bulb temperature, and relative humidity.

N. Alarm fields shall be displayed with a red background when an alarm condition exists (and shall be transmitted to e-mail addresses as directed by the using agency).

O. The color graphics editor on the existing ADX shall be used to generate color graphics for this project. Provide color graphic flow charts screens similar to the ones shown in

the control diagrams on the mechanical prints, showing the input/output to the mechanical equipment with respect to input values, outputs values, setpoints, damper position, valve position, fan, pump, chiller, status, etc. Graphics shall be generated for each chilled water system and condenser water system.

P. A manual control menu shall also be provided which allows the operator to turn points on or off, start or stop points, adjust values of control loops, set points to local mode or release points to automatic mode.

Q. Provide a licensed copy of the control network setup, management, database, and engineering tools. All system nodes and controllers shall be installed under this software license and the vendor license shall be transferred to the Owner upon final acceptance of the project.

PART 3 - EXECUTION

3.1 GENERAL

A. Installation of the control system shall be supervised by the controls contractor.

B. All installation work shall be scheduled and coordinated with other trades to expedite job progress.

1. The installation shall match erection of slabs and walls such that no damage, cutting or patching will be required.

C. All work shall be installed in accordance with current control industry practices.

1. Only top quality workmanship will be permitted.
2. Any work not properly executed shall be removed and replaced without extra expense to the Owner.

3.2 SENSORS AND GUARDS

A. Controls contractor shall verify all wall mounted sensor locations with the General Contractor in order to avoid interference with wall mounted furnishings.

1. Where interferences require moving the sensor more than two feet, consult with the Engineer for new location.
2. Wall sensors to be mounted with bottom of sensor at 6" above top of modular furniture walls. Confirm height with Architect before mounting. Adjustable wall sensors shall be mounted in accordance with ADA requirements.

B. Flow switches and flow rate sensors: Install where indicated on Drawings and in accordance with manufacturer's recommendations. Provide recommended distances of

straight unobstructed pipe upstream and downstream of each device. Calibrate or adjust sensitivity of each sensor as needed to provide proper operation with expected flow conditions. Provide all wiring and connections to the control network and safety interlocks as indicated and as required to provide the specified sequence of operation.

3.4 ELECTRIC WIRING

A. Provide all control wiring required by the project. All control and interlock wiring shall be as specified in "Electric Wiring" paragraph in Section 230529 - Basic Mechanical Materials and Methods. Provide diagrams and coordinate all work with the Division 26 contractor as required.

1. All control wiring shall be installed in raceway. Wiring shall be UL listed low voltage cable, rated for installation in a plenum, even though it will be installed in a metal conduit. All conduit provided for control wiring shall be labeled by the 230900 contractor to identify it as part of the controls system, and shall be factory painted a color to be selected by WSU (review color options with WSU). Provide fire safing of all penetrations in accordance with section 230529. Provide flexible metal conduit where connecting to vibrating or rotating equipment.

2. All control and interlock wiring shall be provided by the controls contractor. The control contractor shall review the electrical drawings and provide engineering assistance to the electrical contractor regarding required interlocks. Control and interlock wiring shall be in separate conduit from power wiring of Division 26. All wiring shall be in accordance with Division 26. Wiring not indicated on Division 26 drawings shall be responsibility of the controls contractor.

3. Control connections to variable frequency motor drives shall include analog signal optical isolators or optical fiber network connection to drive.

4. Inside one of the controls cabinets inside the chiller room, 230900 contractor shall provide a single 120V duplex outlet, wired to the same circuit that serves the electronics inside the panel.

3.5 SERVICE AND WARRANTY/PROJECT CLOSEOUT

A. The control system herein specified shall be free from defects in workmanship and material under normal use and service. After completion of the installation the controls contractor shall regulate and adjust all thermostats, control valves, damper motors and other equipment provided under this contract. If within twelve (12) months from the date of acceptance by Engineer and Owner any of the equipment herein described is proved to be defective in workmanship or materials, it will be replaced or repaired free of charge in accordance with "Warranties" paragraph in Section 230500. Note that the date of acceptance of the control system by the Engineer and Owner may occur after the date of substantial completion on the project/building.

B. The Controls Contractor shall, after acceptance by the Owner and Engineer, provide any service incidental to the proper performance of the control system under guarantees outlined in Division 1 for the period of one year.

C. When all devices are installed, a fully qualified technician shall set, adjust, and calibrate all components.

1. A letter certifying completion of the system shall be forwarded to the Engineer's office, prior to acceptance of project by Owner and Engineer.
2. Contractor shall then schedule a time to demonstrate system to Owner and Engineer. Contractor must be ready to simulate inputs for any contingency or situation Owner or Engineer requests to be demonstrated.
3. At the end of the demonstration session, Engineer will compile a list of deficiencies observed during the session. 230900 Contractor shall correct all deficiencies, then write the Owner and Engineer a new letter certifying completion as described in Item 1 above, then arrange a new demonstration session with Owner and Engineer. This repeats until no deficiencies are observed.
4. Only after no deficiencies are observed at demonstration session, the Owner and Engineer will sign a certificate of completion. All warranty dates for the control system begin on the date of this signature.

3.6 INSTRUCTION AND ADJUSTMENT

A. On completion of the job the controls contractor shall have completely adjusted the entire control system. He shall arrange to instruct the Owner's representative on operation of the control system and supply him with three (3) copies of the control operating and instruction manuals. He shall obtain from the owner's representative a signed receipt that he has received the instruction manuals and complete instructions on the operation of the system.

B. Record Drawings: At completion of the job the controls contractor shall furnish two (2) copies of corrected wiring diagrams, one enclosed in laminated plastic and mounted on wall of the main mechanical room or as directed.

C. System Verification: At completion of the job, the controls contractor shall coordinate with and assist the Testing and Balancing Contractor, the Commissioning Agent, Electrical Contractor, and equipment suppliers in testing and verification of proper operation of all control systems including HVAC, ventilation, lighting, and subsystem interfaces.

3.7 SEQUENCE OF OPERATION

A. General:

1. All HVAC Systems shall be controlled with Direct Digital Control (DDC) according to the sequence contained in this section of the specifications and shall be stand-alone. Additional points or software programming not listed in the sequence or in the schematics but which are required to meet the following sequences of operation shall be provided.
2. Monitor all pumps and fans with adjustable setpoint current switches. Indicate equipment status, and generate an alarm if a motor fails or if an uncommanded change of status exists: i.e. control system sequence commands a pump to turn off, but it continues to operate because its starter has been locally set to the hand 'on' position, or vice-versa.
3. Alarms generated on the DDC system shall be classified as critical or non-critical. Review classification of each alarm with WSU. Non-critical alarms generate a message on the operator workstation or existing ADX server as designated by the owner. Critical alarms will first generate a message on the operator workstation or existing ADX server. If the alarm has not been manually cleared within 5 minutes (programmable), the system will automatically generate an email or text message alarm on a pager or mobile phone of the owner's choosing.
4. The term 'enabled', as used in these control sequences, means a piece of equipment is capable of being turned on by the BAS. It does not mean it has been turned on by the BAS.
5. All setpoints are programmable.

B. Unit Heaters:

Start unit fans when space temperature is below setpoint (initially 50°F, adjustable, with 5°F differential, on at 50°F and off at 55°F). Two position heating water valves open when fan is on, and close when fan is off. Generate an alarm when space temperature drops below 40°F for 15 minutes.

C. In-Line Solids Separators (ISS-1):

The in-line solids separator is to be interlocked with condenser water pumps P-1/P-2 so the separator runs whenever either condenser water pump is operating, and shuts down when neither condenser water pump is operating.

The separator's two-position motorized blow-down valve shall be interlocked with the TDS controller provided as part of the cooling tower water treatment package. A signal from the TDS will open and close the valve. Interlock valve with TDS controller.

Monitor the solids separator pump with an adjustable setpoint current switch, and generate an alarm upon pump failure.

D. Variable Frequency Drives:

All VFDs shall be connected to the control network via a BACnet MS/TP interface. Each drive shall accept the following control inputs: start, stop, speed. Each drive shall

provide the following monitoring outputs: speed (Hz), speed (% of full), status, alarm/fault, amps, drive internal temperature, and two additional outputs to be selected by the owner. All of these items shall be indicated on the graphics page for each VFD.

In addition to these inputs and outputs, the VFD BACnet interface provides a large number of additional inputs and outputs. The 230900 contractor shall use their BACnet tools to discover and make this additional information available on the Metasys BACnet system, but is not required to provide graphics for this additional information.

E. Condenser Water Pumps P-1/P-2:

Condenser water pumps P-1 and P-2 are to operate in a primary/back-up configuration. Only one of the pumps is required to serve one or two operating chillers. Monitor the operation of each pump with an adjustable setpoint current switch. Upon pump failure, start the back-up pump and generate an alarm on the control system. Primary/back-up pump designation shall rotate on a weekly basis (programmable interval) so as to provide equal wear on each pump.

Upon a call for condenser water from a chiller, start the lead condenser water pump. The control system shall determine if one or two chillers are operating, and shall select the appropiate pre-programmed pump speed. Each pump is equipped with a variable frequency drive, but these drives are only used to select one of two operating points for each pump. When only one chiller is operating, the pump shall move 1,350 gpm of condenser water. If two pumps are operating, the pump shall move 2,700 gpm of condenser water. The Division 230900 and 230593 contractors shall work together to determine the appropriate manual speed setting necessary to achieve the designated flow rate at each setpoint.

Pumps shall be disabled when no water is detected in the cooling tower cold water basins. This should prevent pump operation during the winter months when the condenser water system has been drained. An electronic water level sensor will be present at the cooling tower and will be monitored on the DDC control system. Use the signal from this electronic water level sensor to determine if adequate water is present in the tower cold water basin for proper pump operation.

F. Cooling Towers CT-1/CT-2:

Cooling towers CT-1 and CT-2 are each designed to serve a single chiller. Designate one of the cooling towers as lead tower and turn it on when the lead chiller calls for condenser water. Lead cooling tower designation shall rotate on a weekly basis (programmable interval) so as to provide equal wear on each tower.

When the lead chiller is started, command the lead cooling tower to start by opening its condenser water isolation valve (V-13 or V-14) and start the tower's fan. Start tower fan at lowest speed, and slowly increase tower fan speed with its variable frequency drive to satisfy the condenser water system setpoint. Monitor each tower fan motor with an

adjustable setpoint current switch, and generate an alarm upon fan failure.

When the lag chiller is started, command the lag cooling tower to start in the same manner. When operating at the same time, modulate the speed of the fans in both towers in unison to satisfy the condenser water system supply water temperature setpoint.

When a chiller shuts down, first wait for the condenser water pump to index to 1,350 gpm, then shut down its cooling tower fan and close its condenser water isolation valve. Failure to perform these steps in the correct order will cause the cooling tower hot water basin to overflow.

Monitor the electronic water level sensor in the cold water basin of cooling tower CT-1. If the water level is low, open the two-position motorized ball valve V-11 until the level sensor indicates the water level satisfies setpoint, then close valve V-11. Totalize the flow of make-up water to the condenser water system by providing a make-up water meter with digital pulse counter. Display make-up water rates in gallons per minute and trend in system memory in gallons per month where data cannot be lost in the event of a power outage. Provide a software switch to disable valve V-11, leaving it in the close position, during the winter months when the condenser water system is drained.

Monitor the vibration cut-out switch at each cooling tower, and generate an alarm if a tower is shut down due to vibrations.

Initial setpoint for condenser water supply temperature is 80°F (adjustable). Note that the McQuay chillers include a condenser water setpoint optimization control algorithm. 230900 shall provide a software switch that allows WSU operations staff to choose between using the fixed condenser water setpoint already described above, or the optimized condenser water temperature setpoint continuously determined by the factory controls on the McQuay chiller.

G. Chillers CH-1/CH-2/CH-3:

The chilled water plant consists of three chillers. A maximum of two chillers can operate at the same time, while the third chiller is a back-up unit that will only operate if one of the active chillers fails. Monitor status of all chillers, and automatically start the back-up chiller if an active chiller fails. Primary, secondary, and back-up chiller designation shall rotate on a weekly basis (programmable interval) so as to provide equal run hours on each chiller.

Upon a call for cooling, start the lead chiller by first opening its 2-way condenser water isolation valve (V-1, V-2, or V-3, 180 seconds to go from full closed to full open, travel time is adjustable), command the lead condenser water pump to operate (pre-programmed flow rate based on number of chillers operating; 1,350 gpm if one chiller running, 2,700 gpm if two chillers are operating), then signal the chiller to start. The modulating 3-way condenser water bypass valve (V-4, V-5, or V-6) at the chiller condenser barrel shall be wired directly to the control output on the chiller's factory control panel so the chiller can modulate valve position based on chiller head pressure.

At the same time the condenser water flow to the chiller is being started, start the chilled water flow to the evaporator by first starting the chilled water pump (P-3 or P-4), and open the chiller's 2-way evaporator isolation valve (V-7, V-8, or V-9, 180 seconds to go from full closed to full open, travel time is adjustable).

System shall start second chiller when the BTU meter indicates the chilled water load in the building has exceeded 210 tons for 15 minutes. The second chiller shall be shut off when the BTU meter indicates the chilled water load in the building is less than 200 tons for 5 minutes. When the second chiller is to be started, do the following:
-Activate a current limit on the lead chiller (25% of full load, adjustable) for 3 minutes.
-Open the two-position chilled water bypass isolation valve V-15 in the existing fan room in the SW quadrant of the building. The chilled water pump will adjust its speed automatically to satisfy the differential pressure sensors in the chilled water distribution piping.
-Open the two-position condenser water isolation valve for the secondary chiller and the condenser water isolation valve at the secondary cooling tower. The condenser water pump is to be indexed to the programmed flow rate for two chillers (2,700 gpm). Adjust time delay between commanding valve to open and indexing of pump speed to prevent overflowing tower hot water basin or causing a low-flow alarm at the lead chiller.
-After current limit on lead chiller has been active for 2 minutes, open evaporator isolation valve on secondary chiller (slow acting). Secondary chiller to be programmed to start 2 minutes (adjustable setpoint) after its evaporator isolation valve has been commanded to open (helps prevent generation of a low flow alarm).

Upon shutdown of the secondary chiller:
-Activate a current limit on the lead chiller (25% of full load, adjustable) for 3 minutes.
-After current limit on lead chiller has been active for 2 minutes, command the secondary chiller to shut down, then close its evaporator and condenser water isolation valves. Index the condenser water pump to the flow rate for a single chiller, and close the isolation valve on the secondary cooling tower.
-Close chilled water bypass isolation valve V-15 in the existing fan room.

Factory controls on board each chiller shall output the following to the 230900 control system through its BACnet IP interface, and these items shall be displayed on the control system graphics:
-Status
-Alarm
-Amps
-Chilled water entering and leaving temperatures
-Chilled water supply temperature setpoint

The factory controls shall accept the following inputs from the 230900 control system through the same BACnet IP interface, and these items shall be displayed on the control system graphics as fields that users can input on the graphics page:
-On/Off
-Chilled water supply temperature setpoint
-Current limit

In addition to these inputs and outputs, the factory installed chiller controls provide a large number of additional inputs and outputs through the BACnet IP interface. The 230900 contractor shall use their BACnet tools to discover and make this additional information available on the Metasys BACnet system through the chiller BACnet interface, but is not required to graphically represent this information on the chiller graphics page.

H. Chilled Water Pumps P-3/P-4:

Condenser water pumps P-3 and P-4 are to operate in a primary/back-up configuration. Only one of the pumps is required to serve one or two operating chillers. Monitor the operation of each pump with an adjustable setpoint current switch. Upon pump failure, start the back-up pump and generate an alarm on the control system. Primary/back-up pump designation shall rotate on a weekly basis (programmable interval) so as to provide equal wear on each pump.

Upon a call for cooling, start the lead chilled water pump. Each of these pumps is equipped with a variable frequency drive. The control system shall modulate pump speed to satisfy the differential pressure setpoint measured at the two differential pressure sensors, one in the 8” chilled water distribution piping to the main arena air handlers, the other in the 4” chilled water distribution piping to the back-of-house air handlers. Ensure the setpoint is met at each sensor so the measured differential pressure is not less than setpoint, do not average the readings at both sensors. Work with the 230593 contractor to determine the appropriate differential pressure setpoint at each sensor.

I. Chiller Room Ventilation Fans EF-1/EF-2:

Chiller room exhaust fan EF-1 shall operate during all occupied times (programmable schedule specific for this fan). When EF-1 is operating, control damper CD-1 shall be open. When EF-1 is off, CD-1 shall be closed. Exhaust fan EF-2 shall operate when the refrigerant leak detection system detects refrigerant. Fan speed is constant. The signal to start ET-2 shall also open CD-2, and CD-2 shall be closed when EF-2 is not signaled to operate. Refrigerant detectors shall monitor the concentration of refrigerant in the chiller room. If the refrigerant concentration rises to the setpoint (R-134a, set for 800 ppm), a local audible and visual alarm shall be generated, an alarm shall be indicated at the operator workstation, and an alarm notification shall be sent to a pager or e-mail address. Shut off fan EF-2 once measured refrigerant levels drop below the activation setpoint. Hard wire the start/stop signal from the refrigerant monitor to damper CD-2 and fan EF-2, and monitor the signal on the 230900 system. Monitor fan status of both fans with variable setpoint current switches. All fan failures shall be alarmed at the operator workstation and shall generate an automatic pager or e-mail notification. Install the leak detection system’s two remote audible/visual enunciators at the locations indicated on the drawings.

Provide one break-glass type switch with tamper resistant cover to shut down all chillers, and install where shown on drawings. Also provide one break-glass type switch with

tamper resistant cover to manually activate exhaust fan EF-2. Generate an alarm whenever either switch is activated. Hard wire these switches to the refrigerant leak detection device to ensure proper activation of the fan and damper, and generate an alarm on the 230900 system when either switch is activated.

J. Chilled Water System Pressure:

Provide a pressure sensor in the pipe that connects the chilled water system expansion tank to the chilled water system main pipe. Display system pressure on the DDC system, and generate an alarm when system pressure drops below a minimum allowable system pressure limit. Disable all chillers and chilled water pumps upon a low system pressure alarm.

END OF SECTION 230900

SECTION 232113 - HVAC PIPING AND SPECIALTIES

PART 1 - GENERAL

1.1 RELATED WORK

A. The General Conditions, Supplementary Conditions and Division 1, General Requirements apply to this Section, and Contractor shall review and adhere to all requirements of these documents.

B. Related work specified in other Sections:

Section 230500 - Basic Mechanical Requirements
Section 230529 - Basic Mechanical Materials and Methods
Section 230540 - Mechanical Sound and Vibration Control
Section 230548 - Mechanical Seismic Control
Section 230700 - Mechanical Insulation
Section 232123 - HVAC Pumps
Section 236400 - Refrigeration
Section 230900 - Electronic Controls
Section 230593 - Testing, Adjusting and Balancing

C. Work installed but furnished under other Sections:

1. Pot Feeders, Water Meters, and Manifolds furnished under Section 232500 - HVAC Water Treatment.
2. Flexible pipe connectors - Section 230540.
3. Two-way automatic control valves.
4. Three-way automatic control valves.
5. Temperature sensing wells.

1.2 SYSTEM DESCRIPTION

A. The work includes, but is not limited to the following:

1. Heating water piping and specialties.
2. Chilled water piping system and specialties.
3. Condenser water piping system and specialties.
4. Relief Valves.
5. Air Vents.
6. Air Separators.
7. Strainers
8. Pump Suction fittings.
9. Valves in accordance with Section 230529.
10. Pipe hangers and supports, saddles and shield in accordance with Section 230529.

11. Mechanical sound and vibration control in accordance with Section 230540.
12. Installation of automatic control valves.
13. Flow Measuring Stations.
14. Water Meters.
16. Tests.

1.3 QUALITY ASSURANCE

A. Welder Qualifications: Welding shall be performed by an NCPWB Certified Welder with current certificate in accordance with ANSI B31.9 for shop and project site welding of piping work.

1.4 REFERENCES

A. Reference Standards: Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations of the following:

1. Comply with American Welding Society (AWS) National Certified Pipe Welding Bureau (NCPWB) and American National Standards Institute (ANSI) Code Numbers B31.2, B31.9 as applicable for welding requirements.
2. Comply with American National Standards Institute (ANSI B31.1) Code for Pressure Piping.
3. ANSI/ASME - Boiler and Pressure Vessel Code.
4. ANSI/ASME B31.9 - Building Services Piping.
5. ANSI/AWS D1.1 - Structural Welding Code.
6. ANSI/ASME Sec. 9 - Welding and Brazing Qualifications.
7. ASTM B32 - Solder Metal.
8. ANSI/AWS A5.8 - Brazing Filler Metal.

1.5 SUBMITTALS

A. Submit Product Data for the following items under provisions of The General Conditions of the Contract.

1. Bladder-Type Expansion Tanks.
2. Air Separators.
3. Flow Meters.
4. Water Meters.

B. Submit printed Operating Instructions and Maintenance Data for the following items under provisions of Operating and Maintenance Data paragraph in Section 230500.

1. Bladder-Type Expansion Tanks.
2. Air Separators.

3. Strainers.
4. Flow Meters.
5. Balancing Valves.
6. Water Meters.
7. Backflow Preventer.
8. Pressure Regulating Valves.

D. Test Reports: Submit certified test reports for the following showing compliance in accordance with the General Conditions of the Contract:

1. Piping pressure tests.
2. Piping systems cleaning and flushing per Section 232500.
3. Certificates: Before proceeding with the Work, submit to the Architect/Engineer/Construction Manager/General Contractor, two copies of Certification that the welding work will be done according to ANSI B31.1 by welders who have been tested and whose qualification test sheets are available, attesting to their ability to weld in accordance with Standard Procedure Specifications as established by the National Certified Pipe Welding Bureau.

1.6 PROJECT CONDITIONS

A. Contractor shall not fabricate or install any piping until he has assured himself that the piping can be run as contemplated in cooperation with Contractors of other Divisions of the Work and the physical constraints of the Structural and Architectural Work.

PART 2 - PRODUCTS

2.1 HEATING WATER, CHILLED WATER, AND CONDENSER WATER SYSTEM PIPING (LESS THAN 90 PSIG)

A. Steel Pipe:

1. Pipe:

2 Inch & Smaller	ASTM A53, Grade A, Schedule 40 black buttweld or continuous welded steel.
2-1/2 Inch & Larger	ASTM A53, Grade B, Schedule 40 black buttweld or continuous welded steel.

2. Fittings:

2 Inch & Smaller	ASTM A197, Class 150 black malleable iron screwed.

2-1/2 Inch & Larger	ASTM A234, Steel butt weld, standard weight forged fittings.

3. Unions:

2 Inch & Smaller	Class 150 black malleable iron screwed bronze to iron, ground joint.
2-1/2 Inch & Larger	Use flanges or grooved couplings.

4. Gaskets:

All Sizes	Class 250 1/8 inch full faced metal spiral wound, 304 stainless steel and flexible graphite filled with entering ring and inner ring.

5. Bolting: ASTM A307, Grade B, regular square head machine bolts with heavy hex nuts.

6. Flanges:

All Sizes	ASTM A181, Grade 1, Class 150 slip-on or weld neck flat faced.

B. Copper Tubing:

1. Tube:

Up to 4" inclusive	ASTM B 88, Type L, hard drawn.

2. Fittings:

a. ANSI/ASME B16.23 cast brass and/or
b. ANSI/ASME B16.29 solder wrought copper

3. Joints:

a. ASTM B32, solder, Grade 95 TA.

2.2 HEATING WATER, CHILLED WATER AND CONDENSER WATER PIPING FOR GROOVED PIPE OPTION

A. General: At Contractor's option, heating water, condenser water and chilled water piping may be mechanical roll grooved pipe couplings, fittings and butterfly valves.

B. Acceptable Manufacturers: Victaulic, Anvil/Gruvlok, Grinnell.

C. Chilled water piping includes risers, mains, equipment connections, branches, supply and return lines under operating conditions not exceeding minus 30 degrees Fahrenheit to plus 230 degrees Fahrenheit.

1. Pipe: ASTM A53, 3/4 inch to 1-1/2 inch Type F; 2 inch to 20 inch Type E or S, Grade B Standard roll grooved to coupling manufacturer's specification, standard weight steel pipe.
2. Couplings: Line and fitting joints to be Victaulic "Style 75 or 77" with Grade "E" gaskets and nuts and bolts. Rated –30°F. to 230°F.
3. "Rigid" line fitting and valve joints to be Victaulic "Style S-07" Couplings with or Grade "E" gaskets and nuts and bolts.
4. Joints designated Outlet Couplings to be Victaulic "Style 72" with Grade "E" gaskets and nuts and bolts.
5. Joints designated Reducing Couplings to be Victaulic "Style 750" with Grade "E" gaskets and standard nuts and bolts.
6. Flanged components connections to be Victaulic "Style 741 Vic-Flanges" with Grade "E" gaskets.
7. Fittings: Fittings to be Victaulic "Full Flow" malleable iron or ductile iron or segmentally welded fittings, with grooved or shouldered ends.
8. Valves: Butterfly valves 2" - 12" inch to be Victaulic S/300 with 300 psi rating, latch-lock throttling handles, Grade "E" linings and standard trim. Sizes 14" - 24" to be Victaulic S/708 with 175 psi rating. Valves greater than or equal to 8” shall be supplied with gear operator.
9. All materials to be manufactured in the USA, and must be designed and intended for use on HVAC systems. No fire sprinkler parts are allowed.

2.3 STATIONARY PRESSURE GAUGES

A. Acceptable manufacturers: Trerice 600C Series, Weksler Regal Series, Weiss Instruments, Miljoco.

B. Schedule:

Type	4-1/2” Dial
Bourdon tube/socket	Stainless steel tube 316 stainless steel socket
Accuracy	ANSI B40.1 Grade 1A 1% F.S. over middle half of range
Case	Cast aluminum
Window	Clear glass
Snubber	Yes
Coil siphon	For steam service
Gauge cock	Yes
Set hand	No
Silicone filled	No
Weatherproof	No

C. Range: Select gauges for the following standard ranges unless otherwise indicated on drawings, or as required for special systems:

2.4 STATIONARY THERMOMETERS

A. Acceptable manufacturers: Trerice Industrial Series, Ametek Industrial Series, Weiss Instruments, Miljoco, Weksler.

B. Schedule:

Type	Adjustable angle
Case	9" cast aluminum
Window	Clear acrylic
Tube	Red Alcohol
Stem	Aluminum, insertable
Separable Socket	Brass

C. Range: Select thermometers, for the following standard ranges unless otherwise indicated on Drawings, or as required for special systems.

1. Chilled water 0 to 100 °F
2. Condenser water 0 to 100 °F
3. Heating water 30 to 240 °F

2.5 TEMPERATURE AND PRESSURE TEST PLUGS (T&PTP)

A. Manufacturer: Trerice, Fairfax, Flow Design, Peterson Equipment (Pete's Plug), Sisco.

B. Plugs suitable for vacuum to 600 psig and temperatures of -20 deg.F to 300 deg.F with cap and extension for insulated pipe where required.

C. Provide one pressure gauge(s), gauge adapter, and two thermometers in shock-proof case.

D. Schedule:

PLAN CODE:	MAKE:	MODEL :	PRESSURE & TEMPERATURE TEST KIT
T&PTP	Trerice	D3741	Trerice D3751 (0-200 psig)

2.6 FLANGES, UNIONS, AND COUPLINGS

A. Pipe Size 2 Inches and Under: 150 psig malleable iron unions for threaded ferrous piping; bronze unions for copper pipe, soldered joints.

B. Pipe Size Over 2 Inches: 150 psig forged steel slip-on flanges for ferrous piping; bronze flanges for copper piping; 1/16 inch thick preformed neoprene bonded to asbestos.

C. Grooved and Shouldered Pipe End Couplings: Malleable iron housing clamps to engage and lock, designed to permit some angular deflection, contraction, and expansion; C-shape elastomer composition sealing gasket for operating temperature range from -30 degrees F to 230 degrees F; steel bolts, nuts, and washers; galvanized couplings for galvanized pipe.

2.7 RELIEF VALVES

A. Acceptable Manufacturers: Kunkle, Watts, McDonnell and Miller, Lonegren, Conbraco, Spirax Sarco, Spence.

B. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labeled.

C. Size as required for maximum operating pressure and heat transfer capacity of the equipment. Provide relief valve in each system to protect piping, tanks, and equipment.

2.8 PUMP SUCTION FITTINGS

A. Acceptable Manufacturers: Metraflex, or Equal.

B. Provide CRV flex at inlet to all pumps.

C. Maximum allowable pressure drop across CRV flex fitting at system design flow is 1 psi. Provide reducer as necessary to connect CRV flex fitting to pump inlet.

2.9 AIR ELIMINATORS

A. Air Eliminators: Steel, max. working pressure 150 psi, ASME stamped, max. working temp. 270°F, turbulence suppressive design, integral air chamber with automatic vent valve, skimming valve, dirt removal chamber, blowdown connection, and coalescing media. Acceptable manufacturers: Spirotherm - Spirovent Air/Dirt Separator, no exceptions.

2.10 STRAINERS

A. Acceptable Manufacturers: Armstrong, Boylston, AW Cash, ITT, Hoffman, Keckley, Mueller, Trane, Metraflex, Victaulic, Conbraco, Spirax Sarco, Gruvlok, IFC.

B. Size 2 inch and Under: Screwed brass or iron body for 175 psig working pressure, Y pattern with 1/32 inch stainless steel perforated screen.

C. Size 2-1/2 inch to 4 inch: Flanged or grooved iron body for 175 psig working pressure, Y pattern with 3/64 inch stainless steel perforated screen.

D. Size 5 inch and Larger: Flanged or grooved iron body for 175 psig working pressure, basket pattern with 1/8 inch stainless steel perforated screen.

E. Do not install duplicate system strainers in series with strainers that are factory installed on chillers. If shown on drawings, verify with Engineer prior to pipe installation to determine if additional strainer is required.

2.11 BLADDER-TYPE EXPANSION TANKS

A. Acceptable Manufacturers: Bell and Gossett, Amtrol, Woods, Taco, Wheatley, Armstrong, Flexcon, Wessels, Patterson.

B. Provide tanks of size and capacity shown on Drawings.

C. Construction: Welded steel, tested and stamped in accordance with Section 8D of ANSI/ASME Code; supplied with National Board Form U-1, rated for working pressure of 125 psig, with flexible EPDM bladder sealed into tank, and steel legs or saddles.

D. Accessories: Pressure gauge and air-charging fitting, tank drain; precharge to required psig.

2.12 AIR VENTS

A. Manual Type: Short vertical sections of 2 inch diameter pipe to form air chamber, with 1/4 inch copper tubing to a petcock.

2.13 FLOW MEASURING STATIONS (VENTURI)

A. Furnish and install where shown on drawings, complete Venturi Flow Measuring System as manufactured by Hyspan Barco, Flow Design, Febco, Bell & Gossett, Preso, Armstrong, Gerand.

B. Each primary flow element shall be a Venturi selected from manufacturer's engineering data to permit prescribed flow at a minimum of head loss. The beta ratio shall be selected to allow for a differential pressure compatible with the meter as specified herein and insure a properly calibrated system accuracy within 1% throughout the entire range. Each Venturi shall be furnished with 2 built-in sensing taps, nipples, shut-off valves, and quick connect couplings. Venturis shall be complete with identification tag on chain, giving pipe size, Venturi series, station identification and meter reading at specified flow rate. Furnish flow vs. differential pressure curves and installation instructions.

C. Venturi stations shall be one-piece bronze threaded 1/2" through 3". Sizes 2-1/2" through 8" shall consist of one-piece cadmium plated cast steel Venturi with weld neck or flanged ends.

D. Venturi sizes and beta ratios shall be selected so that design flow rates shall read between 20% and 80% of the full scale range on a linear meter with permanent pressure loss of not more than 25% of indicated flow rate differential pressure.

E. Provide with portable indicating meter with 6” round dial, 270 degrees indication. It shall be the dual rupture-proof liquid filled bellows type with integral temperature compensation. The meter shall have over-range protection in either direction equal to the working pressure equivalent of the instrument housing (250 psig at 250 deg.F). The accuracy of the meter shall be no less than 0.5% full scale. The meters case shall be waterproof coated with appropriate paint. It shall have external zero and range adjusting screws and life-long lubrication. Scale shall be calibrated uniformly either in differential pressure; percent of flow; or directly in gpm.

1. Portable Master Meters shall be mounted in a durable metal reinforced plastic carrying case with the following accessories:

a. Two 10” lengths of connecting hose, each with color coded quick connect couplings compatible with the Venturi couplings.
b. Two brass blow-down valves with Buna-N seals.
c. Blow-down hoses.
d. Instruction book with flow vs. differential curves.

2.14 BALANCING VALVES (TERMINAL EQUIPMENT)

A. Acceptable Manufacturer: Bell & Gossett, Gerand, Armstrong, Taco, Amtrol, Tour & Andersson, Flow Design, Gruvlok, Danfoss.

B. Furnish and install calibrated balancing valves with screwed, sweated, or flanged connections suitable for 125 psig. Maximum working temperature shall be 250°F. Valves shall be equipped with brass readout valves fitted with an integral EPT insert and check valves designed to minimize system fluid loss during the balancing and monitoring process. Each balancing valve shall have a calibrated nameplate to assure specific valve settings, be constructed with internal seals to prevent leakage and be supplied with preformed Polyurethane insulation suitable for use on heating and cooling system.

C. Provide a metal identification tag, with wire, for each flow control valve. The tag to be marked with zone identification, valve model number, and rated flow in GPM.

D. Correct flow shall be verified by establishing that the operating pressure differential across the valve tappings is within the operating range indicated on the submittal data sheet for that model number.

PART 3 - EXECUTION

3.1 PIPE WORKMANSHIP

A. Piping shown on the drawings shall be installed complete, and shall be of the size shown on the drawings. When a size is not indicated, the sub-contractor shall request the pipe size from the Architect/Engineer thru the General Contractor. All piping shall be installed parallel or perpendicular to the building construction. All piping shall be installed so as to allow for expansion. Install saddles and shields per Section 230529.

B. Relief Valve: Install a 1” safety relief valve, set at a pressure no more than 5 psig less than the relief valve on boiler or chiller evaporator barrel, to protect against damage by expanding liquid or other source of overpressure during test or normal operation. Discharge of this system relief valve shall be piped to the glycol fill tank for recovery of glycol should relief valve be discharged.

3.2 PIPE SLOPE

A. Slope all domestic water, chilled water, heating water and condenser water piping at 1”/40’ toward drains.

3.3 PIPING JOINTS

A. All pipe shall be reamed to full pipe diameter before joining. Screwed joints shall be made with standard pipe thread, and an approved compound applied to the male thread only. Welded joints shall be made in accord with the procedure outlined in National Certified Pipe Welding Bureau, or by other reputable testing laboratory or agency. Subcontractor shall use only "Threadolet" or "Weldolet" fittings for intersection welding of branches to mains. Valves and specialties shall have screwed or flanged joints. No bushings allowed.

B. All pipe shall be reamed to full pipe diameter before joining.

C. Pull tee (T-drill) fittings are forbidden.

3.4 SYSTEM PRESSURE SETTINGS

A. Chilled Water System: Pre-charge bladder-type expansion tank to 15 psig.

3.5 RELIEF VALVES

A. Provide a pressure relief valve in each closed loop system set at 125 psig.

3.6 CHANGE IN PIPE SIZE

A. Where changes in the pipe size are required at equipment connections, change the pipe size within a maximum length of three pipe size diameters of the final connection.

B. Where changes in pipe size occur in horizontal straight lengths of pipe, install concentric reducers.

3.7 AUTOMATIC CONTROL VALVES

A. Install automatic control valves as required and specified in Section 230900 - Electronic Controls.

3.8 AIR VENTS

A. At all changes in elevation downward in direction of flow, and where shown, provide a manual air vent as follows: install a full size air chamber and pipe down with 1/4 inch copper tubing to a petcock. If the vent is above a ceiling, install the petcock just above the ceiling. Provide air vent fittings (manual) on hydronic coils.

3.9 PIPING CONNECTORS

A. Install flexible pipe connectors at equipment coils and pumps and elsewhere as required to accommodate thermal expansion, misalignment and vibration in accordance with Section 230540 - Mechanical Sound and Vibration Control.

3.10 AIR SEPARATOR

A. Contractor shall remove and clean strainer after 24 hours operation and after 30 days.

3.11 FLOW SWITCHES

A. Contractor shall furnish and install flow switches for mounting in chilled water and condenser water piping of each chiller machine.

3.12 THERMOMETERS AND GAUGES FOR CHILLER INSTALLATION

A. Contractor shall furnish and install a set of four adjustable, indicating type, mercury filled thermometers of the separable socket adjustable type in glass faced metal cases. They shall be placed in the piping adjacent to the machine in the following locations:

1. Condenser water line entering condenser.
2. Condenser water line leaving condenser.

3. Chilled water line entering evaporator.
4. Chilled water line leaving evaporator.
5. Where indicated on plans, details and schematics.

B. Thermometer bulb shall project sufficiently into pipe (at least 1/3 of nominal pipe diameter) to accurately measure water temperature. Cases shall clear insulation.

C. Contractor shall provide and install gauge valves and gauges so that water pressure difference across these vessels is indicated.

D. Mount thermometers and gauges in a readily accessible location and easily read in a standing position from the equipment room floor.

E. Provide a shut-off valve on the branch line to each pressure gauge located in the system.

3.13 BACKFLOW PREVENTER

A. Provide on cold water make-up line to heating water and chilled water piping systems. Locate on high pressure side of reducing valve on system water make-up line.

3.14 TESTS

A. General: Provide test pump, gauges, meters, other instruments, materials, and labor, in connection with tests.

B. Relief Valve: Install a 1” safety relief valve, set at a pressure no more than 5 psig less than the relief valve on boiler or chiller evaporator barrel, to protect against damage by expanding liquid or other source of overpressure during test or normal operation. Discharge of this system relief valve shall be piped to the glycol fill tank for recovery of glycol should relief valve be discharged.

C. Pressure Tests: Before testing piping systems, remove or otherwise protect from damage, control devices, air vents and other parts which are not designed to stand pressure used in testing piping.

D. Hydrostatic Pressure: Test hydronically, piping for all services (except pneumatic system compressed air) to 125 psi or 1.5 times the maximum working pressure, whichever is greater, for at least six consecutive hours, during which time pressure shall remain constant without pumping. Subject welded joints to the hammer test, and copper joints to soap suds while under hydrostatic pressure.

3.15 CLEANING OF PIPING SYSTEMS

A. Provide for the cleaning of the HVAC Water Piping Systems after hydrostatic tests have been completed and prior to the operating tests in accordance with Section 232500 - HVAC Water Treatment.

B. 232113 Contractor is to provide bypasses and isolation valves as required by 232500 Contractor to allow circulation of cleaning solution in new piping heating water system without allowing system cleaning solution to circulate through existing piping system. Note that the entire new and existing chilled water system is required to be cleaned and flushed. Division 232113 Contractor is responsible for removing and cleaning strainers in new or existing system plugged by cleaning of new system. Simply blowing down strainers is unacceptable.

3.16 HVAC WATER TREATMENT

A. Provide valved tees and piping and 3/4 inch threadolets for water treatment apparatus in accordance with Section 232500 HVAC Water Treatment Contractor instructions.

END OF SECTION 232113

SECTION 232123 - HVAC PUMPS

PART 1 - GENERAL

1.1 RELATED WORK

A. The General Conditions, Supplementary Conditions and Division 1 General Requirements apply to this Section, and Contractor shall review and adhere to all requirements of these documents.

B. Related work specified in other Sections:

Section 230500 - Basic Mechanical Requirements
Section 230529 - Basic Mechanical Materials and Methods
Section 230540 - Mechanical Sound and Vibration Control
Section 230548 - Mechanical Seismic Control
Section 230700 - Mechanical Insulation
Section 232113 - HVAC Piping and Specialties
Section 236400 - Refrigeration
Section 235700 - Heat Transfer
Section 230900 - Electronic Controls
Section 230593 - Testing, Adjusting and Balancing

1.2 SYSTEM DESCRIPTION

A. The work includes, but is not limited to, providing the following:

1. Chilled water system pumps.
2. Condenser water system pumps.

1.3 REFERENCES

A. Reference Standards: Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations of the following:

1. Comply with American National Standards Institute (ANSI B31.1) Code for Pressure Piping.

1.4 SUBMITTALS

A. Shop Drawings: Submit Shop Drawings and Product Data including materials of construction, actual impeller size, pump speed, motor size, motor efficiency, motor amps, mounting requirements, weights, dimensioned drawings, and performance curves at scheduled flow conditions and 120% of scheduled head, for the following items in accordance with the General Conditions of the Contract:

1. Heating water system pumps.
2. Chilled water system pumps.
3. Condenser water system pumps.

B. Operating Instructions and Maintenance Data: Submit printed Operating Instructions and Maintenance Data for the following items in accordance with Operating and Maintenance Data paragraph in Section 230500.

1. All pumps.

PART 2 - PRODUCTS

2.1 BASE MOUNTED, VERTICAL, SPLIT COUPLED CIRCULATING PUMPS

A. General: Provide pumps and motors of sizes and capacities scheduled on Drawings. Pump manufacturer to check suction condition on pumps, and provide pumps suitable for operation at proper net pump suction head (NPSH).

B. Selection Criteria: Pumps shall be selected to satisfy the specified flow/head conditions shown on pump schedule while in the mid-range of the selected pump performance curve.

C. Motor to be non-overloading throughout the range of the pump curve and in accordance with "Motors" in Section 230529. Provide variable frequency drives where indicated, in accordance with Section 230810.

D. Provide shaft grounding kit on all pump motors.

E. The pumps shall be single stage, veritcal-suction and discharge design, in ductile iron and bronze fitted constructed.

F. The impeller shall be of the enclosed type, statically and dynamically balanced and keyed to the shaft and secured with a suitable locknut.

G. Pump seal shall be standard single mechanical seal with carbon seal ring and ceramic seat.

H. The bearing frame assembly of the pump shall be fitted with regreaseable ball bearings equivalent to electric motor bearing standards for quiet operation.

I. The pump and motor shall be vertically mounted on top of Pump Housing, and it shall be possible to lift motor up off top of pump assembly without disturbing piping. Motor shaft shall be one piece steel with bronze shaft sleeve. Casing shall have a replaceable wear ring. The entire pump shall not require grouting for operation within hydraulic institute standards for vibration.

J. The pump shall be factory tested, thoroughly cleaned, and painted with one coat of machinery enamel prior to shipment. A set of installation instructions shall be included with the pump at the time.

K. Pump provided for this project cannot exceed the maximum footprint listed on the pump schedule.

L. Manufacturers: Bell and Gossett, Armstrong, Taco, Paco, Allis Chalmers, Weinman, Peerless, Aurora, Grundfos, Patterson.

PART 3 - EXECUTION

3.1 GENERAL

A. Provide installation in accordance with Section 230540 - Mechanical Sound and Vibration Control.

B. Lubricate the pumps in accordance with manufacturer's instructions after completion of the system and before start-up.

3.2 BASE MOUNTED VERTICAL, SPLIT COUPLED CIRCULATING PUMPS

A. Valves and fittings in piping to pumps to be full line size with reductions made directly to pump suction (eccentric reducer) and discharge (concentric increaser).

B. Pumps and motors to be leveled and aligned on bases and foundation pads in strict accordance with the manufacturer's instructions and within their recommended tolerances using an indicating micrometer. This is to be done before any piping or electrical connections are made. After connections have been made and just prior to placing each pump in operation, recheck levels and alignments. Make adjustments to assure that the thrust is balanced, that shaft rotates freely when turned by hand, and that pump is quiet in operation. When adjustments are completed, tightly bolt and grout motor and pump.

END OF SECTION 232123

SECTION 232500 - HVAC WATER TREATMENT

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Pre-Startup cleaning of HVAC Piping Systems.

B. Pre-Startup cleaning of Boilers and Steam and Condensate Piping Systems.

C. Chemical Feeders.

D. Treatment for Closed Systems:

1. Chilled Water
2. Heating Water (branch lines to unit heaters)

E. Treatment for Open Systems:

1. Condenser Water System

1.2 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS

A. Furnish only the following items to Section 232113 - HVAC Piping Contractor for installation:

Manifolds
Solenoid Water Valves with Strainers
Motorized Ball Valves for solids separator blowdown/bleed

1.3 RELATED WORK

A. The General Conditions, Supplementary Conditions and Division 1, General Requirements apply to this Section, and Contractor shall review and adhere to all requirements of these documents.

B. Section 230500 - Basic Mechanical Requirements.

C. Section 230529 - Basic Mechanical Materials and Methods.

D. Section 221411 - Disinfecting Water Supply System.

E. Section 232113 - HVAC Piping and Specialties.

1.4 QUALITY ASSURANCE

A. All products shall be provided by a single Contractor to ensure there being a single source of responsibility.

B. While it is recognized that there are, for most items, several equal brands and manufacturers, the water treatment contractor will for the purpose of this bid, offer only specified equipment and chemicals.

C. The only Water Treatment, Chemical and Service Supplier approved for this project is West, Inc. No exceptions.

1.5 SUBMITTALS

A. Technical Data: Submit Shop Drawings and Product Data for the following items in accordance with the General Conditions of the Contract:

1. Water Treatment Materials and Equipment.
2. Control Diagrams.
3. Chemicals and quantity provided.

B. Operating Instructions and Maintenance Data: Submit printed Operating Instructions and Maintenance Data for the following items in accordance with Operating and Maintenance Data Paragraph in Section 230500.

1. All Water Treatment Equipment and Procedures.
2. Water Treatment Program Control Chart.

1.6 MAINTENANCE SERVICE

A. Provide the services of a fully qualified Field Engineer and laboratory and technical assistance from a fully qualified laboratory staff for one year warranty period. Services and assistance shall include the following:

1. A two hour training course for the Owner's operating personnel instructing them clearly and fully on the installation, care, maintenance, testing, and operation of the water treatment systems. The training course shall be arranged by the Division 23 Contractor at the startup of the system.

2. A quarterly technical service visit to the jobsite of the installation to perform field inspections and to make water analysis on site, both of such complexity as to evaluate the water systems operations. The Field Engineer shall detail findings with the proper personnel in writing on proper practices, chemical treating requirements, and any corrective actions needed to protect the water systems from scale, corrosion, and fouling. Two copies of the written field service report shall be forwarded to the Owner and the Division 23 Contractor after each visit.

3. Be on call at no additional cost increase to the Contract Sum to make on-site inspections of equipment during scheduled or emergency outages in order to properly evaluate the success of the water treatment program, and to make recommendations in writing based upon these inspections.

1.7 EXTRA STOCK

A. Provide sufficient chemicals for treatment and testing during one year warranty period. If any system loses the chemicals due to pipe leaks or any other system malfunction, the Division 230000 Contractor shall replace the chemicals at no expense to the Owner. Chemicals shall not be harmful to the system in which they are used, and shall comply with Jurisdictional Codes governing the use and discharge of chemical formulations.

PART 2 - PRODUCTS

2.1 PRE-STARTUP CLEANER

A. Provide a pre-startup liquid alkaline dispersant cleaner for the flushing and cleaning of all condenser water and chilled water systems (both new and existing chilled water piping, so all chilled water piping in the building is included), and the new heating water system piping, to remove oil and foreign matter from the piping and equipment prior to the final filling of the systems. This chemical shall not be injurious to persons, piping, pipe joint compounds, packings, coils, valves, pumps, and their mechanical seals, tubes or other parts of the system.

B. Provide a pre-startup liquid alkaline dispersant cleaner for the flushing and cleaning of the steam boilers and related equipment to remove oil and foreign matter from the equipment prior to startup.

C. Furnish complete instructions dictating the quantities of the cleaner to use, methods, and duration of the operation.

2.2 CHEMICAL FEED EQUIPMENT FOR CLOSED SYSTEMS

A. Provide pot feeders for the following closed systems:

1. Chilled Water

B. Feeder shall be bypass Pot Feeder of sufficient capacity with 3/4" brass drain valve. All feeders shall be able to withstand a maximum working pressure of 175 psi

2.3 CLOSED SYSTEM WATER TREATMENT CHEMICALS

A. Provide liquid borate nitrite corrosion inhibitor plus an azole inhibitor treatment for the prevention of corrosion in closed systems at 700 PPM total nitrite level.

2.4 WATER TREATMENT CONTROL SYSTEM FOR COOLING TOWERS

A. Acceptable Manufacturers:

Water Treatment Control System: Lakewood Instruments, LMI.
Chemical Feed Pumps: LMI, Prominent, Precision.

B. Provide an automatic condenser water control system which shall be completely automated for inhibitor feed, blowdown and biocide feeds. Inhibitor application and blowdown shall be conductivity activated, and directly responsive to variables in concentrations of the recirculating water. Biocides shall be automatically fed on an alternating basis with the blowdown locked out to insure proper biocide retention time in the recirculating water.

C. Control system shall incorporate the latest advantages of solid state technology including integrated circuits and digital LED displays. All control circuits shall be in a single NEMA-12 steel enclosure. Door shall be gasketed and lockable. The digital control system shall have the following features and capabilities:

1. TDS - The dissolved solids control portion of the system is based on conductivity and shall have the following features and accessories:

a. LED digital readout display (micromho/cm).
b. Temperature Compensated Sensor Probe adaptable to sample stream manifold.
c. High, Low, Normal conductance indicator lights (LED).
d. High or Low conductance alarm light (flash or steady switch), trip points field adjustable. Flash or Steady Switch shall have a Silence position.
e. Illuminated Legend: "Alarm", whenever alarm condition exists. Cannot be disabled.
f. HOA switch for solenoid bleed valve.
g. Illuminated Legend: "Bleed", when valve is operated.
h. Adjustable hysteresis or dead-band (internal).

2. Inhibitor Treatment - The inhibitor feed control portion of the system shall be based on blowdown and shall have the following features and accessories:

   a. Test Switch.
   b. HOA switch for chemical pump.
   c. Illuminated Legend: "Feed", when pump is activated.
   d. Solid State Lock-out Timer (adjustable 1/4 to 3 hours) and indicator light. Lock-out timer shall deactivate the pump and activate the alarm circuits described in TDS control section.

3. Biocide Programmer - The biocide programmer portion of the system shall have the following features:

   a. 24 Hour Timer with 14-Day Skip feature to permit the activation any hour of the day.
   b. Precision Solid State bleed lock-out timer (0-9 hrs.) and (0-2 1/4 hrs.) biocide pump timer, clock controlled.
   c. Solid State alternator to enable the use of two different formulations.
   d. Digital Display of the time of day (24 hours).
   e. LED display of day of week - 14 days.
   f. Fast and slow clock set controls (internal).
   g. Battery back-up on timekeeping, so clock is not disturbed by power outages. Quartz timekeeping accuracy.
   h. HOA switch for Biocide pump.

D. Provide two chemical feed pumps of suitable materials of construction that shall have adequate capacity to handle chemical inhibitors of variable pH. Pump shall be positive displacement, diaphragm type, with adjustable volume from 0-100% of capacity while in operation. Pump shall have a discharge relief valve for ease of priming. Maximum capacity shall be 24 gallons per day against 100 PSI to feed the chemical inhibitor directly from the shipping drum. Pump shall be 115/1/60 volts.

E. Provide a 1” motorized ball valve for mounting on solids separator for blowdown.

F. System shall include 3/4" PVC Flow Switch adaptable to sample stream piping manifold.

G. System shall include 3/4" PVC sample stream piping manifold system with three chemical injection tees, check valve, sample cock, shut-off valves, flow switch and probe fitting.

H. Provide spill containment basin under chemical treatment stand. Size basin to include pumps, chemical drums, and mounting stand. Construct basin of polyethylene, polypropylene, FRP, concrete, or other approved material. Secure basin and stand as required by Section 230548 – Mechanical Seismic Control.

2.5 OPEN SYSTEM WATER TREATMENT CHEMICALS

A. Provide an organic phosphonate based scale inhibitor containing molybdate and zinc based corrosion inhibitors and sludge dispersants. The treatment shall be in liquid form and be suitable for feeding into the system directly from the shipping container. This chemical treatment must not contain chromate or phosphate.

B. Provide algaecides of two different types of formulations to be used on an alternating basis and to be effective against all normally encountered algae and slime growths. Algaecides must be isolthizolone or gluteraldehyde.

C. Chemicals used in direct evaporative cooling media sumps shall be approved for use in the supply air stream by OSHA and EPA.

2.6 WATER TREATMENT CONTROL TESTING EQUIPMENT

A. Provide testing chemicals to properly analyze the condenser water for organic phosphonate and closed system water for nitrite. Furnish the necessary test kits for these tests.

B. Provide a Myron L "DS" meter, single range, 0-5000 MICROMHOS/CM auto-temp compensation 50-160 deg.F, 9-volt transistor batteries, and built in cell cup.

C. Furnish a supply of log sheets on which to record the test results and bound copy of full test instructions.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Coordinate where installation of equipment in piping systems is required with the Section 232113 - HVAC Piping Contractor and Electrical requirements per Section 230529 - Basic Mechanical Materials and Methods and provide installation instructions to those firms providing installation.

3.2 CLEANING OF PIPING SYSTEMS

A. Thoroughly clean the HVAC water piping systems after hydrostatic tests have been completed and prior to the operating tests with liquid alkaline dispersant cleaner per instructions specified in Part 2 dictating the quantities of the cleaner to use, methods, and duration of the operation. Systems shall then be drained and thoroughly flushed out with fresh water. Thoroughly clean the steam and condensate piping system and equipment.

B. Contractor shall notify Architect/Engineer prior to cleaning operation, and shall verify in writing to the Architect/Engineer after the system has been cleaned.

C. Failure of any part of the system due to improper cleaning or inadequate chemical feed shall be the responsibility of the Division 23 Contractor.

D. In addition to the condenser water system and new heating water piping, the Division 232113 Contractor is required to clean and flush the entire chilled water system, both new and existing piping. The contractor shall thoroughly flush the entire system and clean all new and existing chilled water strainers in the building so they are free of debris when the system is handed over to WSU.

E. Division 232113 contractor is required to provide bypass piping in heating water system so only new piping is cleaned and flushed. Provide a circulating pump as necessary during the circulating phase of the clean and flush process.

3.3 SYSTEM START-UP

A. The Water Treatment Supplier shall put the treatment equipment into operation, and make adjustments necessary for proper operation.

B. The Water Treatment Supplier shall provide a written report to the Division 23 Contractor indicating that the start-up has been completed and that all equipment is operating properly.

3.4 OPERATOR TRAINING AND SERVICE

A. The Water Treatment Supplier shall instruct the Owner's operating personnel so as to familiarize them with all treatment equipment and procedures per Maintenance Service specified in Part 1 of this Section. Minimum of 2 hours/system type.

B. The Water Treatment Supplier shall obtain a signed receipt from the Owner's operating personnel to confirm that adequate training has been received to operate the systems properly.

END OF SECTION 232500

SECTION 233300 - DUCTWORK AND ACCESSORIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Low pressure ductwork.

B. Damper operator hardware.

C. Volume control dampers.

D. Gravity backdraft dampers.

E. Flexible duct fan connections.

F. Access door hardware.

G. Duct access doors.

1.2 RELATED REQUIREMENTS

A. The General Conditions, Supplementary Conditions and Division 1, General Requirements apply to this Section, and Contractor shall review and adhere to all requirements of these documents.

B. Section 230500 - Basic Mechanical Requirements.

1.3 RELATED SECTIONS

A. Section 230529 - Basic Mechanical Material and Methods.

B. Section 230540 - Mechanical, Sound and Vibration Control.

C. Section 230700 - Mechanical Insulation.

D. Section 230900 - Electronic Controls.

E. Section 230593 - Testing, Adjusting and Balancing.

1.4 REFERENCES AND CODE REQUIREMENTS

A. ASHRAE - Handbook 2009 Fundamentals; Chapter 21 - Duct Design.

B. ASHRAE - Handbook 2008 HVAC Systems and Equipment; Chapter 18 - Duct Construction.

C. ASTM A90 - Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles.

D. ASTM A167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.

E. ASTM A525 - General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.

F. ASTM A527 - Steel Sheet, Zinc-Coated (Galvanized) by Hot-Dip Process, Lock Forming Quality.

G. ASTM B209 - Aluminum and Aluminum Alloy Sheet and Plate.

H. ASTM C14 - Concrete Sewer, Storm Drain, and Culvert Pipe.

I. ASTM C443 - Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.

J. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.

K. NFPA 90B - Installation of Warm Air Heating and Air Conditioning Systems.
NFPA 92A - Smoke Control Systems.
NFPA 92B - Smoke Management Systems.

L. NFPA 96 - Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment.

M. SMACNA - HVAC Duct Construction Standards.

N. SMACNA - HVAC Air Duct Leakage Test Manual

O. SMACNA - Fibrous Glass Duct Construction Standards.

P. UL 33 - Heat Responsive Links for Fire-Protection Service.

Q. UL 181 - Factory-Made Air Ducts and Connectors.

R. UL 555 - Fire Dampers and Ceiling Dampers.
UL 555S - Leakage Rated Dampers for Smoke Control Systems.

1.5 DEFINITIONS

A. Duct Sizes: Inside clear dimensions. For lined ducts, maintain sizes inside lining.

B. Low Pressure: Design and Construct to SMACNA 2 in. w.g. pressure class. Low pressure duct shall include: Supply duct downstream of VAV boxes, return duct, general/toilet exhaust ducts, fresh air duct, relief duct, smoke exhaust duct and combustion air duct, unless otherwise indicated on drawings.

1.6 REGULATORY REQUIREMENTS

A. Construct ductwork to NFPA 90A standards.

1.7 SUBMITTALS

A. Submit Product Data for the following items under provision of The General Conditions of the Contract:

1. Backdraft dampers.

1.8 PROJECT CONDITIONS

A. Contractor shall not fabricate or install any ductwork until he has assured himself that the ductwork can be run as contemplated in cooperation with Contractors of other Divisions of the Work and the physical constraints of the Structural and Architectural Work.

B. Contractor shall prepare 1/4" = 1'-0" scale shop drawings of all ductwork and plenums within confines of chiller rooms for coordination with other trades and the Architectural and structural work.

C. Provide any and all off-sets and fittings required to coordinate with field conditions. The lack of coordination will not constitute a change in contract price. The contract drawings are of a schematic nature only, exact duct routing and field coordination is the responsibility of the Division 233300 Contractor.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Steel Ducts: ASTM A525 and ASTM A527 galvanized steel sheet, lock-forming quality, having G90 zinc coating each side in conformance with ASTM A90.

B. Fasteners: Rivets, bolts, or sheet metal screws.

C. Sealant: Non-hardening, water resistant, fire resistive, compatible with mating materials; liquid used alone or with tape, or heavy mastic.

D. Hanger Rod: Steel, galvanized; threaded both ends, threaded one end, or all thread.

2.2 LOW PRESSURE DUCTWORK

A. Fabricate and support in accordance with SMACNA HVAC Duct Construction Standards and ASHRAE handbooks, except as indicated. Provide duct material, gauges, reinforcing, and sealing for operating pressures specified or as indicated on drawings.

B. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows are used, provide turning vanes. Where acoustical lining is indicated, provide turning vanes of perforated metal with glass fiber insulation.

C. Construct fittings with 45 degree wye or 90 degree wye with 45 degree entry.

D. Round take-offs shall be plain spin collar fittings of 90 degrees unless indicated otherwise on drawings.

E. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible. Divergence upstream of equipment shall not exceed 30 degrees; convergence downstream shall not exceed 45 degrees.

F. Provide easements where low pressure ductwork conflicts with piping and structure. Where easements exceed 10 percent duct area, split into two ducts maintaining original duct area.

G. Use crimp joints with or without bead for joining round duct sizes <8> <_> inch and smaller with crimp in direction of airflow.

2.3 DAMPER OPERATOR HARDWARE

A. Manufacturers: Ventfabrics Ventlok Regulators, Metropolitan Air.

B. Other acceptable manufacturers offering equivalent product: Duro Dyne, Daniel.

C. Regulators and End Bearings.

Damper shaft length:
12" or less - Ventlok #620 Regulator.
12" to 20" - Ventlok #635 Regulator and #607 Bearings.
Larger dampers - Ventlok #640 or #641 Regulator and #607 Bearings.

D. Provide equivalent model elevated bases for insulated ducts.

E. Provide remote damper control where any damper does not have permanent access. System to include a locking worm drive gear, ¼” flexible steel shaft and a concealed ceiling cap of 1”. Acceptable manufacturers: Young Regulator or submitted equal.

2.4 VOLUME CONTROL DAMPERS

A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards, and as indicated.

B. Fabricate single blade dampers for duct sizes to 9-1/2 x 30 inch.

C. Fabricate multi-blade damper of opposed blade pattern with maximum blade sizes 6 x 72 inch. Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.

D. Except in round ductwork 12 inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon or sintered bronze bearings.

E. Provide locking, indicating quadrant regulators on single and multi-blade dampers.

F. On insulated ducts, mount quadrant regulators on stand-off mounting brackets, bases, or adapters.

2.5 GRAVITY BACKDRAFT DAMPERS (LOW VELOCITY COUNTERBALANCE TYPE) (< 2.0” w.c.)

A. Acceptable Manufacturers: Air Balance, American Warming, Arrow United (Type 655), Louvers and Dampers Inc., Prefco, Ruskin (CBD4 or CBD6), C.E. Sparrow, Airstream, Greenheck, Pottorff.

B. Gravity backdraft dampers, size 18 x 18 inches or smaller, furnished with air moving equipment, may be air moving equipment manufacturers standard construction.

C. Fabricate multi-blade, parallel action gravity balanced backdraft dampers of 16 gauge galvanized steel or extruded aluminum, with center pivoted blades of maximum 6 inch width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, steel ball bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.

2.6 FLEXIBLE DUCT FAN CONNECTIONS

A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards, and as indicated.

B. Indoor: UL listed fire-resistant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 30 oz. per sq. yd., minimum 4-inch wide, crimped into metal edging strip.

2.7 ACCESS DOOR HARDWARE

A. Manufacturer: Ventfabrics Ventlok Series

B. Other acceptable manufacturers offering equivalent product: Duro Dyne.

C. Latches, hinges and gasketing:

Doors less than 4 square feet - Series 100.
Doors 4 to 8 square feet - Series 200.
Larger doors and in medium pressure systems - Series 300.

2.8 DUCT ACCESS DOORS

A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards as indicated.

B. Review locations prior to fabrication.

C. Fabricate rigid and close-fitting doors of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ductwork, install minimum one inch thick insulation with sheet metal cover.

D. Access doors smaller than 12 inches square may be secured with sash locks.

E. Provide two hinges and two sash locks for sizes up to 18 inches square, three hinges and two compression latches with outside and inside handles for sizes up to 24 x 48 inches. Provide an additional hinge for larger sizes.

F. Access doors with sheet metal screw fasteners are not acceptable.

PART 3 - EXECUTION

3.1 GENERAL SHEET METAL INSTALLATION

A. Duct sizes fall within the limiting dimensions indicated on the Drawings. Provide sheet metal duct systems, connections, dampers, duct turns, housings, hinged sheet metal doors and necessary removable access doors for the complete supply, return, and exhaust systems. Install accessories in accordance with manufacturer's instructions.

B. Seal low pressure ductwork per IECC and SMACNA HVAC Air Duct Leakage Test Manual to Seal Class A. This includes all joints, seams and wall penetrations.

C. Wherever exposed ducts pass through walls, floors, or ceilings, a 2-inch flanged sheet-metal collar fitting close around ducts to be slipped along duct until flange is tight against finished surface covering edges of openings and presenting a neat appearance. Lock collar to duct.

D. Wherever ducts penetrate floors or fire walls, install safing insulation to maintain fire wall integrity.

E. Cut or drill temporary test holes in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps. Permanent test holes shall be factory fabricated, airtight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

F. Provide openings in ductwork where required to accommodate thermometers and controllers.

G. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

H. Where Bellmouth fittings are specifically called for on Drawings, provide standard Bellmouth fittings per SMACNA Standards.

I. Wherever dampers are concealed under insulation, provide marker ribbon for identification. Hang ribbon below adjacent ductwork to allow view from any angle.

3.2 SEALING OF DUCTWORK

A. Seal all ductwork to Seal Class A per SMACNA HVAC Duct Construction Standards and the most current edition of the International Energy Conservation Code (IECC). Additional sealing of ductwork will be required if audible air leaks are observed by the Engineer. Where joints are not accessible for proper sealing, cut hand holes in duct and seal the joints from the inside.

3.3 DUCTWORK APPLICATION SCHEDULE

A.

AIR SYSTEM	MATERIAL
Chiller Room Exhaust	Galv. Steel, Aluminum

3.4 DAMPER OPERATOR HARDWARE

A. Install per manufacturer’s instructions and recommendations. Coordinate any celing control locations prior to installation.

B. Coordinate length of flexible shaft on site.

3.5 VOLUME CONTROL DAMPERS

A. Provide balancing dampers at points on low pressure supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing.

3.6 GRAVITY BACKDRAFT DAMPERS (LOW PRESSURE SYSTEMS)

A. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside of building and where indicated.

3.7 FLEXIBLE DUCT FAN CONNECTIONS

A. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment.

B. At least 1-inch slack shall be allowed in these connections to insure that no vibration is transmitted from fan to duct work. The fabric shall either be folded in with the metal or attached with metal collar frames at each end to prevent air leakage.

3.8 DUCT ACCESS DOORS

A. Provide duct access doors for inspection, maintenance and cleaning at all automatic dampers, flow station, humidifiers, fire and smoke dampers <and duct turning vanes> and before and after all booster coils.

B. Provide maximum 8 x 8 inch size for hand access, 24 x 24 inch size for shoulder access and as indicated.

C. Provide observation windows to see all automatic modulating dampers.

END OF SECTION 233300

SECTION 233400 - AIR HANDLING FANS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Cabinet Fans
B. In-Line Centrifugal Fans

1.2 RELATED WORK

A. The General Conditions, Supplementary Conditions and Division 1, General Requirements apply to this section and Contractor shall review and adhere to all requirements of these documents.

1. Section 230500 - Basic Mechanical Requirements.
2. Section 230529 - Basic Mechanical Materials and Methods.
3. Section 230540 - Mechanical Sound and Vibration Control.
4. Section 230548 - Mechanical Seismic Control.
5. Section 230593 - Testing, Adjusting and Balancing.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of specified fans with characteristics, sizes, and capacities required, whose specified fan has been in satisfactory use in similar service for not less than 3 years.

1.4 SUBMITTALS

A. Submit shop drawings and product data for the following items under provisions of the General Conditions of the Contract:

1. Shop Drawings: Submit assembly-type shop drawings showing unit dimensions, weight loadings, required clearances, construction details, and field connection details for each fan.
2. Product Data: Submit manufacturer's technical product data for all fans showing dimensions, weights, capacities, ratings, fan performance curves with operating point clearly indicated, motor electrical characteristics, gages and finishes of materials. Provide multiple-speed performance curves for fans with variable speed drives.

B. Submit printed Operating Instructions and Maintenance Data for the following items under provisions of Operating and Maintenance Data paragraph in Section 230500:

1. All fans.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver fans with factory-installed shipping skids and lifting lugs; pack components in factory-fabricated protective containers.

B. Handle fans carefully to avoid damage to components, enclosures, and finish. Do not install damaged components; replace and return damaged components to fan manufacturer.

C. Store fans in clean dry place and protect from weather and construction traffic.

D. Comply with Manufacturer's rigging and installation instructions for unloading fans and moving them to final location.

1.6 EXTRA STOCK

A. Provide one spare set of belts for each belt-driven fan.

PART 2 - PRODUCTS

2.1 CABINET FANS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide cabinet fan of one of the following: Loren Cook, Greenheck, Twin City, Trane, New York Blower, ACME, Peerless, Barry, Penn, Soler and Palau.

B. Furnish and install cabinet fans of size and capacity shown on drawings.

C. Cabinet shall be constructed of steel with removable panels for access to all internal parts.

D. Fan shall be double width, double inlet multi-blade centrifugal type with V-belt drive and adjustable speed sheave, or direct drive with solid-state speed controller.

E. Fans shall be statically and dynamically balanced and shall run on permanently lubricated bearings.

F. Motor shall be provided per requirements of "Motors" in Section 230529.

2.2 IN-LINE TUBULAR CENTRIFUGAL FANS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide in-line centrifugal fan of one of the following: Twin City, Chicago Blower, New York Blower, Greenheck, ACME, Coolair, Carnes, Loren Cook.

B. Fan shall be in-line tubular centrifugal type having capacity shown on the drawings. Fans shall be constructed according to applicable AMCA standards.

C. Fans shall be belt driven. Drive shall be sized for 150% of the motor horsepower. A belt guard meeting applicable safety codes shall be provided. Three minimum belts shall be provided, oil resistant type. The drive pulley shall be adjustable.

D. 200,000 hour self aligning pillow block bearings with external grease fittings shall support the stainless steel fan shaft.

E. Wheel shall be airfoil type statically and dynamically balanced and key way locked onto the shaft.

F. Housing shall be constructed of tubular steel, fan base and bearing supports shall be structural steel welded. The inlet shall be flanged with an inlet cone. Discharge shall be flanged with straightening vanes. A bolted access door for bearing and wheel inspection shall be provided.

G. Motor shall meet all provisions of Section 230529 "Motors". An acoustically insulated drive and motor cover shall be provided. The cover shall have ventilation openings.

H. Motor base shall have adjustable slide rails, and thrust restraints.

PART 3 – EXECUTION

3.1 INSTALLATION OF FANS

A. Install fans where indicated, in accordance with equipment manufacturer's installation instructions, and with recognized industry practices, to ensure that equipment complies with requirements and serves intended purposes.

B. Coordinate with other work, including ductwork, floor construction, and electrical work as necessary to interface installation of air handling equipment with other work.

C. Access: Provide access space around fans for service as indicated, but in no case less than that recommended by manufacturer.

D. Do not operate fans for any other purpose, temporary or permanent, until ductwork is clean, filters in place, bearings lubricated, and fan has been test run under observation.

E. Support: Install floor-mounted fans on 4" high reinforced concrete pad, 6" larger on each side than unit base in accordance with Section 230529.

F. Mounting: Mount fans on vibration isolators, in accordance with manufacturer's instructions and Section 230540.

G. Seismic Restraint: Provide seismic restraints in accordance with Section 230548.

H. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.

1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer with rotation in direction indicated and intended for proper performance. If there is no rotation arrow supplied by the manufacturer, install a correct rotation arrow.

I. Duct Connections: Refer to Division 23 Air Distribution sections. Provide ductwork, accessories, and flexible connections as indicated.

J. Dryer exhaust booster fan airflow must be adjusted to match the dryer fan capacity. Booster fan airflow rate cannot exceed the dryer fan capacity.

3.2 FIELD QUALITY CONTROL

A. Upon completion of installation of air handling equipment, and after motor has been energized with normal power source, test equipment to demonstrate compliance with requirements. Where possible, field correct malfunctioning equipment, then retest to demonstrate compliance. Replace equipment which cannot be satisfactorily corrected.

3.3 EXTRA BELTS

A. Deliver one spare set of belts for each belt-driven fan unit, obtain receipt from Owner that belts have been received.

END OF SECTION 233400

SECTION 236400 - REFRIGERATION

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Centrifugal Water Chillers

B. Cooling Towers (Induced Draft)

C. Installation of cooling tower on supporting steel

D. Solids Separator

1.2 RELATED WORK

A. The General Conditions, Supplementary Conditions and Division 1, General Requirements apply to this section, and Contractor shall review and adhere to all requirements of these documents.

B. Related work specified in other Sections:

Section 230500 - Basic Mechanical Requirements
Section 230529 - Basic Mechanical Materials and Methods
Section 230540 - Mechanical Sound and Vibration Control
Section 230548 - Mechanical Seismic Control
Section 230593 - Testing, Adjusting and Balancing
Section 230700 - Mechanical Insulation
Section 232113 - HVAC Piping & Specialties
Section 232123 - HVAC Pumps
Section 232500 - HVAC Water Treatment

1.3 REFERENCES

A. Reference Standards: Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations of the following:

1. Air Conditioning and Refrigeration Institute (ARI):

Standards for the following:

210/240 - Unitary Air-Conditioning and Air-Source Heat Pump Equipment

# 270 -	Sound Rating of Outdoor Unitary Equipment
# 410-72 -	Plate Fin Type Refrigerant Coils
# 450 -	Water Cooled Condensers
# 460 -	Remote Mechanical-Draft Air Cooled Condensers
# 520 -	Positive Displacement Condensing Units
# 550/590 -	Water Chilling Packages using the Vapor Compression Cycle
# 575 -	Method of Measuring Machinery Sound within an Equipment Space

2. American National Standards Institute (ANSI):

   ANSI B9.1 "Safety Code for Mechanical Refrigeration." (Also known as ANSI/ASHRAE 15).

   ANSI B31.5 "Refrigeration Piping," and extend applicable lower pressure limits to pressures below 15 psig.

1.4 QUALITY ASSURANCE

A. Quality control shall be in accordance with Section 230500 - Basic Mechanical Requirements.

B. The firm installing the refrigeration piping shall have at least 3 years of successful installation experience on projects with refrigeration piping system work similar to that required for this project.

C. Brazing Qualifications: Certify operators, brazing procedures and brazers in accordance with ANSI B31.5 for shop and job-site brazing of refrigerant piping work.

1.5 SUBMITTALS

A. Shop Drawings: Submit Shop Drawings and Product Data for the following items in accordance with the General Conditions of the Contract:

   1. Cooling Towers
   2. Solids Separator

B. Certificates: Before proceeding with refrigerant piping work, submit to the Engineer and Owner two copies of Certification that brazing procedures, brazers and operators will be in accordance with ANSI B31.5.

C. Operating Instructions and Maintenance Data: Submit printed Operating Instructions and Maintenance Data for the following items in accordance with Operating and Maintenance Data paragraph in Section 230500.

   1. Chillers, Accessories and Auxiliaries
   2. Chiller Starters and Variable Speed Drives

3. Cooling Towers
4. Solids Separator

PART 2 - PRODUCTS

2.1 CENTRIFUGAL WATER CHILLER

A. The three chillers for this project have been purchased by WSU, have been delivered from the factory to the campus, and are currently being stored at the existing campus-wide central chilled water plant, ready for this contractor to load them and move them to the Dee Events Center for installation in the existing chiller room. This contractor shall be responsible for all aspects of loading, transporting, unloading, setting, installing, piping, wiring, controlling, setting up, and starting these chillers up to operate as described in these contract documents.

B. A condensed version of the chiller submittals is included at the end of this specification for reference by the contractor.

2.2 COOLING TOWER (INDUCED DRAFT, VERTICAL DISCHARGE, COUNTERFLOW)

A. Acceptable Manufacturer: Baltimore Aircoil, Marley, Evapco.

B. Furnish and install cooling tower of size and capacity shown on Drawings. Capacity rating shall be in accordance with Cooling Tower Institute Standards.

C. Cooling tower shall be constructed with heavy gauge, stainless steel angle and channel framework, with stainless steel casing or with fiberglass reinforced polyester (FRP) panels. Exterior of panels to be furnished with low VOC acrylic latex finish or stainless steel.

D. Louvers shall be PVC integral with the fill sheet, or stainless steel. Louvers shall be factory installed.

E. The cold water basin shall be constructed of heavy gauge, stainless steel, with standard depressed center section with side outlet and drain/cleanout connection and stainless steel strainer.

E. Hot water distribution basins shall be open gravity type constructed of stainless steel. Distribution weirs and plastic metering orifices shall be provided to assure even distribution of water over wet deck surface. Tower shall be furnished with a single inlet water connection to automatically balance and deliver water to distribution basins or with flow control valves.

F. The wet deck surface shall consist of wave-formed sheets of self-extinguishing polyvinyl chloride. It shall be noncombustible per NFPA Standard 220 and impervious to rot, decay, fungus or biological attack.

G. The drift eliminators shall be constructed of polyvinyl chloride.

H. Fan shall be heavy duty cast aluminum with either fixed pitch blades or individually adjustable pitch blades.

I. Fan shall be driven by either a one-piece multi-groove, neoprene/polyester PowerBand designed specifically for cooling tower service or through a right angle gear reducer connected to the drive motor with a non lubricated flexible driveshaft. Gearbox for driveshaft shall be suitable for use at low speeds (fan on VFD) while maintaining adequate lubrication.

J. Fan motor shall be TEAO, VFD compatible, 1800 rpm, reversible, squirrel cage, ball bearing type designed specifically for cooling tower service. Motor shall be furnished with special moisture protection on windings, shafts and bearings.

K. Fan motor shall be located on one side of tower, below the top of the tower. Provide a working platform at the motor on the side of the tower where technicians can stand when working on the motor and fan drive assembly.

L. Access doors shall be provided for access to eliminators and plenum section. A heavy gauge, stainless steel wire fan guard shall be provided over each fan cylinder.

M. All steel components of the tower(s) shall be made from stainless steel.

N. Hot water basin covers shall be furnished to eliminate the accumulation of debris in the hot water distribution basins.

O. Cooling tower shall be complete with the following:

1. Side outlet depressed sump.
2. Safety cage and ladder from slab to fan deck.
3. Air inlet screens.
4. Vibration cutout switch.
5. Extended lube and oil fill lines with sight glass or dipstick
6. Safety railings around motor platform on side of tower.
7. Electric water level control package (120/1/60) with minimum 5 sensor rods and no solenoid make-up water valve. Only provide on one of the two towers for this project.
8. Removable davit to lower fan motor to slab (1 for the project).

2.3 INLINE SOLIDS SEPARATOR

A. Approved Manufacturers: Griswold, Lakos, Puroflux.

B. Furnish and install packaged solids separator system of size and capacity shown on Drawings.

C. Packaged solids separator system to consist of a centrifugal separator, basket strainer, pump, piping, gauges, starter with HOA switch, disconnect, single-point wiring panel, and control panel all mounted on a welded steel skid.

D. Separator shall remove a minimum of 97.8% of entrained solids 45 micron/325 mesh in size and heavier than 1.20 specific gravity per pass. Separator to be constructed of carbon steel with an exterior grade enamel paint. Separator to be capable of effective separation with a pressure drop of 3 psi across the unit. Solids outlet to be located on bottom of unit to allow removal of separated solids to drain.

E. Pump to be centrifugal type, capable of performance indicated on the unit schedule. Pump to be mounted on skid such that pump or motor can be removed without disassembling piping. Provide with an inline basket strainer and UL approved TEFC motor.

F. Electrical components shall be housed in a NEMA 1X enclosure with quick release latch. Enclosure to be complete with a single-point wiring panel. Electrical panel to be complete with motor starter, disconnect, and adjustable overload and short circuit protection.

G. Piping, strainer, and separator to be rated at 150 psi maximum working pressure.

H. Note that the Division 232500 Contractor will furnish a motorized ball valve to be installed on the purge outlet on the bottom of the separator. This valve will be controlled by a signal from the total dissolved solids (TDS) controller provided by the 232500 contractor, with the wire between the TDS controller and motorized ball valve by the Division 230900 Contractor. This valve will open to purge separated solids from the separator. Do not provide a separate purge timer system on the unit.

PART 3 - EXECUTION

3.1 REFRIGERATION EQUIPMENT INSTALLATION

A. General: Comply with manufacturer's recommended installation instructions.

B. Provide sound and vibration isolation in accordance with Section 230540 - Mechanical Sound and Vibration Control.

C. Equipment manufacturer to provide labor to assemble, test, charge, start-up, calibrate, and instruct Owner's personnel in operation and maintenance.

3.2 WATER CHILLER

A. The chillers indicated on the drawings have been purchased by WSU, and are being stored at the existing campus-wide central chilled water plant. This contractor shall move these three chillers from the central chilled water plant to the Dee Events Center, and shall install them where shown on the drawings. While these chillers are Owner furnished, the Division 23 contractor is responsible for loading and transporting the chillers across campus to the Dee Events Center, unloading, setting, and installing the chillers in the Dee Events Center, and piping and wiring (provide services of Division 26 sub-contractor) the chillers so they are fully functional and code compliant. In addition, this contractor is responsible for scheduling factory start-up of these chillers (start-up services already paid for by WSU), providing all start-up assistance required by the factory authorized start-up technicians, and for providing all one-year warranty services for the chillers as outlined in Specification Section 230500 (factory warranty has been purchased by WSU, contractor is responsible for overseeing the warranty, scheduling warranty items with factory, and providing labor in the field, just as if the contractor had purchased the chillers). For all intents and purposes, the contractor is responsible for all aspects of these chillers just as if the contractor had paid for them.

B. The chiller includes a separate harmonics filter that serves the integral variable frequency drive on the chiller. This contractor shall install the harmonics filter where shown on the drawings, and coordinate wiring with the Division 26 sub-contractor.

C. Comply with manufacturer's recommended installation instructions and jurisdictional codes. Provide all labor, materials, equipment and services to perform all operations required for the complete installation and related work as required in the Contract Documents.

C. Installation and equipment shall be in compliance with Mechanical Refrigeration Safety Code, ANSI B9.1, latest edition.

D. Coordinate the main power and starter installation and control wiring with the Division 26 Contractor per the wiring diagrams and instructions furnished by the chiller manufacturer in accordance with "Electric Wiring" paragraph in Section 230529.

E. These chillers are equipped with internal water flow sensors that are integrated into the factory chiller controls so chiller will not operate unless water flows are proven. Stand-alone flow switches are not required.

F. Contractor shall make connections to any water supply, drain, and vent connections as are required by Drawings and Jurisdictional Codes.

G. Contractor shall furnish and install refrigerant vent line to outdoors as shown on drawings.

H. Mount chiller on vibration isolators that were provided by the factory with the chillers.

I. WSU has paid for the services of a factory trained mechanic employed by the chiller manufacturer to; leak test, refrigerant pressure test, evacuate, dehydrate, charge, start and

calibrate controls. Contractor is responsible for scheduling services of the factory authorized mechanic and providing all assistance required by this mechanic, the same as if the contractor had purchased the chiller. Verify all strainers have been visually inspected and cleaned before start-up. Start-up supervision only, of contractor personnel, will not be acceptable.

J. After the above services have been performed, the same factory trained representative shall be available for a sufficient length of time, but not less than three working days to instruct the owner's personnel in the proper operation and maintenance of the chiller.

3.3 COOLING TOWER

A. Comply with manufacturer's instructions for installation.

B. Install cooling tower on supporting steel as described on sheet M501.

C. Mount and level cooling tower on steel support beams and seismically restrain.

D. Verify fan rotation direction.

a. Balance condenser water flow to each tower and to each inlet.

b. Pipe main and overflow to floor drain or other approved receptor.

END OF SECTION 236400

SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL

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. Electrical equipment coordination and installation.
2. Sleeves for raceways and cables.
3. Sleeve seals.
4. Raceways.
5. Grout.
6. Common electrical installation requirements.
7. Concrete equipment bases.
8. Building wire and connectors.
9. Supporting devices for electrical components.
10. Electrical identification.
11. Electricity-metering components.
12. Cutting and patching for electrical construction.
13. Touchup painting.
14. Workmanship.
15. Coordination drawings.
16. Rough-ins.
17. Electrical installations.
18. Cutting and patching.
19. Submittals.
20. Record documents.
21. Maintenance manuals.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

C. PVC: Polyvinyl chloride.

D. OSHA: Occupational Safety and Health Administration.

E. NFPA: National Fire Protection Association.

F. EPA: Environmental Protection Agency

G. KW: Kilowatts.

H. NECA: National Electrical Contractor Association

I. EMT: Electrical metallic tubing.

J. FMC: Flexible metal conduit.

K. IMC: Intermediate metal conduit.

L. LFMC: Liquidtight flexible metal conduit.

M. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

A. Product Data: For sleeve seals.

B. Product Data: Follow the procedure specified in Division 1 Section “Submittals”.

C. Shop Drawings: Dimensioned plans and sections or elevation layouts of electrical-metering equipment.

D. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

E. Additional copies may be required by individual sections of these Specifications.

F. Prepare coordination drawings in accordance with Division 1 Section “Project Coordination”, to a scale of ¼”=1’-0”, or larger; detailing major elements, components, and systems of electrical equipment and materials in relationship with other systems, installation, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the work.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping and conduit installed at required slope.
4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

5. Clearance for servicing equipment, including space for equipment disassembly required for periodic maintenance.
6. Exterior wall and foundation penetrations.
7. Fire rated wall and floor penetrations.
8. Equipment connections and support details.
9. Sizes and location of required concrete pad and bases.

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

C. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.

D. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.

E. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in the building.

F. Where electrical identification devices are applied to field-finished surfaces, coordinate installation of identification devices with completion of finished surface.

G. Where electrical identification markings and devices will be concealed by acoustical ceilings and similar finishes, coordinate installation of these items before ceiling installation.

H. Verify voltage, phase and amps of all equipment, prior to rough-in phase of project.

I. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

J. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping".

K. Indicate the proposed locations of the major raceway systems, equipment and materials. Including the following:
1. Clearance for servicing equipment, including space for equipment disassembly required for periodic maintenance.
2. Exterior wall and foundation penetrations.
3. Fire rated wall and floor penetrations.
4. Equipment connections and support details.
5. Sizes and location of required concrete pad and bases.

1.7 WORKMANSHIP

A. All materials and equipment shall be installed in accordance with the recommendations of the manufacturer to conform to the contract documents. The installation shall be accomplished by workmen skilled in the type of work involved.

B. The Electrical Contractor shall have a licensed or certified Master Electrician assigned to direct the electrical work and to coordinate work with the General Contractor and other trades. Furthermore, a licensed or certified journeyman electrician shall be assigned to supervise the

actual performance of all electrical work under Division 26. All installers must be certified journeyman.

1. All workmen doing electrical work of any nature must at all times carry their electrician's license with them and show it upon request.

2. The licensed or certified journeyman assigned to supervise the performance of Division 26 electrical work, shall be required to be on the job site at all times, while Division 26 work is being performed.

C. The installation shall conform to the applicable rules of the National Electrical Code and National Electrical Safety Code except where more stringent requirements are noted in these specifications. Conflicts shall be brought to the attention of the Architect/Engineer.

D. The Contractor and Sub-contractors shall comply with OSHA and EPA Standards while in the performance of this contract.

1.8 SUBSTITUTIONS

A. The equipment specified carries brand names and catalog numbers and shall be interpreted as establishing a standard of quality. Use only specified items or those listed by addenda.

B. Any conflict arising from the use of substituted equipment shall be the responsibility of the supplier, who shall bear all costs required to make the equipment comply with the intent of the plans and specifications.

C. At the option of the Architect/Engineer, samples may be required for non-standard items before installation during construction.

D. No materials or apparatus shall be substituted after the bid opening except where the equipment manufacturer has been discontinued or delivery becomes a problem, then written approval of the Architect/Engineer is required.

1.9 RECORD DOCUMENTS

A. Prepare record documents in accordance with the requirements in Division 1 Section "PROJECT CLOSEOUT." In addition to the requirements specified in Division 1, indicate installed conditions for:

1. Major raceway systems, size, and location, for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; and fuse and circuit breaker size and arrangements.

2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.

PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

A. PVC Pipe Sleeves: Schedule 40, PVC, plain ends.

B. Sleeves for Rectangular Openings: Galvanized sheet steel.

1. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches, thickness shall be 0.052 inch.

2.2 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Metraflex Co.
d. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: As required to match the specified roof material interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.

2.3 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

B. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

C. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

D. Right of Way: Give to piping systems installed at a required slope.

E. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.

3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Electrical penetrations occur when raceways, cables, wireways, cable trays, penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors 2 inches above finished floor level.

G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry

1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants.".

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.3 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated, but not less than 4 inches larger, in both directions, than supported unit. Follow supported equipment manufacturer's anchorage recommendations and setting templates for anchor-bolt and tie locations, unless otherwise indicated. Use 4000-psi, 28-day compressive-strength concrete and reinforcement.

3.5 FIRESTOPPING

A. Apply firestopping to penetrations of cable tray, fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.6 DEMOLITION

A. Protect existing electrical equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality at no cost to the owner.

B. Accessible Work: Remove exposed electrical equipment and installations, indicated to be demolished, in their entirety.

C. Abandoned Work: Cut and remove buried raceway and wiring, indicated to be abandoned in place, 2 inches below the surface of adjacent construction. Cap raceways and patch surface to match existing finish.

D. Remove demolished material from Project site.

E. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.

F. Contractor shall remove lamps and ballasts from the existing light fixtures and dispose them in the owner furnished containers.

3.7 CUTTING AND PATCHING

A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.

B. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

C. Repair conduit and system that have been disturbed or broken, see 3.6B.

3.8 FIELD QUALITY CONTROL

A. Inspect installed components for damage and faulty work, including the following:
   1. Raceways.
   2. Building wire and connectors.
   3. Supporting devices for electrical components.

4. Electrical identification.
5. Electricity-metering components.
6. Concrete bases.
7. Electrical demolition.
8. Cutting and patching for electrical construction.
9. Touchup painting.

B. Test Owner's electricity-metering installation for proper operation, accuracy, and usability of output data.
1. Connect a load of known kW rating, 1.5 kW minimum, to a circuit supplied by the metered feeder.
2. Turn off circuits supplied by the metered feeder and secure them in the "off" condition.
3. Run the test load continuously for eight hours, minimum, or longer to obtain a measurable meter indication. Use a test load placement and setting that ensure continuous, safe operation.
4. Check and record meter reading at end of test period and compare with actual electricity used based on test load rating, duration of test, and sample measurements of supply voltage at the test load connection. Record test results.
5. Repair or replace malfunctioning metering equipment or correct test setup; then retest. Repeat for each meter in installation until proper operation of entire system is verified.

3.9 REFINISHING AND TOUCHUP PAINTING

A. Refinish and touch up paint. Paint materials and application requirements are specified in Division 9 Section "Painting."

3.10 CLEANING AND PROTECTION

A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.

B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

END OF SECTION 260500

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

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. This Section includes the following:

1. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.
3. Sleeves and sleeve seals for cables.

B. Related Sections include the following:

1. Division 26 Section "Medium-Voltage Cables" for single-conductor and multiconductor cables, cable splices, and terminations for electrical distribution systems with 2001 to 35,000 V.
2. Division 26 Section “Electrical System Testing” for testing of all conductor and cables installations.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

C. NFPA: National Fire Prevention Association

D. ASTM: American Society for Testing and Materials

E. NEMA: National electrical Manufacturers Association

F. NETA: National Educational Telecommunications Association

1.4 SUBMITTALS

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

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

1.6 COORDINATION

A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American Insulated Wire Corp.; a Leviton Company.
2. General Cable Corporation.
3. Senator Wire & Cable Company.
4. Southwire Company.

B. Refer to Part 3 “Conductor Insulation and Multiconductor Cable Applications and Wiring Methods” Article for insulation type, cable construction and ratings.

C. Copper Conductors: Comply with NEMA WC 70.

D. Conductor Material: Copper complying with NEMA WC 5 stranded conductor. Aluminum conductors are allowed on this project.

E. Conductor Insulation Types: Type THHN-THWN complying with NEMA WC 5.

F. Minimum Conductor Size (power conductors): #12 AWG

G. MC-Cable or Romex cables shall not be used in this project.

2.2 CONNECTORS AND SPLICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AFC Cable Systems, Inc.
2. Hubbell Power Systems, Inc.
3. O-Z/Gedney; EGS Electrical Group LLC.
4. 3M; Electrical Products Division.
5. Tyco Electronics Corp.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

C. Refer to Part 3 "Conductor and Insulation Applications" Article for insulation type, cable construction, and ratings.

D. Conductor Material: Copper complying with NEMA WC 5 stranded conductor. Aluminum conductors are not allowed on this project.

E. Conductor Insulation Types: Type THHN-THWN complying with NEMA WC 5.

F. Minimum Conductor Size (power conductors): #12 AWG.

2.3 SLEEVES FOR CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.138-inch thickness as indicated and of length to suit application.

C. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

2.4 SLEEVE SEALS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Metraflex Co.
4. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.

1. Sealing Elements: As required for the specified materials interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
2. Pressure Plates: Carbon steel. Include two for each sealing element.
3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

C. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.

1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
2. Pressure Plates: Carbon steel. Include two for each sealing element.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper. Stranded for all conductor sizes, unless otherwise indicated.

B. Branch Circuits: Copper. Provide solid conductors for power and lighting circuits no. 10 AWG and smaller. Provide stranded conductors for sizes no. 8 AWG and larger. All control conductors shall be THHN/THWN stranded in raceway. Motor loads shall be stranded copper..

C. Aluminum conductors are not allowed on this project.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN-THWN, single conductors in raceway .

B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN-THWN, single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

E. Feeders Installed below Raised Flooring: Type THHN-THWN, single conductors in raceway.

F. Exposed Branch Circuits, Including in Crawlspaces: Type THHN-THWN, single conductors in raceway.

G. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.

H. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

I. Branch Circuits Installed below Raised Flooring: Type THHN-THWN, single conductors in raceway.

J. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

K. Fire Alarm Circuits: Type THHN-THWN, in single raceway, unless specified otherwise in Section 28, ”Digital, Addressable Fire Alarm System”.

L. Class 1 Control Circuits: Type THHN-THWN, in raceway.

M. Class 2 Control Circuits: Type THHN-THWN, in raceway.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

E. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."

F. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

G. Seal around cables penetrating fire-rated elements according to Division 7 Section "Through-Penetration Firestop Systems."

H. Clean conduits with a 95% mandrel, prior to installation of conductors.

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches of slack.

3.5 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Rectangular Sleeve Minimum Metal Thickness:

1. For sleeve rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 0.052 inch.

E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

F. Cut sleeves to length for mounting flush with both wall surfaces. (Public Areas)

G. Extend sleeves installed in floors 2 inches above finished floor level. (Utility Areas)

H. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.

I. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and cable, using joint sealant appropriate for size, depth, and location of joint according to Division 07 Section "Joint Sealants."

K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at cable penetrations. Install sleeves and seal with firestop materials according to Division 07 Section "Penetration Firestopping."

L. Roof-Penetration Sleeves: Seal penetration of individual cables with flexible boot-type flashing units applied in coordination with roofing work.

M. Aboveground Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeves to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

N. Underground Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between cable and sleeve for installing mechanical sleeve seals.

3.6 SLEEVE-SEAL INSTALLATION

A. Install to seal underground exterior-wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for cable material and size. Position cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07 Section "Penetration Firestopping."

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors, and conductors feeding the following critical equipment and services for compliance with requirements.

2. Prior to energizing, check installed wires and cables with megaohm meter to determine insulation resistance levels to assure requirements are fulfilled.

3. Provide written documents for all Megger testing.

4. Prior to energizing, test wires and cables for electrical continuity and for short-circuits.

5. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

C. Remove and replace malfunctioning units and retest as specified above.

D. Refer to "Commissioning Specification" sections for project commissioning requirements.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING 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. This Section includes methods and materials for grounding systems and equipment., plus the following special applications:
   1. Underground distribution grounding.

B. Related Sections include the following:
   1. Division 2 Section "Underground Ducts and Utility Structures" for ground test wells.

1.3 SUBMITTALS

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

B. Other Informational Submittals: Plans showing dimensioned locations of proposed grounding features specified in Part 3 "Field Quality Control" Article, including the following:
   1. Ground rods.
   2. Grounding arrangements and connections for separately derived systems.

C. Qualification Data: For testing agency and testing agency's field supervisor.

1.4 QUALITY ASSURANCE

A. Comply with UL 467 for grounding and bonding materials and equipment.

B. Comply with NFPA 70; for medium-voltage underground construction, comply with IEEE C2.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   1. Grounding Conductors, Cables, Connectors, and Rods:
      a. Chance/Hubbell.
      b. Copperweld Corp.
      c. Erico Inc.; Electrical Products Group.
      d. Framatome Connectors/Burndy Electrical.

e. Harger Lightning Protection, Inc.
f. Heary Brothers Lightning Protection Co.
g. Kearney/Cooper Power Systems.
h. Korns: C. C. Korns Co.; Division of Robroy Industries.
i. Lyncole XIT Grounding.
j. O-Z/Gedney Co.; a business of the EGS Electrical Group.
k. Raco, Inc.; Division of Hubbell.
l. Thomas & Betts, Electrical.

2.2 CONDUCTORS

A. Insulated Conductors: Copper or tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:
1. Stranded Conductors: ASTM B 8.
2. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
3. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
4. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
5. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

C. Grounding Bus:
1. Rectangular bars of annealed copper, 1/4 by 2 inches by 14 inches in cross section, unless otherwise indicated; with insulators.

2.3 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

1. Non Reversible Crimps

B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions required at the grounding rods.

2.4 GROUNDING ELECTRODES

A. Ground Rods: stainless steel; 3/4 inch by 10 feet in diameter.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Stranded for all conductor sizes, unless otherwise indicated.

B. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.

C. In raceways, use insulated equipment grounding conductors.

D. Exothermic-Welded Connections: Use for underground connections, except those at test wells.

E. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.

F. Grounding Bus: Install in all electrical and all telephone equipment rooms, in rooms housing service equipment, under all raised floors and elsewhere as indicated.
   1. Use insulated spacer; space 1 inch from wall and support from wall 6 inches above finished floor, unless otherwise indicated.
   2. At doors, route the bus up to the top of the doorframe, across the top of the doorway, and down to the specified height above the floor.

G. Underground Grounding Conductors: Use tinned- copper conductor, No. #2 AWG Bare CU minimum. Bury at least 24 inches below grade or bury 12 inches above duct bank when installed as part of the duct bank.

H. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 3/0 AWG minimum or as shown on the plans.

   1. Bury at least 24 inches below grade.

I. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

   1. Install bus on insulated spacers 1 inch, minimum, from wall 6 inches above finished floor, unless otherwise indicated.

J. Conductor Terminations and Connections:

   1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
   2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
   3. Connections to Structural Steel: Non Reversible Crimp.

3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Coordinate with Drawings and with Division 26 Section "Underground Ducts and Raceways for Electrical Systems.".

C. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.

D. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to

manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.

E. Pad-Mounted Transformers and Switches: Install two ground rods around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches from the foundation.

3.3 EQUIPMENT GROUNDING

A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.

B. Install insulated equipment grounding conductors with all feeders and branch circuits.

C. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.
7. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.

D. Computer Outlet Circuits: Install insulated equipment-grounding conductor in branch-circuit runs from computer-area power panels or power-distribution units.

E. Nonmetallic Raceways: Install an equipment-grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.

F. Air-Duct Equipment Circuits: Install an equipment-grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners and heaters. Bond conductor to each unit and to air duct.

G. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate equipment-grounding conductor to each electric water heater, heat-tracing, and antifrost heating cable. Bond conductor to heater units, piping, connected equipment, and components.

H. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

I. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch grounding bus.
2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

J. Metal Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.4 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Rods:
1. Drive ground rods until tops are 12 inches below finished floor or final grade, unless otherwise indicated.
2. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging copper coating.
3. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
4. For grounding electrode system, install at least two rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
5. Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

D. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

E. Bond each aboveground portion of gas piping system upstream from equipment shutoff valve.

F. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70, using a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG.

1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to grounding electrode external to concrete.

3.5 CONNECTIONS

A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.

D. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

E. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

F. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

G. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.6 UNDERGROUND DISTRIBUTION SYSTEM GROUNDING

A. Duct Banks: Install a grounding conductor with a 50 percent ampacity of the largest phase conductor in the duct bank. (2) #4/0 AWG Bare CU minimum.

B. Manholes and Handholes: Install a driven ground rod close to wall and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide a No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.

C. Connections to Manhole Components: Connect exposed-metal parts, such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.

D. Pad-Mounted Transformers and Switches: Install two ground rods and counterpoise circling pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Use tinned-copper conductor not less than No. 2 AWG for counterpoise and for taps to equipment ground pad. Bury counterpoise not less than 18 inches below grade and 6 inches from the foundation.

3.7 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

2. Prepare dimensioned drawings locating each test well, ground rod and ground rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS 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. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

B. Related Sections include the following:

1. Division 26 Section "Vibration And Seismic Controls For Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Steel slotted support systems.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:

1. Trapeze hangers. Include Product Data for components.
2. Steel slotted channel systems. Include Product Data for components.
3. Nonmetallic slotted channel systems. Include Product Data for components.
4. Equipment supports.

C. Welding certificates.

1.6 QUALITY ASSURANCE

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

B. Comply with NFPA 70.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Allied Tube & Conduit.
b. Cooper B-Line, Inc.; a division of Cooper Industries.
c. ERICO International Corporation.
d. GS Metals Corp.
e. Thomas & Betts Corporation.
f. Unistrut; Tyco International, Ltd.
g. Wesanco, Inc.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
5. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      1) Hilti Inc.
      2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      3) MKT Fastening, LLC.
      4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.

2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
5. Toggle Bolts: All-steel springhead type.
6. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 3/8 inch in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with single-bolt conduit clamps using spring friction action for retention in support channel.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 3/4inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
5. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
6. To Light Steel: Sheet metal screws.
7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

F. Support structure width shall be 24 inches (min), unless specified otherwise.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete."

C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touchup: Comply with requirements in Division 09 painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529

SECTION 260533 - RACEWAY 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. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

B. Related Sections include the following:

1. Division 26 Section "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. ENT: Electrical nonmetallic tubing.

C. EPDM: Ethylene-propylene-diene terpolymer rubber.

D. FMC: Flexible metal conduit.

E. IMC: Intermediate metal conduit.

F. LFMC: Liquidtight flexible metal conduit.

G. LFNC: Liquidtight flexible nonmetallic conduit.

H. NBR: Acrylonitrile-butadiene rubber.

I. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.

1. Custom enclosures and cabinets.
2. For handholes and boxes for underground wiring, including the following:

a. Duct entry provisions, including locations and duct sizes.
b. Frame and cover design.
c. Grounding details.
d. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
e. Joint details.

C. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Structural members in the paths of conduit groups with common supports.
2. HVAC and plumbing items and architectural features in the paths of conduit groups with common supports.

D. Manufacturer Seismic Qualification Certification: Submit certification that enclosures and cabinets and their mounting provisions, including those for internal components, will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

a. The term "withstand" means "the cabinet or enclosure will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will retain its enclosure characteristics, including its interior accessibility, after the seismic event."

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.

E. Qualification Data: For professional engineer and testing agency.

F. Source quality-control test reports.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AFC Cable Systems, Inc.
2. Alflex Inc.

3. Allied Tube & Conduit; a Tyco International Ltd. Co.
4. Anamet Electrical, Inc.; Anaconda Metal Hose.
5. Electri-Flex Co.
6. Manhattan/CDT/Cole-Flex.
7. Maverick Tube Corporation.
8. O-Z Gedney; a unit of General Signal.
9. Wheatland Tube Company.

B. Rigid Steel Conduit: ANSI C80.1.

C. IMC: ANSI C80.6.

D. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.

1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch, minimum.

E. EMT: ANSI C80.3.

F. FMC: Zinc-coated steel.

G. LFMC: Flexible steel conduit with PVC jacket.

H. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
2. Fittings for EMT:
   a. Steel, set-screw type in interior/dry locations.
   b. Utilize steel, compression type in damp or exterior locations.
3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch, with overlapping sleeves protecting threaded joints.

I. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 OPTICAL FIBER/COMMUNICATIONS CABLE RACEWAY AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Arnco Corporation.
2. Endot Industries Inc.
3. IPEX Inc.
4. Lamson & Sessions; Carlon Electrical Products.

B. Description: Comply with UL 2024; flexible type, approved for plenum installation.

2.3 METAL WIREWAYS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper B-Line, Inc.
2. Hoffman.
3. Square D; Schneider Electric.

B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, unless otherwise indicated.

C. Fittings and Accessories: Include 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.

D. Wireway Covers: Screw-cover type or As indicated.

E. Finish: Manufacturer's standard enamel finish.

F. Fittings and Accessories: Include 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.

2.4 SURFACE RACEWAYS

A. Surface Metal Raceways: Galvanized steel with snap-on covers. Manufacturer's standard enamel finish in color selected by Architect/Engineer.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      a. Thomas & Betts Corporation.
      b. Walker Systems, Inc.; Wiremold Company (The).
      c. Wiremold Company (The); Electrical Sales Division.

2.5 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
2. EGS/Appleton Electric.
3. Erickson Electrical Equipment Company.
4. Hoffman.
5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
6. O-Z/Gedney; a unit of General Signal.
7. RACO; a Hubbell Company.
8. Robroy Industries, Inc.; Enclosure Division.
9. Scott Fetzer Co.; Adalet Division.
10. Spring City Electrical Manufacturing Company.
11. Thomas & Betts Corporation.
12. Walker Systems, Inc.; Wiremold Company (The).
13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.

B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

D. Metal Floor Boxes: Cast or sheet metal, fully adjustable, rectangular.

E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

F. Junction Boxes: NEMA FB 1, galvanized, cast iron with gasketed cover.

G. Hinged-Cover Enclosures: NEMA 250, Type 1, 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.

2.6 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. Description: Comply with SCTE 77.

1. Color of Frame and Cover: Gray.
2. Configuration: Units shall be designed for flush burial and have open bottom, unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, "ELECTRIC, “COMMUNICATION,” or as indicated for each service.
6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
7. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

B. Fiberglass Handholes and Boxes with Polymer-Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester-resin enclosure joined to polymer-concrete top ring or frame.

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

a. Armorcast Products Company.
b. Carson Industries LLC.
c. Christy Concrete Products.
d. Synertech Moulded Products, Inc.; a division of Oldcastle Precast.
e. Quazite.

2.7 SLEEVES FOR RACEWAYS

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.138" thickness as indicated and of length to suit application.

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

2.8 SLEEVE SEALS

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

1. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Metraflex Co.
4. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.

1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
2. Pressure Plates: Carbon steel. Include two for each sealing element.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.9 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. 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.
2. 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: Rigid steel conduit or IMC.
2. Concealed Conduit, Aboveground: Rigid steel conduit or IMC.
3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried. Conduit bends over 22 deg. must be rigid steel including exterior lighting feeds.
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.
6. Minimum Raceway Size: 1-inch trade size.
7. Application of Handholes and Boxes for Underground Wiring:

a. Handholes and Pull Boxes in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Fiberglass enclosures with polymer-concrete frame and cover, SCTE 77, Tier 15 structural load rating.
b. Handholes and Pull Boxes in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Heavy-duty fiberglass units with polymer-concrete frame and cover, SCTE 77, Tier 8 structural load rating.
c. Handholes and Pull Boxes Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf vertical loading.

B. Comply with the following indoor applications, unless otherwise indicated:
1. Minimum Raceway Size: 3/4-inch trade size.
2. Exposed, Not Subject to Physical Damage: EMT.
3. Exposed, Not Subject to Severe Physical Damage: EMT.
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: Rigid steel conduit or IMC.
7. Raceways for Optical Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical fiber/communications cable raceway or EMT.
8. Raceways for Optical Fiber or Communications Cable Risers in Vertical Shafts: Riser-type, optical fiber/communications cable raceway or EMT.
9. Raceways for Concealed General Purpose Distribution of Optical Fiber or Communications Cable: Plenum-type, optical fiber/communications cable raceway or EMT.
10. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.
11. Wire Gutters: Minimum size 6” x 6” x 20”

C. 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.

D. Aluminum conduits are not permitted on project.

3.2 INSTALLATION

A. Keep raceways at least 12 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

B. Complete raceway installation before starting conductor installation.

C. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."

D. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

E. Install temporary closures to prevent foreign matter from entering raceways.

F. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.

G. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.

H. Install concealed raceways with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.

I. Install exposed raceways parallel and perpendicular to nearby surfaces or structural members and follow the surface contours as much as practical.

J. Run exposed, parallel, or banked raceways together. Make bends in parallel or banked runs from the same center line so that the bends are parallel. Factory long sweep on medium voltage elbows may be used in banked runs only where they can be installed parallel. This requires raceways be of the same size. In other cases provide field bends for parallel raceways.

K. Install no more than the equivalent of four 90-degree bends in any conduit run except for communications conduits, for which no more than two 90-degree bends are allowed.

L. Conceal conduit and EMT within finished walls, ceilings, and below floors, unless otherwise indicated.

M. 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.

N. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

O. 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.
   1. Telephone and Signal System Raceways, 2-Inch Trade Size and Smaller: In addition to above requirements, install raceways in maximum lengths of 100 feet and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements. Follow the ANSI/TA/EIA-569-B standards. Conduit to end withing 12 inches of cable tray with a bend toward IDF room. Provide throat type or equal type plastic bushing.

P. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment with rigid steel conduit; LFMC may be used 6 inches above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.

Q. Raceways for Optical Fiber and Communications Cable: Install raceways, metallic and nonmetallic, rigid and flexible, as follows:

   1. 1-Inch Trade Size and Smaller: Install raceways in maximum lengths of 50 feet.
   2. 1-Inch Trade Size and Larger: Install raceways in maximum lengths of 75 feet.
   3. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

R. Install raceway sealing fittings at suitable, approved, and accessible locations 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 at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where otherwise required by NFPA 70.

S. Expansion-Joint Fittings for RNC: Install in each run of aboveground conduit that is located where environmental temperature change may exceed 30 deg F, and that has straight-run length that exceeds 25 feet.

1. Install expansion-joint fittings for each of the following locations, and provide type and quantity of fittings that accommodate temperature change listed for location:

   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 the Outdoors without Physical Separation: 125 deg F temperature change.
   d. Attics: 135 deg F temperature change.

2. 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.
3. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at the time of installation.

T. Flexible Conduit Connections: Use maximum of 72 inches of flexible conduit for recessed and semirecessed lighting fixtures, 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.

U. 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.

V. Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying raceways to receptacle or fixture ground terminals.

W. Set metal floor boxes level and flush with finished floor surface.

X. Join raceways with fittings designed and approved for that purpose and make joints tight.
1. Use insulating bushings to protect conductors.

Y. Tighten set screws of threadless fittings with suitable tools i.e Tork hand driver with foot pounds set by the factory.

Z. Set metallic floor boxes level. Trim after installation to fit flush with finished floor surface.

AA. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

BB. Run a 95% mandril through each conduit, prior to the installation of conductors. Contact the Owner’s construction coordinator to witness the pulling of mandril through each conduit. Any conduits that fail the mandril pull shall be replaced prior to installation of conductors.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 31 Section "Earth Moving" for pipe less than 6 inches in nominal diameter.
2. Install backfill as specified in Division 31 Section "Earth Moving."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."
4. Install manufactured duct elbows at vault entrances, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow with 3M Scotchwrap.
5. Install manufactured rigid steel conduit elbows for stub-ups at light poles and equipment and at building entrances through the floor.

    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
    b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.

D. Install handholes and boxes with bottom below the frost line, below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

3.5 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Rectangular Sleeve Minimum Metal Thickness:

1. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 0.052 inch.
2. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 0.138 inch.

E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

F. Cut sleeves to length for mounting flush with both surfaces of walls.

G. Extend sleeves installed in floors 2 inches above finished floor level.

H. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway unless sleeve seal is to be installed or unless seismic criteria require different clearance.

I. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with firestop materials. Comply with Division 07 Section "Penetration Firestopping."

L. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.

M. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

N. Underground, Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between raceway and sleeve for installing mechanical sleeve seals.

3.6 SLEEVE-SEAL INSTALLATION

A. Install to seal underground, exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position raceway in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.8 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533

SECTION 260548 - VIBRATION AND SEISMIC CONTROLS 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. This Section includes the following:

1. Isolation pads.
2. Spring isolators.
3. Restrained spring isolators.
4. Channel support systems.
5. Restraint cables.
6. Hanger rod stiffeners.
7. Anchorage bushings and washers.

B. Related Sections include the following:

1. Division 26 Section "Hangers And Supports For Electrical Systems" for commonly used electrical supports and installation requirements.

1.3 DEFINITIONS

A. The IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

C. OSHPD: Office of Statewide Health Planning and Development for the State of California.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic-Restraint Loading:

1. Site Class as Defined in the IBC: Coordinate with structural documents.
2. Assigned Occupancy Category as Defined in the IBC: II.

   a. Component Importance Factor: Per Structural drawings.
   b. Component Response Modification Factor: Per Structural drawings.
   c. Component Amplification Factor Per Structural drawings.

3. Design Spectral Response Acceleration at Short Periods (0.2 Second) (S_s): per structural drawings.
4. Design Spectral Response Acceleration at 1.0-Second Period (S_1): per structural drawings.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
   a. Annotate to indicate application of each product submitted and compliance with requirements.

3. Restrained-Isolation Devices: Include ratings for horizontal, vertical, and combined loads.

B. Delegated-Design Submittal: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators and seismic restraints. Design loads shall be determined in accordance with ASCE 7-05.

   a. Coordinate design calculations with wind-load calculations required for equipment mounted outdoors. Comply with requirements in other Division 26 Sections for equipment mounted outdoors.

2. Indicate materials and dimensions and identify hardware, including attachment and anchorage devices.
3. Field-fabricated supports.
4. Seismic-Restraint Details:

   a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of all loading scenarios determined in accordance with ASCE 7-05.
   b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.

C. Coordination Drawings: Show coordination of seismic bracing for electrical components with other systems and equipment in the vicinity, including other supports and seismic restraints.

D. Welding certificates.

E. Field quality-control test reports.

1.6 QUALITY ASSURANCE

A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

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

C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

D. Comply with NFPA 70.

1.7 COORDINATION

A. Coordinate layout and installation of seismic bracing with building structural system and architectural features, and with mechanical, fire-protection, electrical, and other building features in the vicinity.

B. Coordinate concrete bases with building structural system.

PART 2 - PRODUCTS

2.1 SEISMIC-RESTRAINT DEVICES

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

1. Amber/Booth Company, Inc.
2. California Dynamics Corporation.
3. Cooper B-Line, Inc.; a division of Cooper Industries.
4. Hilti Inc.
5. Loos & Co.; Seismic Earthquake Division.
6. Mason Industries.
7. TOLCO Incorporated; a brand of NIBCO INC.
8. Unistrut; Tyco International, Ltd.

B. General Requirements for Restraint Components: Rated strengths, features, and application requirements shall be as defined in reports by an evaluation service member of ICC-ES.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

C. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

D. Restraint Cables: ASTM A 603 galvanized-steel cables with end connections made of steel assemblies with thimbles, brackets, swivels, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.

E. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod. Do not weld stiffeners to rods.

F. Bushings for Floor-Mounted Equipment Anchor: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchors and studs.

G. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices.

H. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

I. Mechanical Anchor: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchors with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

J. Adhesive Anchor: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.2 ANCHORAGE AND STRUCTURAL ATTACHMENT COMPONENTS

A. Coordinate products in this Article with structural engineer and with Drawings.

B. Strength: Defined in reports by ICC Evaluation Service or another agency acceptable to authorities having jurisdiction.
   1. Structural Safety Factor: Strength in tension and shear of components used shall be at least two times the maximum seismic forces to which they will be subjected.

C. Concrete and Masonry Anchor Bolts and Studs: Steel-expansion wedge type.

D. Concrete Inserts: Steel-channel type.

E. Through Bolts: Structural type, hex head, high strength. Comply with ASTM A 325.

F. Welding Lugs: Comply with MSS SP-69, Type 57.

G. Beam Clamps for Steel Beams and Joists: Double sided. Single-sided type is not acceptable.

H. Bushings for Floor-Mounted Equipment Anchors: Neoprene units designed for seismically rated rigid equipment mountings, and matched to the type and size of anchor bolts and studs used.

I. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for seismically rated rigid equipment mountings, and matched to the type and size of attachment devices used.

2.3 FACTORY FINISHES

A. Finish: Manufacturer's standard prime-coat finish ready for field painting.

B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings.
2. All hardware shall be galvanized.
3. Hot-dipped galvanize metal components for exterior use.
4. Corrosive Locations: Stainless Steel.
5. Baked enamel or powder coat for metal components on isolators for interior use.
6. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

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

3.2 APPLICATIONS

A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an evaluation service member of ICC-ES.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Equipment and Hanger Restraints:

1. Install restrained isolators on electrical equipment.
2. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
3. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES providing required submittals for component.

B. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

C. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

D. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ELECTRICAL EQUIPMENT ANCHORAGE

A. Anchor rigidly to a single mobile structural element or to a concrete base that is structurally tied to a single mobile structural element.

B. Anchor panelboards, motor-control centers, motor controls, switchboards, switchgear, transformers, fused power-circuit devices, transfer switches, busways, battery racks, static uninterruptible power units, power conditioners, capacitor units, communication system components, and electronic signal processing, control, and distribution units as follows:
1. Size concrete bases so expansion anchors will be a minimum of 10 bolt diameters from the edge of the concrete base.
2. Concrete Bases for Floor-Mounted Equipment: Use female expansion anchors and install studs and nuts after equipment is positioned.
3. Bushings for Floor-Mounted Equipment Anchors: Install to allow for resilient media between anchor bolt or stud and mounting hole in concrete.
4. Anchor Bolt Bushing Assemblies for Wall-Mounted Equipment: Install to allow for resilient media where equipment or equipment-mounting channels are attached to wall.
5. Torque bolts and nuts on studs to values recommended by equipment manufacturer.

C. STRUCTURAL ATTACHMENTS
1. Use bolted connections with steel brackets, slotted channel, and slotted-channel fittings to spread structural loads and reduce stresses.
2. Attachments to New Concrete: Bolt to channel-type concrete inserts or use expansion anchors.
3. Attachments to Existing Concrete: Use expansion anchors.
4. Holes for Expansion Anchors in Concrete: Drill at locations and to depths that avoid reinforcing bars.
5. Attachments to Solid Concrete Masonry Unit Walls: Use expansion anchors.
6. Attachments to Hollow Walls: Bolt to slotted steel channels fastened to wall with expansion anchors.
7. Attachments to Wood Structural Members: Install bolts through members.
8. Attachments to Steel: Bolt to clamps on flanges of beams or on upper truss chords of bar joists.

3.5 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where they terminate with connection to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Remove and replace malfunctioning units and retest as specified above.

C. Testing: Test pull-out resistance of seismic anchorage devices.
1. Provide necessary test equipment required for reliable testing.
2. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
3. Retain subparagraphs below with any paragraph selected above.
4. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post-connection testing has been approved), and with at least seven days' advance notice.
5. Obtain Architect's approval before transmitting test loads to the structure. Provide temporary load-spreading members.
6. Edit sampling frequency in subparagraph below to suit Project.
7. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
8. Test to 90 percent of rated proof load of device.
9. If a device fails the test, modify all installations of same type and retest until satisfactory results are achieved.
10. Record test results.

3.7 ADJUSTING

A. Adjust isolators after isolated equipment is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust active height of spring isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.8 ELECTRICAL VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE SCHEDULE

A. Supported or Suspended Equipment:

1. Equipment Location: as required.
2. Pads:

   a. Material: Neoprene.
   b. Thickness: ¼ inches.

3. Isolator Type: As designated in Part 2.
4. Component Importance Factor: Per Structural requirement..
5. Component Response Modification Factor: Per Structural requirement..
6. Component Amplification Factor: Per Structural requirement..

END OF SECTION 260548

SECTION 260553 - 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.
8. Miscellaneous identification products.

1.3 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products, as requested by owner.

C. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.4 QUALITY ASSURANCE

A. Comply with ANSI 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.

1.5 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 POWER RACEWAY IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.

B. Colors for Raceways Carrying Circuits at 600 V or Less (see 3.1F):

1. Black letters on an orange field.
2. Legend: Indicate system or service and voltage.

C. Colors for Raceways Carrying Circuits at More Than 600 V (see 3.1F):

1. Black letters on an orange field.
2. Legend: "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch-high letters on 20-inch centers.

D. Tape and Stencil for Raceways Carrying Circuits More Than 600 V: 4-inch-wide black stripes on 10-inch centers diagonally over orange background that extends full length of raceway or duct and is 12 inches wide. Stop stripes at legends.

E. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.

2.2 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.3 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape, not less than 3 mils thick by 1 to 2 inches wide. Conductors in sizes #6 and below shall be color coded with the colored insulation. Larger sizes may be identified with colored tape.

2.4 UNDERGROUND-LINE WARNING TAPE

A. Tape:

1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
2. Printing on tape shall be permanent and shall not be damaged by burial operations.
3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:

1. Comply with ANSI Z535.1 through ANSI Z535.5.
2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

C. Tag: Type ID (warning tape with metal core):

1. 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.
2. Overall Thickness: 5 mils.
3. Foil Core Thickness: 0.35 mil.
4. Weight: 28 lb/1000 sq. ft.
5. 3-Inch Tensile According to ASTM D 882: 70 lbf, and 4600 psi.

2.5 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Warning label and sign 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:"
   a. Working Voltage 208V: 36 inches.
   b. Working Voltage 480V: 48 inches.
   c. Working Voltage 4160V: 60 inches.
   d. Working Voltage 12,470V: 10 feet.
   e. Working Voltage 46,000V: 10 feet.

2.6 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. inches and 1/8 inch thick for larger sizes.

1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

B. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch.

2.7 EQUIPMENT IDENTIFICATION LABELS

A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

2.8 CABLE TIES

A. 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 Division 09 painting Sections for paint materials and application requirements. Select 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 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Sequence of Work: If identification is applied to surfaces that require finish, install identification after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and other designations with corresponding designations in the Contract Documents or with those required by codes and standards. Use consistent designations throughout Project.

F. Color Banding Raceways and Exposed Cables: Band exposed and accessible raceways of the systems listed below:
   1. Bands: Pretensioned, wraparound plastic sleeves; colored adhesive tape; or a combination of both. Make each color band 2 inches wide, completely encircling conduit, and place adjacent bands of two-color markings in contact, side by side.
   2. Band Locations: 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.
   3. Apply the following colors to the systems listed below:

      a. Fire-Suppression Supervisory and Control System: Red and yellow.
      b. Combined Fire-Alarm and Security System: Red and blue
      c. Security System: Purple
      d. Mechanical and Electrical Supervisory System: Green and blue.
      e. Emergency power system: Yellow.
      f. 277/480 volts system: Brown.
      g. 120/208 volts system: Black.
      h. Clocks & Bells: Orange.
      i. Sound System: Green.
      j. Traveler (switch to light or switch to switch) 120 volts: Pink
      k. Traveler (switch to light or switch to switch) 277 volts: Purple
      l. Lighting control and dimmers systems: White.

G. Provide Colored raceway and couplings: Provide colored raceway for the entire length for the systems listed below:
   1. Colored coatings shall be applied over the in-line galvanized coating for the following systems listed below:
      a. Fire-Alarm: Red.
      b. Telecommunications Blue.

H. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

I. 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.

J. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench. Extend metal tape cable to inside transformer low voltage enclosure.

K. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

L. Circuit Identification Labels on Boxes: Install labels externally.
   1. Exposed Boxes: Pressure-sensitive, self-adhesive plastic label on cover.
   2. Concealed Boxes: Plasticized card-stock tags.

3. Labeling Legend: Permanent, waterproof listing of panel and circuit number or equivalent.

3.2 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 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, Armored and Metal-Clad Cables, More Than 600 V: Snap-around labels. Install labels at 10-foot maximum intervals.

C. Accessible Raceways, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A, and 120 V to ground: Identify with color conduit. Install labels at 10-foot maximum intervals.

D. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:

1. Emergency Power.
2. Power.

E. 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.
b. Colors for 208/120-V Circuits:
   1) Phase A: Black.
   2) Phase B: Red.
   3) Phase C: Blue.
   4) Neutral : White
   5) Ground : Green
   6) Isolated Ground: White & Green
   7) Control: Violet
c. 480/277-V Conductors:
   1) Phase A: Brown.
   2) Phase B: Orange.
   3) Phase C: Yellow.
   4) Neutral : Gray
   5) Ground : Green
   6) Isolated Ground: White & Green
   7) Control: Violet

d. Fire Alarm-Circuit Conductor Identification, 600 V or Less: For conductors in pull and junction boxes and enclosures, use factory colored cables and conductors to identify the individual circuits. All conductors shall be stranded.

F. 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 Factory apply color the entire length of conductors, except the following field-applied, color-coding methods may be used instead of factory-coded wire for sizes larger than No. 10 AWG:

a. Colored, pressure-sensitive plastic tape in half-lapped turns for a 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. Use 1-inch-wide tape in colors specified. Adjust tape bands to avoid obscuring cable identification markings.
b. Colored cable ties applied in groups of three ties of specified color to each wire at each terminal or splice point starting 3 inches from the terminal and spaced 3 inches apart. Apply with a special tool or pliers, tighten to a snug fit, and cut off excess length.

G. Power-Circuit Conductor Identification, More than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use nonmetallic plastic tag holder with adhesive-backed phase tags, and a separate tag with the circuit designation.

H. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

I. Apply identification to conductors as follows:
1. Conductors to Be Extended in the Future: Indicate source and circuit numbers.
2. Multiple Power or Lighting Circuits in the Same Enclosure: Identify each conductor with source, voltage, circuit number, and phase. Use color-coding to identify circuits' voltage and phase.
3. Multiple Control and Communication Circuits in the Same Enclosure: Identify each conductor by its system and circuit designation. Use a consistent system of tags, color-coding, or cable marking tape.

J. Apply warning, caution, and instruction signs as follows:
1. Warnings, Cautions, and Instructions: Install to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.
2. Emergency Operation: Install engraved laminated signs with white legend on red background with minimum 3/8-inch- high lettering for emergency instructions on power transfer, load shedding, and other emergency operations.

K. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.

L. 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 the Operation and Maintenance Manual.

M. 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 both direct-buried cables and cables in raceway.

N. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

O. 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.

P. 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.

Q. 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.

R. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the 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 systems unless equipment is provided with its own identification.

1. Labeling Instructions:

a. Indoor Equipment: Engraved, laminated acrylic or melamine 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 provided with self-adhesive means of attachment, fasten labels 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 self-adhesive, engraved label.
b. Enclosures and electrical cabinets.
c. Switchgear.
d. Switchboards.
e. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
f. Emergency system boxes and enclosures.
g. Motor-control centers.
h. Enclosed switches.
i. Enclosed circuit breakers.
j. Enclosed controllers.
k. Contactors.
l. Panelboards, electrical cabinets, and enclosures.
m. Emergency system boxes and enclosures.
n. Disconnect switches.
o. Enclosed circuit breakers.
p. Control devices.

END OF SECTION 260553

SECTION 260574 – ELECTRICAL TESTING

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 SUMMARY

A. This Section includes general requirements for electrical field testing and inspecting. Detailed requirements are specified in each Section containing components that require testing. General requirements include the following:

1. Qualifications of testing agencies and their personnel.
2. Suitability of test equipment.
3. Calibration of test instruments.
4. Coordination requirements for testing and inspecting.
5. Reporting requirements for testing and inspecting.

B. Allowances: Electrical tests and inspections specified in various Division 23 and 26 Sections are covered by a testing and inspecting allowance specified in Division 1 Section "Allowances." See Division 1 Section "Allowances" for what is included in allowance amount, the amount of the allowance, payment procedures for allowances, changes to allowance amounts, and disposition of unused portions of allowance.

1.3 QUALITY ASSURANCE

A. Testing Agency Qualifications: As specified in each Section containing electrical testing requirements and in subparagraph and associated subparagraph below.

1. Independent Testing Agencies: Independent of manufacturers, suppliers, and installers of components to be tested or inspected.

a. Testing Agency's Field Supervisor for Power Component Testing: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Division 16 power component Sections.

B. Test Equipment Suitability: Comply with NETA ATS, Section 5.2.

C. Test Equipment Calibration: Comply with NETA ATS, Section 5.3.

PART 2 - NOT USED

PART 3 - EXECUTION

3.1 GENERAL TESTS AND INSPECTIONS

A. If a group of tests are specified to be performed by an independent testing agency, prepare systems, equipment, and components for tests and inspections, and perform preliminary tests to ensure that systems, equipment, and components are ready for independent agency testing. Include the following minimum preparations as appropriate:

1. Perform insulation-resistance tests in all panelboard feeders.
2. Perform continuity tests.
3. Perform rotation test (for motors to be tested).
4. Provide a stable source of single-phase, 208/120-V electrical power for test instrumentation at each test location.
5. Provide certification for main GFI.

B. Test and Inspection Reports: In addition to requirements specified elsewhere, report the following:

1. Manufacturer's written testing and inspecting instructions.
2. Calibration and adjustment settings of adjustable and interchangeable devices involved in tests.
3. Tabulation of expected measurement results made before measurements.
4. Tabulation of "as-found" and "as-left" measurement and observation results.

END OF SECTION 260574

SECTION 262416 - PANELBOARDS

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. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.

1.3 DEFINITIONS

A. SVR: Suppressed voltage rating.

B. TVSS: Transient voltage surge suppressor.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Panelboards 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: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types and details for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Short-circuit current rating of panelboards and overcurrent protective devices.
5. Include evidence of NRTL listing for series rating of installed devices.
6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
7. Include wiring diagrams for power, signal, and control wiring.

8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

C. Qualification Data.

D. Seismic Qualification Certificates: Submit certification that panelboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:

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.

E. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

F. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NEMA PB 1.

E. Comply with NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards.

B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.8 PROJECT CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

   a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.
   b. Altitude: Not exceeding 6600 feet.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet.

1.9 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: One year from date of Substantial Completion.

1.11 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Keys: Two spare for each type of panelboard cabinet lock.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

C. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Siemens Energy & Automation, Inc.
2. Square D; a brand of Schneider Electric.
3. General Electric.
4. Cutler-Hammer.

D. Enclosures: Flush- and surface As specified on the drawings -mounted cabinets.

1. Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
b. Outdoor Locations: NEMA 250, Type 3R.
c. Kitchen or Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
4. Finishes:

a. Panels and Trim: Steel factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
b. Back Boxes: Same finish as panels and trim.

5. Directory Card: Inside panelboard door, mounted in transparent card holder.

E. Incoming Mains Location: As required.

F. Phase, Neutral, and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

G. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Main and Neutral Lugs: Mechanical type.
3. Ground Lugs and Bus-Configured Terminators: Mechanical type.
4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
5. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.

H. Service Equipment Label: UL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.

I. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

2.2 PANELBOARD SHORT-CIRCUIT RATING

A. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.
   1. Lighting and appliance branch-circuit panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an UL. Include size and type of allowable upstream and branch devices, listed and labeled for series-connected short-circuit rating by an UL.

2.3 DISTRIBUTION PANELBOARDS

A. Panelboards: NEMA PB 1, power and feeder distribution type.

B. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

   1. For doors more than 36 inches high, provide two latches, keyed alike.

C. Mains: Circuit breaker or Lugs as shown.

D. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

B. Mains: As specified on the drawings.

C. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

D. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.5 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

   1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
   2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
   a. Instantaneous trip.
   b. Long- and short-time pickup levels.
   c. Long- and short-time time adjustments.
   d. Ground-fault pickup level, time delay, and I2t response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
6. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
7. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
8. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

   a. Standard frame sizes, trip ratings, and number of poles.
   b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
   c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
   d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
   e. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring and Control."
   f. Shunt Trip: 120 V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
   g. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
   h. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
   i. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
   j. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
   k. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.
   l. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.
   m. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
   n. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

B. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

1. Fuses, and Spare-Fuse Cabinet: Comply with requirements specified in Division 26 Section "Fuses."
2. Fused Switch Features and Accessories: Standard ampere ratings and number of poles.
3. Auxiliary Contacts: Two normally open and normally closed contact(s) that operate with switch handle operation.

2.6 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Equipment Mounting: Fasten enclosures firmly to walls and structural surfraces, ensuring tha they are permanently and mechanically anchored.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

D. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

E. Mount top of trim 74 inches above finished floor unless otherwise indicated.

F. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

G. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.

H. Install filler plates in unused spaces.

I. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future.

J. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

K. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.4 CONNECTIONS

A. Ground equipment according to Division 26 Section “Grounding and Bonding for Electrical System”.

B. Connect wiring according to Division 26 Section “Low-voltage Electrical Power Conductors and Cables”.

3.5 FIELD QUALITY CONTROL

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

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Provide a written report to certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

E. Panelboards will be considered defective if they do not pass tests and inspections.

3.6 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.

1. Measure as directed during period of normal system loading.
2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.7 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 262416

SECTION 262726 - WIRING DEVICES

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. This Section includes the following:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Twist-locking receptacles.
3. Receptacles with integral surge suppression units.
4. Snap switches and wall-box dimmers.
5. Wall-switch.
6. Pendant cord-connector devices.
7. Cord and plug sets.
8. Floor service outlets, poke-through assemblies, service poles, and multioutlet assemblies.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

D. RFI: Radio-frequency interference.

E. TVSS: Transient voltage surge suppressor.

F. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Provide a sample of each type of device to be used.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

1.6 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1. Cord and Plug Sets: Match equipment requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
3. Leviton Mfg. Company Inc. (Leviton).
4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 STRAIGHT BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
2. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; 5351 (single), 5352 (duplex).
b. Hubbell; HBL5351 (single), CR5352 (duplex).
c. Leviton; 5891 (single), 5352 (duplex).
d. Pass & Seymour; 5381 (single), 5352 (duplex).

2.3 GFCI RECEPTACLES

A. General Description: Straight blade, feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
2. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; GF20.
b. Pass & Seymour; 2084.

2.4 TVSS RECEPTACLES

A. General Description: Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 1449, with integral TVSS in line to ground, line to neutral, and neutral to ground.

1. TVSS Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 volts and minimum single transient pulse energy dissipation of 240 J, according to IEEE C62.41.2 and IEEE C62.45.
2. Active TVSS Indication: Visual and audible, with light visible in face of device to indicate device is "active" or "no longer in service."

B. Duplex TVSS Convenience Receptacles:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
2. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; 5362BLS.
b. Hubbell; HBL5362SA.
c. Leviton; 5380.

3. Description: Straight blade, 125 V, 20 A; NEMA WD 6 configuration 5-20R.

2.5 TWIST-LOCKING RECEPTACLES

A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
2. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; L520R.
b. Hubbell; HBL2310.
c. Leviton; 2310.
d. Pass & Seymour; L520-R.

3. Verify voltage and Amperage.

2.6 PENDANT CORD-CONNECTOR DEVICES

A. Description: Matching, locking-type plug and receptacle body connector; NEMA WD 6 configurations L5-20P and L5-20R, heavy-duty grade.

1. Body: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.
2. External Cable Grip: Woven wire-mesh type made of high-strength galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.7 CORD AND PLUG SETS

A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.

1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.
2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.8 SNAP SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches, 120/277 V, 20 A:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
2. Products: Subject to compliance with requirements, provide one of the following:

   a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).
   b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
   c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
   d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).

C. Pilot Light Switches, 20 A:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
2. Products: Subject to compliance with requirements, provide one of the following:

   a. Cooper; 2221PL for 120 V and 277 V.
   b. Hubbell; HPL1221PL for 120 V and 277 V.
   c. Leviton; 1221-PLR for 120 V, 1221-7PLR for 277 V.
   d. Pass & Seymour; PS20AC1-PLR for 120 V.

3. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."

2.9 WALL PLATES

A. Single and combination types to match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: Smooth, high-impact thermoplastic 0.035-inch-thick.
3. Material for Unfinished Spaces: Galvanized steel.
4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in "wet locations."

B. Wet-Location, Weatherproof Cover Plates:
1. NEMA 250, complying with type 3R weather-resistant, die-cast aluminum with lockable cover.
2. NEMA 3R-in-Use cover, plastic, weather resistant.

2.10 FLOOR SERVICE FITTINGS

A. Type: Modular, flush-type, dual-service units suitable for wiring method used.

B. Compartments: Barrier separates power from voice and data communication cabling.

C. Service Plate: Rectangular die-cast aluminum with satin finish.

D. Power Receptacle: NEMA WD 6 configuration 5-20R, gray finish, unless otherwise indicated.

E. Voice and Data Communication Outlet: Blank cover with bushed cable opening.

2.11 MULTIOUTLET ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Hubbell Incorporated; Wiring Device-Kellems.
2. Wiremold Company (The).

B. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.

C. Raceway Material: Metal, with standard finish.

D. Wire: No. 12 AWG.

2.12 FINISHES

A. Color: Wiring device catalog numbers in Section Text do not designate device color.

1. Wiring Devices Connected to Normal Power System: white, unless otherwise indicated or required by NFPA 70 or device listing.
2. Wiring Devices Connected to Emergency Power System: Red.
3. TVSS Devices: Blue.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Coordination with Other Trades:

1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.

D. Device Installation:

1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.
2. Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade at the top.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

H. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

A. Comply with Division 26 Section "Identification for Electrical Systems."

1. Receptacles: Identify panelboard and circuit number from which served. Use engraved machine printing with black-filled lettering on face, and durable wire markers or tags inside outlet boxes.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. In healthcare facilities, prepare reports that comply with recommendations in NFPA 99.
2. Test Instruments: Use instruments that comply with UL 1436.
3. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

END OF SECTION 262726

SECTION 262813 - FUSES

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. This Section includes the following:

1. Cartridge fuses rated 600-V ac and less for use in enclosed switches, and enclosed controllers.
2. Plug fuses rated 125-V ac and less for use in plug-fuse-type enclosed switches and fuseholders.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:

B. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
1. Let-through current curves for fuses with current-limiting characteristics.
2. Time-current curves, coordination charts and tables, and related data.
3. Fuse size for elevator feeders and elevator disconnect switches.

C. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.

1. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
2. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.

D. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

a. Let-through current curves for fuses with current-limiting characteristics.
b. Time-current curves, coordination charts and tables, and related data.
c. Ambient temperature adjustment information.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NEMA FU 1.

D. Comply with NFPA 70.

1.5 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.6 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Quantity equal to 5 percent of each fuse type and size, but no fewer than 2 of each type and size.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Bussmann, Inc.
2. Ferraz Shawmut, Inc.
3. Littelfuse, Inc.

2.2 CARTRIDGE FUSES

A. NEMA FU 1 class is same as UL class. Class defines fuse performance category, including interrupting rating. See Editing Instruction No. 2 in the Evaluations.

B. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class and current rating indicated; voltage rating consistent with circuit voltage.

2.3 SPARE-FUSE CABINET

A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.

1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
2. Finish: Gray, baked enamel.
3. Identification: "SPARE FUSES" in 1-1/2-inch- high letters on exterior of door.
4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

B. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

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

D. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

E. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

3.2 FUSE APPLICATIONS

1. Motor Branch Circuits: Class RK1, time delay.
2. Control Circuits: Class CC, fast acting.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 262813

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.
3. Receptacle switches.
4. Shunt trip switches.
5. Molded-case circuit breakers (MCCBs).
6. Molded-case switches.
7. Enclosures.

1.3 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 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: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Include evidence of NRTL listing for series rating of installed devices.

5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.

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

C. Qualification Data: For qualified testing agency.

D. Seismic Qualification Certificates: For enclosed switches and circuit breakers, accessories, and 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.

E. Field quality-control reports.

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

F. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NFPA 70.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
2. Altitude: Not exceeding 6600 feet.

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Owner no fewer than seven days in advance of proposed interruption of electric service.
2. Indicate method of providing temporary electric service.
3. Do not proceed with interruption of electric service without Owner's written permission.
4. Comply with NFPA 70E.

1.8 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.9 EXTRA MATERIALS

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
1. Siemens Energy & Automation, Inc.
2. Square D; a brand of Schneider Electric.
3. General Electric Company.
4. Cuttler-Hammer.

B. Provide fusible switches with quantity of poles and amperage, as indicated on the drawings.

C. Type HD, Heavy Duty, Single Throw, [240] [600]-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. Type HD, Heavy Duty, Six Pole, Single Throw, 600-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

E. Type HD, Heavy Duty, Double Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

F. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
5. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
6. Allows use of a hookstick to operate the handle.
7. Lugs: Mechanical type, suitable for number, size, and conductor material.
8. Labeled for use as service equipment.

2.2 NONFUSIBLE SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
1. Siemens Energy & Automation, Inc.
2. Square D; a brand of Schneider Electric.

B. Provide fusible switches with quantity of poles and amperage, as indicated on the drawings.

C. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. Type HD, Heavy Duty, Six Pole, Single Throw, 600-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

E. Type HD, Heavy Duty, Double Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

F. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
4. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
5. Allows use of a hookstick to operate the handle.
6. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.3 SHUNT TRIP SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:

1. Cooper Bussmann, Inc.
2. Ferraz Shawmut, Inc.
3. Littelfuse, Inc.

B. General Requirements: Comply with ASME A17.1, UL 50, and UL 98, with 200-kA interrupting and short-circuit current rating when fitted with Class J fuses.

C. Switches: Three-pole, horsepower rated, with integral shunt trip mechanism and Class J fuse block; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

D. Control Circuit: 120-V ac; obtained from integral control power transformer, with primary and secondary fuses, with a control power transformer of enough capacity to operate shunt trip, connected pilot, and indicating and control devices.

E. Accessories:

1. Oiltight key switch for key-to-test function.
2. Green ON pilot light.
3. 100 percent rating.
4. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.
5. Form C alarm contacts that change state when switch is tripped.
6. Fire-safety and alarm relay; 120-V ac coil voltage.
7. Fire-alarm voltage monitoring relay complying with NFPA 72.

2.4 MOLDED-CASE CIRCUIT BREAKERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
1. Siemens Energy & Automation, Inc.
2. Square D; a brand of Schneider Electric.
3. General Electric Company.
4. Cuttler-Hammer

B. Show pole quantities and voltage and ampere ratings of MCCBs and switches on Drawings.

C. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

D. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

E. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

F. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:

1. Instantaneous trip.
2. Long- and short-time pickup levels.
3. Long- and short-time time adjustments.
4. Ground-fault pickup level, time delay, and I^2t response.

G. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
5. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
6. Alarm Switch: One NO/NC contact that operates only when circuit breaker has tripped.

2.5 MOLDED-CASE SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
1. Siemens Energy & Automation, Inc.
2. Square D; a brand of Schneider Electric.
3. General Electric Company.
4. Cuttler-Hammer

B. General Requirements: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.

C. Features and Accessories:

1. Standard frame sizes and number of poles.
2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
3. Ground-Fault Protection: Comply with UL 1053; remote-mounted and powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
5. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic switch contacts, "b" contacts operate in reverse of switch contacts.
6. One NO/NC contact that operates only when switch has tripped.
7. Externally mounted to prohibit switch operation; key shall be removable only when switch is in off position.
8. Integral with ground-fault shunt trip unit; for interlocking ground-fault protection function.
9. Provide remote control for on, off, and reset operations.

2.6 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
2. Outdoor Locations: NEMA 250, Type 3R

3. NEMA 250, Type 4X, stainless steel.
4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in fusible devices.

E. Comply with NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study".

END OF SECTION 262816

SECTION 265100 - INTERIOR LIGHTING

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. This Section includes the following:

1. Interior lighting fixtures, lamps, and ballasts.
2. Emergency lighting units.
3. Exit signs.
4. Lighting fixture supports.
5. Retrofit kits for fluorescent lighting fixtures.

B. Related Sections include the following:

1. Division 26 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
2. Division 26 Section "Wiring Devices" for manual wall-box dimmers for incandescent lamps.

1.3 DEFINITIONS

A. BF: Ballast factor.

B. CRI: Color-rendering index.

C. CU: Coefficient of utilization.

D. HID: High-intensity discharge.

E. LER: Luminaire efficacy rating.

F. Luminaire: Complete lighting fixture, including ballast housing if provided.

G. RCR: Room cavity ratio.

1.4 SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:

1. Physical description of lighting fixture including dimensions.

2. Emergency lighting units including battery and charger.
3. Ballast.
4. Energy-efficiency data.
5. Life, output, and energy-efficiency data for lamps.
6. Photometric data, in IESNA format, based on laboratory tests of each lighting fixture type, outfitted with lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.

    a. For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by the manufacturer.
    b. Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program (NVLAP) for Energy Efficient Lighting Products.

B. Shop Drawings: Show details of nonstandard or custom lighting fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories.

1. Wiring Diagrams: Power and control wiring.

C. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Lighting fixtures.
2. Suspended ceiling components.
3. Structural members to which suspension systems for lighting fixtures will be attached.
4. Other items in finished ceiling including the following:

    a. Air outlets and inlets.
    b. Speakers.
    c. Sprinklers.
    d. Smoke and fire detectors.
    e. Occupancy sensors.
    f. Access panels.

5. Perimeter moldings.

D. Samples for Verification: Interior lighting fixtures designated for sample submission in Interior Lighting Fixture Schedule. Each sample shall include the following:

1. Lamps: Specified units installed.
2. Accessories: Cords and plugs.

E. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, signed by product manufacturer.

F. Qualification Data: For agencies providing photometric data for lighting fixtures.

G. Field quality-control test reports.

H. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.

I. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

D. FMG Compliance: Lighting fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FMG.

1.6 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.7 WARRANTY

A. Special Warranty for Ballasts: Manufacturer's standard form in which ballast manufacturer agrees to repair or replace ballasts that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Electronic Ballasts: Five years from date of Substantial Completion.

B. Special Warranty for T5 and T8 Fluorescent Lamps: Manufacturer's standard form, made out to Owner and signed by lamp manufacturer agreeing to replace lamps that fail in materials or workmanship, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.

1. Warranty Period: One year from date of Substantial Completion.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Furnish stock or replacement lamps amounting to 2%, but not less than 2 lamps in each case, of each type and size lamp used in each type fixture (indoor and outdoor). Deliver replacement stock as directed to the Owner's storage space.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In Interior Lighting Fixture Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified on the fixture schedule in the drawings.

2.2 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

B. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.

C. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

F. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:

   1. White Surfaces: 85 percent.
   2. Specular Surfaces: 83 percent.
   3. Diffusing Specular Surfaces: 75 percent.
   4. Laminated Silver Metallized Film: 90 percent.

G. Plastic Diffusers, Covers, and Globes:

   1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

      a. Lens Thickness: At least 0.125 inch minimum unless different thickness is indicated.
      b. UV stabilized.

   2. Glass: Annealed crystal glass, unless otherwise indicated.

2.3 BALLASTS FOR LINEAR FLUORESCENT LAMPS

A. Electronic Ballasts: Comply with ANSI C82.11; Program-start type, unless otherwise indicated, and designed for type and quantity of lamps served. Ballasts shall be designed for full light output unless dimmer or bi-level control is indicated.

   1. Sound Rating: A.
   2. Total Harmonic Distortion Rating: Less than 10 percent.

3. Transient Voltage Protection: IEEE C62.41, Category A or better.
4. Operating Frequency: [20] kHz or higher.
5. Lamp Current Crest Factor: 1.7 or less.
6. BF: 0.78.
7. Power Factor: [0.95] or higher.
8. Parallel Lamp Circuits: Multiple lamp ballasts shall comply with ANSI C 82.11 and shall be connected to maintain full light output on surviving lamps if one or more lamps fail.

B. Single Ballasts for Multiple Lighting Fixtures: Factory-wired with ballast arrangements and bundled extension wiring to suit final installation conditions without modification or rewiring in the field.

C. Ballasts for Low-Temperature Environments:

1. Temperatures 0 Deg F and Higher: [Electronic] type rated for 0 deg F starting and operating temperature with indicated lamp types.

D. Ballasts for Bi-Level Controlled Lighting Fixtures: Electronic type.

1. Operating Modes: Ballast circuit and leads provide for remote control of the light output of the associated lamp between high- and low-level and off.

a. High-Level Operation: 100 percent of rated lamp lumens.
b. Low-Level Operation: 50 percent of rated lamp lumens.

2. Ballast shall provide equal current to each lamp in each operating mode.
3. Compatibility: Certified by manufacturer for use with specific bi-level control system and lamp type indicated.

2.4 BALLASTS FOR COMPACT FLUORESCENT LAMPS

A. Description: Electronic programmed rapid-start type, complying with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated:

1. Lamp end-of-life detection and shutdown circuit.
2. Automatic lamp starting after lamp replacement.
3. Sound Rating: A.
4. Total Harmonic Distortion Rating: Less than 20 percent.
5. Transient Voltage Protection: IEEE C62.41, Category A or better.
6. Operating Frequency: 20 kHz or higher.
7. Lamp Current Crest Factor: 1.7 or less.
8. BF: 0.95 or higher, unless otherwise indicated.
9. Power Factor: 0.95 or higher.
10. Ballast Case Temperature: 75 deg C, maximum.

2.5 EXIT SIGNS

A. Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:
1. Lamps for AC Operation: LEDs, 70,000 hours minimum rated lamp life.

2. Master/Remote Sign Configurations:

   a. Master Unit: Comply with requirements above for self-powered exit signs, and provide additional capacity in LED power supply for power connection to remote unit.
   b. Remote Unit: Comply with requirements above for self-powered exit signs, except omit power supply. Arrange to receive full power requirements from master unit. Connect for testing concurrently with master unit as a unified system.

2.6 FLUORESCENT LAMPS

A. Low-Mercury Lamps: Comply with EPA's toxicity characteristic leaching procedure test; shall yield less than 0.2 mg of mercury per liter when tested according to NEMA LL 1.

B. T8 premium program-start low-mercury lamps, rated 28 W maximum, nominal length of 48 inches, 2725 initial lumens (minimum), CRI 75 (minimum), color temperature 4100 K, and average rated life 20,000 hours, unless otherwise indicated.

C. T8 premium program-start low-mercury lamps, rated 17 W maximum, nominal length of 24 inches, 1300 initial lumens (minimum), CRI 75 (minimum), color temperature 4100 K, and average rated life of 20,000 hours, unless otherwise indicated.

D. T5 program-start low-mercury lamps, rated 28 W maximum, nominal length of 45.2 inches 2900 initial lumens (minimum), CRI 85 (minimum), color temperature 4100 K, and average rated life of 20,000 hours, unless otherwise indicated.

E. T5HO program-start, high-output low-mercury lamps, rated 54 W maximum, nominal length of 45.2 inches, 5000 initial lumens (minimum), CRI 85 (minimum), color temperature 4100 K, and average rated life of 20,000 hours, unless otherwise indicated.

F. Compact Fluorescent Lamps: program-start 4-Pin, low mercury, CRI 80 (minimum), color temperature 4100 K, average rated life of 10,000 hours at 3 hours operation per start, unless otherwise indicated.

   1. 13 W: T4, double or triple tube, rated 900 initial lumens (minimum).
   2. 18 W: T4, double or triple tube, rated 1200 initial lumens (minimum).
   3. 26 W: T4, double or triple tube, rated 1800 initial lumens (minimum).
   4. 32 W: T4, triple tube, rated 2400 initial lumens (minimum).
   5. 42 W: T4, triple tube, rated 3200 initial lumens (minimum).
   6. 55 W: T4, triple tube, rated 4300 initial lumens (minimum).

2.7 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage

E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage.

F. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

2.8 REQUIREMENTS FOR INDIVIDUAL LIGHTING FIXTURES

(See Drawings)

PART 3 - EXECUTION

3.1 INSTALLATION

A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.

B. Support for Lighting Fixtures in or on Grid-Type Suspended Ceilings: Use grid as a support element.

1. Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 6 inches from lighting fixture corners.
2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.

C. Suspended Lighting Fixture Support:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.

D. Air-Handling Lighting Fixtures: Install with dampers closed and ready for adjustment.

E. Adjust aimable lighting fixtures to provide required light intensities.

F. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.2 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 265100