



United States Geological Survey
PROJECT MANUAL SPECIFICATIONS

BID DOCUMENTS

**Earth Resources Observation and Science Center
Sioux Falls, South Dakota
Phase I: Fluid Coolers Design Services**

Architect
Fox Architects
1 Memorial Dr. STE 1800
St. Louis, MO 63108
314-621-4343

MEP/Structural Engineer
SSC Engineering
18207 Edison Ave.
Chesterfield, MO 63005
636-530-7770

Rev 1: Update the specification to remove references to the architect and clarify that the COR will perform this function.

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DOCUMENT 003119 - EXISTING CONDITION INFORMATION

1.1 EXISTING CONDITION INFORMATION

- A. This Document with its referenced attachments is part of the Procurement and Contracting Requirements for Project. They provide Owner's information for Bidders' convenience and are intended to supplement rather than serve in lieu of the Bidders' own investigations. They are made available for Bidders' convenience and information but are not a warranty of existing conditions. This Document and its attachments are not part of the Contract Documents.
- B. Existing drawings that include information on existing conditions including previous construction at Project site are available for viewing at the office of Owner and partial drawings at the office of Architect.
- C. Survey information that includes information on existing conditions, are a part of Drawings.

END OF DOCUMENT 003119

DOCUMENT 003126 - EXISTING HAZARDOUS MATERIAL INFORMATION

1.1 EXISTING HAZARDOUS MATERIAL INFORMATION

- A. This Document with its referenced attachments is part of the Procurement and Contracting Requirements for Project. They provide Owner's information for Bidders' convenience and are intended to supplement rather than serve in lieu of Bidders' own investigations. They are made available for Bidders' convenience and information but are not a warranty of existing conditions. This Document and its attachments are not part of the Contract Documents.
- B. There was no asbestos or ACM (asbestos containing material) survey performed within the project area.
- C. There was no lead or PCB (Polychlorinate Biphenyl) survey performed within the project area.
- D. Existing Condition documentation is available upon request by bidders in PDF format. Originals or paper copies will not be provided.

END OF DOCUMENT 003126

SECTION 011000 - SUMMARY

1.1 SUMMARY

A. Section Includes:

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

1.2 PROJECT INFORMATION

A. Project Information:

1. Facility Name: Earth Resources Observation and Science Center
2. Project Name: Phase I: Cooling Tower Design Services
3. Project Location: 47914 252nd Street. Sioux Falls, SD 57198

B. Owner: USGS.

1. Contracting Officer: Kimberly Schneider,
kimberly_schneider@ios.doi.gov
[REDACTED]
2. Contracting Officer's Representative:
 - a. Jesse Boyer, (605) 594-2644, jboyer@usgs.gov

C. COR: Fox Architects

1. [REDACTED]
2. [REDACTED]
3. [REDACTED]

D. MEP Engineer: SSC Engineering

1. [REDACTED]
2. [REDACTED]

E. Project Web Site: A project Web site administered by Contractor will be used for purposes of managing communication and documents during the construction stage.

1. See Section 013100 "Project Management and Coordination." for requirements for establishing and using Project Web site.

1.3 WORK COVERED BY CONTRACT DOCUMENTS

A. The Work of Project is defined by the Contract Documents and consists of, but is not limited to, the following:

1. Selective demolition and modification of concrete slabs, flooring, and ceilings.
2. Construction of 2-HR rated wall shafts as piping chases.
3. Installation of 2x2 access panel.
4. Replacement of existing cooling towers.
5. Replacement of condenser water and chilled water piping.
6. Addition of new 300-ton chiller for redundancy.

B. Type of Contract.

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

1.4 ACCESS TO SITE

A. General: Contractor shall have full use of Project site area 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 outside the project area 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 areas within the Contract limits indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.

1. Limits: Confine construction operations to areas documented on the drawings.
2. Limits: Limit site disturbance, including earthwork and clearing of vegetation, 10 feet (3 m) beyond constructed areas with permeable surfaces (such as pervious paving areas, stormwater detention facilities, and playing fields) that require additional staging areas in order to limit compaction in the constructed area.
3. Driveways, Walkways and Entrances: Keep driveways 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. Except for when the exterior ramp work begins. Provide access signage directing to secondary entry.

- 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.

1.5 COORDINATION WITH OCCUPANTS

- A. Full Owner Occupancy: Owner will occupy site and existing building during entire construction period. Cooperate with Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with Owner's day-to-day operations. Maintain existing exits unless otherwise indicated.
 1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from Owner and approval of authorities having jurisdiction.
 2. Notify Owner not less than 72 hours in advance of activities that will affect Owner's operations.
- B. Partial 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.
- C. Owner Limited Occupancy of Completed Areas of Construction: Owner reserves the right to occupy and to place and install equipment in completed portions of the Work, prior to Substantial Completion of the Work, provided such occupancy does not interfere with completion of the Work. Such placement of equipment and limited occupancy shall not constitute acceptance of the total Work.
 1. COR will prepare a Certificate of Substantial Completion for each specific portion of the Work to be occupied prior to Owner acceptance of the completed Work.
 2. Obtain a Certificate of Occupancy from authorities having jurisdiction before limited Owner occupancy.
 3. Before limited Owner occupancy, mechanical and electrical systems shall be fully operational, and required tests and inspections shall be successfully completed. On occupancy, Owner will operate and maintain mechanical and electrical systems serving occupied portions of Work.
 4. On occupancy, Owner will assume responsibility for maintenance and custodial service for occupied portions of Work.

1.6 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 a.m. to 6 p.m., Monday through Friday, unless otherwise indicated.
- 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.
- 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 the posted distance of the project site area.
- F. Controlled Substances: Use of tobacco products and other controlled substances within the existing building or on the Project site is not permitted.

1.7 SPECIFICATION AND DRAWING CONVENTIONS

- A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
 - 1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
 - 2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.
- B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.
- C. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:
 - 1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.

2. Abbreviations: Materials and products are identified by abbreviations scheduled on Drawings.
3. Keynoting: Materials and products are identified by reference keynotes referencing Specification Section numbers found in this Project Manual.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 011000

SECTION 012500 - SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for substitutions.
- B. Related Requirements:
 - 1. Section 016000 "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers.

1.2 DEFINITIONS

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

1.3 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. COR Action: If necessary, COR will request additional information or documentation for evaluation within seven days of receipt of a request for substitution. COR 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 COR Supplemental Instructions for minor changes in the Work.
 - b. Use product specified if COR does not issue a decision on use of a proposed substitution within time allocated.

1.4 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.

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: COR will consider Contractor's request for substitution when the following conditions are satisfied:
 - a. Requested substitution is consistent with the Contract Documents and will produce indicated results.

- b. Requested substitution will not adversely affect Contractor's construction schedule.
 - c. Requested substitution has received necessary approvals of authorities having jurisdiction.
 - d. Requested substitution is compatible with other portions of the Work.
 - e. Requested substitution has been coordinated with other portions of the Work.
 - f. Requested substitution provides specified warranty.
 - g. 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.
- C. Substitutions for Convenience: COR will consider requests for substitution if received within 60 days after the Notice of Award.
- 1. Conditions: COR will consider Contractor's request for substitution when the following conditions are satisfied:
 - a. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Architect for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
 - b. Requested substitution does not require extensive revisions to the Contract Documents.
 - c. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 - d. 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.

PART 3 - EXECUTION (Not Used)

END OF SECTION 012500

SECTION 013100 - PROJECT MANAGEMENT AND COORDINATION

1.1 SUMMARY

- A. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
 - 1. Coordination drawings.
 - 2. Requests for Information (RFIs).
 - 3. Project Web site.
 - 4. Project meetings.
- B. 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 017300 "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.

1.2 DEFINITIONS

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

1.3 INFORMATIONAL SUBMITTALS

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

1.4 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. 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.
- C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
1. Preparation of Contractor's construction schedule.
 2. Preparation of the schedule of values.
 3. Installation and removal of temporary facilities and controls.
 4. Delivery and processing of submittals.
 5. Progress meetings.
 6. Preinstallation conferences.
 7. Project closeout activities.
 8. Startup and adjustment of systems.

1.5 COORDINATION DRAWINGS

- A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, 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. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
 - b. 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 COR 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.

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.
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. Review: COR 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.

1.6 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. COR will return RFIs submitted to COR 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 COR.
 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 solution(s) 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.
- C. RFI Forms: AIA Document G716 or contractor equivalent.
- D. COR Action: COR will review each RFI, determine action required, and respond. Allow seven working days for COR response for each RFI. RFIs received by COR after 1:00 p.m. will be considered as received the following working day.

1. The following RFIs will be returned without action:
 - a. Requests for approval of submittals.
 - b. Requests for approval of substitutions.
 - c. Requests for coordination information already indicated in the Contract Documents.
 - d. Requests for adjustments in the Contract Time or the Contract Sum.
 - e. Requests for interpretation of COR actions on submittals.
 - f. Incomplete RFIs or inaccurately prepared RFIs.
 2. COR action may include a request for additional information, in which case COR time for response will date from time of receipt of additional information.
 3. COR 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 COR 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. Use software log that is part of Project Web site. Software log with not less than the following:
1. Project name.
 2. Name and address of Contractor.
 3. Name and address of COR.
 4. RFI number including RFIs that were dropped and not submitted.
 5. RFI description.
 6. Date the RFI was submitted.
 7. Date COR response was received.
- F. On receipt of COR action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify COR 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.
- 1.7 PROJECT WEB SITE
- A. Use Constructor Provided, administer, and use Project Web site for purposes of hosting and managing project communication and documentation until Final Completion. Project Web site shall include the following functions:
1. Project directory.
 2. Project correspondence.
 3. Meeting minutes.

4. Contract modifications forms and logs.
 5. RFI forms and logs.
 6. Task and issue management.
 7. Photo documentation.
 8. Schedule and calendar management.
 9. Submittals forms and logs.
 10. Payment application forms.
 11. Drawing and specification document hosting, viewing, and updating.
 12. Online document collaboration.
 13. Reminder and tracking functions.
 14. Archiving functions.
- B. Provide up to seven Project Web site user licenses for use of (2) Owner Authority, (2) Architects, and (3) COR consultants. Provide 2 hours of software training at COR office for Project Web site users if not Submittal Exchange or Procore.
- C. On completion of Project, provide one each complete archive copy of Project Web site files to Owner and to COR in a digital storage format acceptable to COR.
- D. Provide one the following Project Web site software packages under their current published licensing agreements:
1. Procore
 2. Meridian Systems, Prolog
 3. Submittal Exchange
- E. Contractor, subcontractors, and other parties granted access by Contractor to Project Web site shall execute a data licensing agreement in the form of Agreement acceptable to Owner and COR.

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 COR 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 COR, within three days of the meeting.
- B. Preconstruction Conference: Owner will schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner and COR, but no later than 15 days after execution of the Agreement.
1. Attendees: Authorized representatives of Owner, COR, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.

2. Agenda: Discuss items of significance that could affect progress, including the following:
 - a. Tentative construction schedule.
 - b. Phasing.
 - c. Critical work sequencing and long-lead items.
 - d. Designation of key personnel and their duties.
 - e. Procedures for processing field decisions and Change Orders.
 - f. Procedures for RFIs.
 - g. Procedures for testing and inspecting.
 - h. Procedures for processing Applications for Payment.
 - i. Distribution of the Contract Documents.
 - j. Submittal procedures.
 - k. Retain first subparagraph below for projects with LEED or other sustainable design documentation requirements.
 - 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.
 3. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.
- C. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity 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 COR 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. Possible conflicts.

- i. Compatibility problems.
 - j. Time schedules.
 - k. Weather limitations.
 - l. Manufacturer's written instructions.
 - m. Warranty requirements.
 - n. Compatibility of materials.
 - o. Acceptability of substrates.
 - p. Temporary facilities and controls.
 - q. Space and access limitations.
 - r. Regulations of authorities having jurisdiction.
 - s. Testing and inspecting requirements.
 - t. Installation procedures.
 - u. Coordination with other work.
 - v. Required performance results.
 - w. Protection of adjacent work.
 - x. Protection of construction and personnel.
3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
 4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.
 5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.

D. Progress Meetings: Conduct progress meetings at weekly intervals.

1. Attendees: In addition to representatives of Owner and COR, 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.
2. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 - 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) Status of submittals.
 - 4) Deliveries.

- 5) Off-site fabrication.
 - 6) Access.
 - 7) Site utilization.
 - 8) Temporary facilities and controls.
 - 9) Progress cleaning.
 - 10) Quality and work standards.
 - 11) Status of correction of deficient items.
 - 12) Field observations.
 - 13) Status of RFIs.
 - 14) Status of proposal requests.
 - 15) Pending changes.
 - 16) Status of Change Orders.
 - 17) Pending claims and disputes.
 - 18) Documentation of information for payment requests.
3. 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.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013100

SECTION 013200 - CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 SUMMARY

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

1.2 DEFINITIONS

- A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a construction schedule consume time and resources.
 - 1. Critical Activity: An activity on the critical path that must start and finish on the planned early start and finish times.
 - 2. Predecessor Activity: An activity that precedes another activity in the network.
 - 3. Successor Activity: An activity that follows another activity in the network.
- B. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Project.
- C. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.

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

- D. Daily Construction Reports: Submit at weekly intervals.
- E. Site Condition Reports: Submit at time of discovery of differing conditions.

1.4 COORDINATION

- A. Coordinate Contractor's construction schedule with the schedule of values, list of subcontracts, submittal schedule, progress reports, payment requests, and other required schedules and reports.
 - 1. Secure time commitments for performing critical elements of the Work from entities involved.
 - 2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

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 Substantial 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 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 COR.
 - 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. Substantial Completion: Indicate completion in advance of date established for Substantial Completion and allow time for COR and Construction Manager's administrative procedures necessary for certification of Substantial Completion.
 - 5. Punch List and Final Completion: Include not more than 15 days for completion of punch list items and final completion.
- C. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.
 - 1. Phasing: Arrange list of activities on schedule by phase.

2. Work under More Than One Contract: Include a separate activity for each contract.
 3. Work by Owner: Include a separate activity for each portion of the Work performed by Owner.
 4. 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. Provisions for future construction.
 - g. Seasonal variations.
 - h. Environmental control.
 5. Work Stages: Indicate important stages of construction for each major portion of the Work.
- 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. 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.
- F. Computer Scheduling Software: Prepare schedules using current version of a program that has been developed specifically to manage construction schedules.
1. Use Scheduling component of Project Web site software specified in Section 013100 "Project Management and Coordination, for Windows XP, Windows Vista, Windows 7, Windows 8, or Windows 10.

2.2 CONTRACTOR'S CONSTRUCTION SCHEDULE (GANTT CHART)

- A. Gantt-Chart Schedule: Submit a comprehensive, fully developed, horizontal, Gantt-chart-type, Contractor's construction schedule within 30 days of date established for the Notice of Award to Proceed.
- B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line.
1. For construction activities that require three months or longer to complete, indicate an estimated completion percentage in 25 percent increments within time bar.

2.3 REPORTS

- A. Daily 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.
 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. 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.

PART 3 - EXECUTION

3.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

- A. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one day 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.
- B. Distribution: Distribute copies of approved schedule to COR, 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 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 013200 "Construction Progress Documentation" for submitting schedules and reports, including Contractor's construction schedule.
 - 2. Section 017823 "Operation and Maintenance Data" for submitting operation and maintenance manuals.
 - 3. Section 017839 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.
 - 4. Section 017900 "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of Owner's personnel.

1.2 DEFINITIONS

- A. Action Submittals: Written and graphic information and physical samples that require COR responsive action.
- B. Informational Submittals: Written and graphic information and physical samples that do not require COR responsive action. Submittals may be rejected for not complying with requirements.

1.3 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 COR and additional time for handling and reviewing submittals required by those corrections.

1.4 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

- A. COR Digital Data Files: Electronic copies of digital data files of the Contract Drawings will be provided by COR for Contractor's use in preparing submittals.
 - 1. COR will furnish Contractor one set of digital data drawing files of the Contract Drawings for use in preparing Shop Drawings.

- a. COR makes no representations as to the accuracy or completeness of digital data drawing files as they relate to the Contract Drawings.
 - b. Contractor shall execute a data licensing agreement in the form of AIA Document C106.
- B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
 1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
 2. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
 - a. Architect 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 COR 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. COR 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.
- D. Paper Submittals: Will not be accepted by COR.
- E. Electronic Submittals: Identify and incorporate information in each electronic submittal file as follows:
 1. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
 2. Name file with submittal number or other unique identifier, including revision identifier.
 - a. File name shall use project identifier and Specification Section number followed by a decimal point and then a sequential number (e.g., LNHS-061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., LNHS-061000.01.A).
 3. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by COR
 4. Transmittal Form for Electronic Submittals: Use software-generated form from electronic project management software acceptable to Owner, containing the following information:
 - a. Project name.
 - b. Date.

- c. Name and address of COR.
 - d. Name of Contractor.
 - e. Name of firm or entity that prepared submittal.
 - f. Names of subcontractor, manufacturer, and supplier.
 - g. Category and type of submittal.
 - h. Submittal purpose and description.
 - i. Specification Section number and title.
 - j. Specification paragraph number or drawing designation and generic name for each of multiple items.
 - k. Drawing number and detail references, as appropriate.
 - l. Location(s) where product is to be installed, as appropriate.
 - m. Related physical samples submitted directly.
 - n. Indication of full or partial submittal.
 - o. Transmittal number
 - p. Submittal and transmittal distribution record.
 - q. Other necessary identification.
 - r. Remarks.
5. Metadata: Include the following information as keywords in the electronic submittal file metadata:
- a. Project name.
 - b. Number and title of appropriate Specification Section.
 - c. Manufacturer name.
 - d. Product name.
- F. Options: Identify options requiring selection by COR.
- G. Deviations: Identify deviations from the Contract Documents on submittals.
- H. 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 COR action stamp.
- I. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
- J. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from COR action stamp.

PART 2 - PRODUCTS

2.1 SUBMITTAL PROCEDURES

A. General Submittal Procedure Requirements:

1. Post electronic submittals as PDF electronic files directly to Project Web site specifically established for Project.
 - a. COR will return annotated file. Annotate and retain one copy of file as an electronic Project record document file.
2. Submittals will not be accepted via Email.
3. 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.
- 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, unless submittal based on COR digital data drawing files is otherwise permitted.
 1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
 - a. Identification of products.
 - b. Schedules.
 - c. Compliance with specified standards.
 - d. Notation of coordination requirements.
 - e. Notation of dimensions established by field measurement.
 - f. Relationship and attachment to adjoining construction clearly indicated.
 - g. Seal and signature of professional engineer if specified.
 2. Submit Shop Drawings in the following format:
 - a. PDF electronic file.
- CI. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.
 1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
 2. Identification: Attach label on unexposed side of Samples that includes the following:
 - a. Generic description of Sample.
 - b. Product name and name of manufacturer.
 - c. Sample source.
 - d. Number and title of applicable Specification Section.
 3. For projects where electronic submittals are required, provide corresponding electronic submittal of Sample transmittal, digital image file illustrating Sample characteristics, and identification information for record.
 4. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
 - a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
 - b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.
 5. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.

- a. Number of Samples: Submit one full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. COR will return submittal with options selected.
- 6. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
 - a. Number of Samples: Submit three sets of Samples. COR will retain two Sample sets; remainder will be returned.
 - 1) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.
- E. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:
 - 1. Submit product schedule in the following format:
 - a. PDF electronic file.
- F. Coordination Drawings Submittals: Comply with requirements specified in Section 013100 "Project Management and Coordination."
- G. Contractor's Construction Schedule: Comply with requirements specified in Section 013200 "Construction Progress Documentation."
- H. Test and Inspection Reports and Schedule of Tests and Inspections Submittals: Comply with requirements specified in Section 014000 "Quality Requirements."
- I. Closeout Submittals and Maintenance Material Submittals: Comply with requirements specified in Section 017700 "Closeout Procedures."
- J. Maintenance Data: Comply with requirements specified in Section 017823 "Operation and Maintenance Data."
- K. 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.
- L. 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.

- M. 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.
- N. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
- O. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
- P. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
- Q. 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.
- R. 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.
- S. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project.
- T. Schedule of Tests and Inspections: Comply with requirements specified in Section 014000 "Quality Requirements."
- U. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
- V. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.
- W. 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.
- X. Design Data: Prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.

2.2 DELEGATED-DESIGN SERVICES

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
 - 1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.
- B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF electronic file and three paper copies of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.
 - 1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

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 COR.
- B. Project Closeout and Maintenance Material Submittals: See requirements in Section 017700 "Closeout Procedures."
- C. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

3.2 COR ACTION

- A. General: COR will not review submittals that do not bear Contractor's approval stamp and will return them without action.
- B. Action Submittals: COR will review each submittal, make marks to indicate corrections or revisions required, and return it. COR will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action, as follows:
 - 1. No Action Taken
 - 2. No Exception
 - 3. Reviewed

4. Reviewed with Comments

- C. Informational Submittals: COR will review each submittal and will not return it if it does not comply with requirements. COR will forward each submittal to appropriate party.
- D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.
- E. Submittals not required by the Contract Documents may not be reviewed and may be discarded.

END OF SECTION 013300

SECTION 014000 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 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. 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.
 - 2. Requirements for Contractor to provide quality-assurance and -control services required by COR, Owner or authorities having jurisdiction are not limited by provisions of this Section.
 - 3. Specific test and inspection requirements are not specified in this Section.

1.2 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 COR.
- C. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria.
- D. Product Testing: Tests and inspections that are performed by an NRTL, an NVLAP, or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.
- E. Source Quality-Control Testing: Tests and inspections that are performed at the source, e.g., plant, mill, factory, or shop.
- F. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.

- G. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.
- H. 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).
- I. Experienced: When used with an entity or individual, "experienced" means having successfully completed a minimum of [five] <Insert number> previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

1.3 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 COR for a decision before proceeding.

1.4 INFORMATIONAL SUBMITTALS

- A. 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 COR.
 - 2. Main wind-force-resisting system or a wind-resisting component listed in the wind-force-resisting system quality-assurance plan prepared by COR.
- B. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.

1.5 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 and signature of laboratory inspector.
 13. Recommendations on retesting and reinspecting.
- B. Manufacturer's Field Reports: Prepare written information documenting tests and inspections specified in other Sections. Include the following:
1. Name, address, and telephone number of representative making report.
 2. Statement on condition of substrates and their acceptability for installation of product.
 3. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
 4. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 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.

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

- D. **Installer Qualifications:** A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
- E. **Professional Engineer Qualifications:** A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar in material, design, and extent to those indicated for this Project.
- F. **Specialists:** Certain Specification Sections require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.
 - 1. Requirements of authorities having jurisdiction shall supersede requirements for specialists.
- G. **Testing Agency Qualifications:** An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated, as documented according to ASTM E 329; and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.
 - 1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
 - 2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.
- H. **Manufacturer's Representative Qualifications:** An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- I. **Preconstruction Testing:** Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:
 - 1. Contractor responsibilities include the following:
 - a. Provide test specimens representative of proposed products and construction.
 - b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
 - c. Build laboratory mockups at testing facility using personnel, products, and methods of construction indicated for the completed Work.
 - d. When testing is complete, remove test specimens, assemblies; do not reuse products on Project.
 - 2. **Testing Agency Responsibilities:** Submit a certified written report of each test, inspection, and similar quality-assurance service to COR, with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.

1.7 QUALITY CONTROL

- A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.
1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspecting they are engaged to perform.
 2. Costs for retesting and reinspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor and the Contract Sum will be adjusted by Change Order.
- B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities required to verify that the Work complies with requirements, whether specified or not.
1. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.
 - a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
 2. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
 3. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
 4. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
 5. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- C. Manufacturer's Field Services: Where indicated, engage a manufacturer's representative to observe and inspect the Work. Manufacturer's representative's services include examination of substrates and conditions, verification of materials, inspection of completed portions of the Work, and submittal of written reports.
- D. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.
- E. Testing Agency Responsibilities: Cooperate with COR and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
1. Notify COR 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.
- F. 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.
- G. 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, obtaining samples, and similar activities.

1.8 SPECIAL TESTS AND INSPECTIONS

- A. Special Tests and Inspections: Engage a qualified testing agency and any required special inspector to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of Owner and as follows:
- B. Special Tests and Inspections: Conducted by a qualified testing agency and/or special inspector as required by authorities having jurisdiction, as indicated in individual Specification Sections, and as follows:
1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviews the completeness and adequacy of those procedures to perform the Work.
 2. Notifying COR and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
 3. Submitting a certified written report of each test, inspection, and similar quality-control service to COR with copy to Contractor and to authorities having jurisdiction.
 4. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
 5. Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.
 6. Retesting and reinspecting corrected work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

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

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

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

3.2 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 014200 - REFERENCES

1.1 DEFINITIONS

- A. General: Basic Contract definitions are included in the Conditions of the Contract.
- B. "Approved": When used to convey COR action on Contractor's submittals, applications, and requests, "approved" is limited to COR duties and responsibilities as stated in the Conditions of the Contract.
- C. "Directed": A command or instruction by COR. Other terms including "requested," "authorized," "selected," "required," and "permitted" have the same meaning as "directed."
- D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."
- E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.
- F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.
- G. "Install": Unload, temporarily store, unpack, assemble, erect, place, anchor, apply, work to dimension, finish, cure, protect, clean, and similar operations at Project site.
- H. "Provide": Furnish and install, complete and ready for the intended use.
- I. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

1.2 INDUSTRY STANDARDS

- A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.
- B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
- C. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.

1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

1.3 ABBREVIATIONS AND ACRONYMS

A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities indicated in Gale's "Encyclopedia of Associations: National Organizations of the U.S." or in Columbia Books' "National Trade & Professional Associations of the United States."

B. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list.

1. AABC - Associated Air Balance Council; www.aabc.com.
2. AAMA - American Architectural Manufacturers Association; www.aamanet.org.
3. AAPFCO - Association of American Plant Food Control Officials; www.aapfco.org.
4. AASHTO - American Association of State Highway and Transportation Officials; www.transportation.org.
5. AATCC - American Association of Textile Chemists and Colorists; www.aatcc.org.
6. ABMA - American Bearing Manufacturers Association; www.americanbearings.org.
7. ABMA - American Boiler Manufacturers Association; www.abma.com.
8. ACI - American Concrete Institute; (Formerly: ACI International); www.abma.com.
9. ACPA - American Concrete Pipe Association; www.concrete-pipe.org.
10. AEIC - Association of Edison Illuminating Companies, Inc. (The); www.aeic.org.
11. AF&PA - American Forest & Paper Association; www.afandpa.org.
12. AGA - American Gas Association; www.aga.org.
13. AHAM - Association of Home Appliance Manufacturers; www.aham.org.
14. AHRI - Air-Conditioning, Heating, and Refrigeration Institute (The); www.ahrinet.org.
15. AI - Asphalt Institute; www.asphaltinstitute.org.
16. AIA - American Institute of Architects (The); www.aia.org.
17. AISC - American Institute of Steel Construction; www.aisc.org.
18. AISI - American Iron and Steel Institute; www.steel.org.
19. AITC - American Institute of Timber Construction; www.aitc-glulam.org.
20. AMCA - Air Movement and Control Association International, Inc.; www.amca.org.
21. ANSI - American National Standards Institute; www.ansi.org.
22. AOSA - Association of Official Seed Analysts, Inc.; www.aosaseed.com.
23. APA - APA - The Engineered Wood Association; www.apawood.org.
24. APA - Architectural Precast Association; www.archprecast.org.
25. API - American Petroleum Institute; www.api.org.
26. ARI - Air-Conditioning & Refrigeration Institute; (See AHRI).
27. ARI - American Refrigeration Institute; (See AHRI).
28. ARMA - Asphalt Roofing Manufacturers Association; www.asphaltroofing.org.
29. ASCE - American Society of Civil Engineers; www.asce.org.
30. ASCE/SEI - American Society of Civil Engineers/Structural Engineering Institute; (See ASCE).
31. ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers; www.ashrae.org.
32. ASME - ASME International; (American Society of Mechanical Engineers); www.asme.org.
33. ASSE - American Society of Safety Engineers (The); www.asse.org.

34. ASSE - American Society of Sanitary Engineering; www.asse-plumbing.org.
35. ASTM - ASTM International; www.astm.org.
36. ATIS - Alliance for Telecommunications Industry Solutions; www.atis.org.
37. AWEA - American Wind Energy Association; www.awea.org.
38. AWI - Architectural Woodwork Institute; www.awinet.org.
39. AWMAC - Architectural Woodwork Manufacturers Association of Canada; www.awmac.com.
40. AWWA - American Water Works Association; www.awwa.org.
41. AWS - American Welding Society; www.aws.org.
42. AWWA - American Water Works Association; www.awwa.org.
43. BHMA - Builders Hardware Manufacturers Association; www.buildershardware.com.
44. BIA - Brick Industry Association (The); www.gobrick.com.
45. BICSI - BICSI, Inc.; www.bicsi.org.
46. BIFMA - BIFMA International; (Business and Institutional Furniture Manufacturer's Association); www.bifma.org.
47. BISSC - Baking Industry Sanitation Standards Committee; www.bissc.org.
48. BWF - Badminton World Federation; (Formerly: International Badminton Federation); www.bissc.org.
49. CDA - Copper Development Association; www.copper.org.
50. CEA - Canadian Electricity Association; www.electricity.ca.
51. CEA - Consumer Electronics Association; www.ce.org.
52. CFFA - Chemical Fabrics and Film Association, Inc.; www.chemicalfabricsandfilm.com.
53. CFSEI - Cold-Formed Steel Engineers Institute; www.cfsei.org.
54. CGA - Compressed Gas Association; www.cganet.com.
55. CIMA - Cellulose Insulation Manufacturers Association; www.cellulose.org.
56. CISCA - Ceilings & Interior Systems Construction Association; www.cisca.org.
57. CISPI - Cast Iron Soil Pipe Institute; www.cispi.org.
58. CLFMI - Chain Link Fence Manufacturers Institute; www.chainlinkinfo.org.
59. CPA - Composite Panel Association; www.pbmdf.com.
60. CRI - Carpet and Rug Institute (The); www.carpet-rug.org.
61. CRRC - Cool Roof Rating Council; www.coolroofs.org.
62. CRSI - Concrete Reinforcing Steel Institute; www.crsi.org.
63. CSA - Canadian Standards Association; www.csa.ca.
64. CSA - CSA International; (Formerly: IAS - International Approval Services); www.csa-international.org.
65. CSI - Construction Specifications Institute (The); www.csinet.org.
66. CSSB - Cedar Shake & Shingle Bureau; www.cedarbureau.org.
67. CTI - Cooling Technology Institute; (Formerly: Cooling Tower Institute); www.cti.org.
68. CWC - Composite Wood Council; (See CPA).
69. DASMA - Door and Access Systems Manufacturers Association; www.dasma.com.
70. DHI - Door and Hardware Institute; www.dhi.org.
71. ECA - Electronic Components Association; (See ECIA).
72. ECAMA - Electronic Components Assemblies & Materials Association; (See ECIA).
73. ECIA - Electronic Components Industry Association; www.eciaonline.org.
74. EIA - Electronic Industries Alliance; (See TIA).
75. EIMA - EIFS Industry Members Association; www.eima.com.
76. EJMA - Expansion Joint Manufacturers Association, Inc.; www.ejma.org.
77. ESD - ESD Association; (Electrostatic Discharge Association); www.esda.org.
78. ESTA - Entertainment Services and Technology Association; (See PLASA).
79. EVO - Efficiency Valuation Organization; www.evo-world.org.
80. FCI - Fluid Controls Institute; www.fluidcontrolsintstitute.org.

81. FIBA - Federation Internationale de Basketball; (The International Basketball Federation); www.fiba.com.
82. FIVB - Federation Internationale de Volleyball; (The International Volleyball Federation); www.fivb.org.
83. FM Approvals - FM Approvals LLC; www.fmglobal.com.
84. FM Global - FM Global; (Formerly: FMG - FM Global); www.fmglobal.com.
85. FRSA - Florida Roofing, Sheet Metal & Air Conditioning Contractors Association, Inc.; www.floridarooft.com.
86. FSA - Fluid Sealing Association; www.fluidsealing.com.
87. FSC - Forest Stewardship Council U.S.; www.fscus.org.
88. GA - Gypsum Association; www.gypsum.org.
89. GANA - Glass Association of North America; www.glasswebsite.com.
90. GS - Green Seal; www.greenseal.org.
91. HI - Hydraulic Institute; www.pumps.org.
92. HI/GAMA - Hydronics Institute/Gas Appliance Manufacturers Association; (See AHRI).
93. HMMA - Hollow Metal Manufacturers Association; (See NAAMM).
94. HPVA - Hardwood Plywood & Veneer Association; www.hpva.org.
95. HPW - H. P. White Laboratory, Inc.; www.hpwhite.com.
96. IAPSC - International Association of Professional Security Consultants; www.iapsc.org.
97. IAS - International Accreditation Service; www.iasonline.org.
98. IAS - International Approval Services; (See CSA).
99. ICBO - International Conference of Building Officials; (See ICC).
100. ICC - International Code Council; www.iccsafe.org.
101. ICEA - Insulated Cable Engineers Association, Inc.; www.icea.net.
102. ICPA - International Cast Polymer Alliance; www.icpa-hq.org.
103. ICRI - International Concrete Repair Institute, Inc.; www.icri.org.
104. IEC - International Electrotechnical Commission; www.iec.ch.
105. IEEE - Institute of Electrical and Electronics Engineers, Inc. (The); www.ieee.org.
106. IES - Illuminating Engineering Society; (Formerly: Illuminating Engineering Society of North America); www.ies.org.
107. IESNA - Illuminating Engineering Society of North America; (See IES).
108. IEST - Institute of Environmental Sciences and Technology; www.iest.org.
109. IGMA - Insulating Glass Manufacturers Alliance; www.igmaonline.org.
110. IGSHPA - International Ground Source Heat Pump Association; www.igshpa.okstate.edu.
111. ILI - Indiana Limestone Institute of America, Inc.; www.iliai.com.
112. Intertek - Intertek Group; (Formerly: ETL SEMCO; Intertek Testing Service NA); www.intertek.com.
113. ISA - International Society of Automation (The); (Formerly: Instrumentation, Systems, and Automation Society); www.isa.org.
114. ISAS - Instrumentation, Systems, and Automation Society (The); (See ISA).
115. ISFA - International Surface Fabricators Association; (Formerly: International Solid Surface Fabricators Association); www.isfanow.org.
116. ISO - International Organization for Standardization; www.iso.org.
117. ISSFA - International Solid Surface Fabricators Association; (See ISFA).
118. ITU - International Telecommunication Union; www.itu.int/home.
119. KCMA - Kitchen Cabinet Manufacturers Association; www.kcma.org.
120. LMA - Laminating Materials Association; (See CPA).
121. LPI - Lightning Protection Institute; www.lightning.org.
122. MBMA - Metal Building Manufacturers Association; www.mbma.com.
123. MCA - Metal Construction Association; www.metalconstruction.org.

124. MFMA - Maple Flooring Manufacturers Association, Inc.; www.maplefloor.org.
125. MFMA - Metal Framing Manufacturers Association, Inc.; www.metalframingmfg.org.
126. MHIA - Material Handling Industry of America; www.mhia.org.
127. MIA - Marble Institute of America; www.marble-institute.com.
128. MMPA - Moulding & Millwork Producers Association; www.wmmpa.com.
129. MPI - Master Painters Institute; www.paintinfo.com.
130. MSS - Manufacturers Standardization Society of The Valve and Fittings Industry Inc.; www.mss-hq.org.
131. NAAMM - National Association of Architectural Metal Manufacturers; www.naamm.org.
132. NACE - NACE International; (National Association of Corrosion Engineers International); www.nace.org.
133. NADCA - National Air Duct Cleaners Association; www.nadca.com.
134. NAIMA - North American Insulation Manufacturers Association; www.naima.org.
135. NBGQA - National Building Granite Quarries Association, Inc.; www.nbgqa.com.
136. NBI - New Buildings Institute; www.newbuildings.org.
137. NCAA - National Collegiate Athletic Association (The); www.ncaa.org.
138. NCMA - National Concrete Masonry Association; www.ncma.org.
139. NEBB - National Environmental Balancing Bureau; www.nebb.org.
140. NECA - National Electrical Contractors Association; www.necanet.org.
141. NeLMA - Northeastern Lumber Manufacturers Association; www.nelma.org.
142. NEMA - National Electrical Manufacturers Association; www.nema.org.
143. NETA - InterNational Electrical Testing Association; www.netaworld.org.
144. NFHS - National Federation of State High School Associations; www.nfhs.org.
145. NFPA - National Fire Protection Association; www.nfpa.org.
146. NFPA - NFPA International; (See NFPA).
147. NFRC - National Fenestration Rating Council; www.nfrc.org.
148. NHLA - National Hardwood Lumber Association; www.nhla.com.
149. NLGA - National Lumber Grades Authority; www.nlga.org.
150. NOFMA - National Oak Flooring Manufacturers Association; (See NWFA).
151. NOMMA - National Ornamental & Miscellaneous Metals Association; www.nomma.org.
152. NRCA - National Roofing Contractors Association; www.nrca.net.
153. NRMCA - National Ready Mixed Concrete Association; www.nrmca.org.
154. NSF - NSF International; www.nsf.org.
155. NSPE - National Society of Professional Engineers; www.nspe.org.
156. NSSGA - National Stone, Sand & Gravel Association; www.nssga.org.
157. NTMA - National Terrazzo & Mosaic Association, Inc. (The); www.ntma.com.
158. NWFA - National Wood Flooring Association; www.nwfa.org.
159. PCI - Precast/Prestressed Concrete Institute; www.pci.org.
160. PDI - Plumbing & Drainage Institute; www.pdionline.org.
161. PLASA - PLASA; (Formerly: ESTA - Entertainment Services and Technology Association); www.plasa.org.
162. RCSC - Research Council on Structural Connections; www.boltcouncil.org.
163. RFCI - Resilient Floor Covering Institute; www.rfci.com.
164. RIS - Redwood Inspection Service; www.redwoodinspection.com.
165. SAE - SAE International; www.sae.org.
166. SCTE - Society of Cable Telecommunications Engineers; www.scte.org.
167. SDI - Steel Deck Institute; www.sdi.org.
168. SDI - Steel Door Institute; www.steeldoor.org.
169. SEFA - Scientific Equipment and Furniture Association (The); www.sefalabs.com.

170. SEI/ASCE - Structural Engineering Institute/American Society of Civil Engineers; (See ASCE).
171. SIA - Security Industry Association; www.siaonline.org.
172. SJI - Steel Joist Institute; www.steeljoist.org.
173. SMA - Screen Manufacturers Association; www.smainfo.org.
174. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association; www.smacna.org.
175. SMPTE - Society of Motion Picture and Television Engineers; www.smpte.org.
176. SPFA - Spray Polyurethane Foam Alliance; www.sprayfoam.org.
177. SPIB - Southern Pine Inspection Bureau; www.spib.org.
178. SPRI - Single Ply Roofing Industry; www.spri.org.
179. SRCC - Solar Rating & Certification Corporation; www.solar-rating.org.
180. SSINA - Specialty Steel Industry of North America; www.ssina.com.
181. SSPC - SSPC: The Society for Protective Coatings; www.sspc.org.
182. STI - Steel Tank Institute; www.steeltank.com.
183. SWI - Steel Window Institute; www.steelwindows.com.
184. SWPA - Submersible Wastewater Pump Association; www.swpa.org.
185. TCA - Tilt-Up Concrete Association; www.tilt-up.org.
186. TCNA - Tile Council of North America, Inc.; www.tileusa.com.
187. TEMA - Tubular Exchanger Manufacturers Association, Inc.; www.tema.org.
188. TIA - Telecommunications Industry Association (The); (Formerly: TIA/EIA - Telecommunications Industry Association/Electronic Industries Alliance); www.tiaonline.org.
189. TIA/EIA - Telecommunications Industry Association/Electronic Industries Alliance; (See TIA).
190. TMS - The Masonry Society; www.masonrysociety.org.
191. TPI - Truss Plate Institute; www.tpinst.org.
192. TPI - Turfgrass Producers International; www.turfgrasssod.org.
193. TRI - Tile Roofing Institute; www.tilerroofing.org.
194. UL - Underwriters Laboratories Inc.; www.ul.com.
195. UNI - Uni-Bell PVC Pipe Association; www.uni-bell.org.
196. USAV - USA Volleyball; www.usavolleyball.org.
197. USGBC - U.S. Green Building Council; www.usgbc.org.
198. USITT - United States Institute for Theatre Technology, Inc.; www.usitt.org.
199. WASTEC - Waste Equipment Technology Association; www.wastec.org.
200. WCLIB - West Coast Lumber Inspection Bureau; www.wclib.org.
201. WCMA - Window Covering Manufacturers Association; www.wcmanet.org.
202. WDMA - Window & Door Manufacturers Association; www.wdma.com.
203. WI - Woodwork Institute; www.wicnet.org.
204. WSRCA - Western States Roofing Contractors Association; www.wsrca.com.
205. WWPA - Western Wood Products Association; www.wwpa.org.

C. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list.

1. DIN - Deutsches Institut für Normung e.V.; www.din.de.
2. IAPMO - International Association of Plumbing and Mechanical Officials; www.iapmo.org.
3. ICC - International Code Council; www.iccsafe.org.
4. ICC-ES - ICC Evaluation Service, LLC; www.icc-es.org.

- D. Federal Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list.
1. COE - Army Corps of Engineers; www.usace.army.mil.
 2. CPSC - Consumer Product Safety Commission; www.cpsc.gov.
 3. DOC - Department of Commerce; National Institute of Standards and Technology; www.nist.gov.
 4. DOD - Department of Defense; www.quicksearch.dla.mil.
 5. DOE - Department of Energy; www.energy.gov.
 6. EPA - Environmental Protection Agency; www.epa.gov.
 7. FAA - Federal Aviation Administration; www.faa.gov.
 8. FG - Federal Government Publications; www.gpo.gov.
 9. GSA - General Services Administration; www.gsa.gov.
 10. HUD - Department of Housing and Urban Development; www.hud.gov.
 11. LBL - Lawrence Berkeley National Laboratory; Environmental Energy Technologies Division; www.eetd.lbl.gov.
 12. OSHA - Occupational Safety & Health Administration; www.osha.gov.
 13. SD - Department of State; www.state.gov.
 14. TRB - Transportation Research Board; National Cooperative Highway Research Program; The National Academies; www.trb.org.
 15. USDA - Department of Agriculture; Agriculture Research Service; U.S. Salinity Laboratory; www.ars.usda.gov.
 16. USDA - Department of Agriculture; Rural Utilities Service; www.usda.gov.
 17. USDJ - Department of Justice; Office of Justice Programs; National Institute of Justice; www.ojp.usdoj.gov.
 18. USP - U.S. Pharmacopeial Convention; www.usp.org.
 19. USPS - United States Postal Service; www.usps.com.
- E. Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the standards and regulations in the following list.
1. CFR - Code of Federal Regulations; Available from Government Printing Office; www.gpo.gov/fdsys.
 2. DOD - Department of Defense; Military Specifications and Standards; Available from DLA Document Services; www.quicksearch.dla.mil.
 3. DSCC - Defense Supply Center Columbus; (See FS).
 4. FED-STD - Federal Standard; (See FS).
 5. FS - Federal Specification; Available from DLA Document Services; www.quicksearch.dla.mil.
 - a. Available from Defense Standardization Program; www.dsp.dla.mil.
 - b. Available from General Services Administration; www.gsa.gov.
 - c. Available from National Institute of Building Sciences/Whole Building Design Guide; www.wbdg.org/ccb.
 6. MILSPEC - Military Specification and Standards; (See DOD).
 7. USAB - United States Access Board; www.access-board.gov.
 8. USATBCB - U.S. Architectural & Transportation Barriers Compliance Board; (See USAB).

- F. State Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list.
1. CBHF; State of California; Department of Consumer Affairs; Bureau of Electronic and Appliance Repair, Home Furnishings and Thermal Insulation; www.bearhfti.ca.gov.
 2. CCR; California Code of Regulations; Office of Administrative Law; California Title 24 Energy Code; www.calregs.com.
 3. CDHS; California Department of Health Services; (See CDPH).
 4. CDPH; California Department of Public Health; Indoor Air Quality Program; www.cal-iaq.org.
 5. CPUC; California Public Utilities Commission; www.cpuc.ca.gov.
 6. SCAQMD; South Coast Air Quality Management District; www.aqmd.gov.
 7. TFS; Texas A&M Forest Service; Sustainable Forestry and Economic Development; www.txforests-service.tamu.edu.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 014200

SECTION 016000 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.
- B. Related Requirements:
 - 1. Section 012500 "Substitution Procedures" for requests for substitutions.

1.2 DEFINITIONS

- A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
 - 1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature, that is current as of date of the Contract Documents.
 - 2. New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.
 - 3. Comparable Product: Product that is demonstrated and approved through submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Basis-of-Design Product Specification: A specification in which a specific manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of additional manufacturers named in the specification.

1.3 ACTION SUBMITTALS

- A. Comparable Product Requests: Submit request for consideration of each comparable product. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
 - 1. COR Action: If necessary, COR will request additional information or documentation for evaluation within one week of receipt of a comparable product

request. COR will notify Contractor of approval or rejection of proposed comparable product request within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.

- a. Form of Approval: As specified in Section 013300 "Submittal Procedures."
- b. Use product specified if COR does not issue a decision on use of a comparable product request within time allocated.

- B. Basis-of-Design Product Specification Submittal: Comply with requirements in Section 013300 "Submittal Procedures." Show compliance with requirements.

1.4 QUALITY ASSURANCE

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

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

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

- B. Delivery and Handling:

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

- C. Storage:

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

1.6 PRODUCT WARRANTIES

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
 - 1. Manufacturer's Warranty: Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
 - 2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner.
- B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.
 - 1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
 - 2. Specified Form: When specified forms are included with the Specifications, prepare a written document using indicated form properly executed.
 - 3. Refer to other Sections for specific content requirements and particular requirements for submitting special warranties.
- C. Submittal Time: Comply with requirements in Section 017700 "Closeout Procedures."

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

- A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.
 - 1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
 - 2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
 - 3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
 - 4. Where products are accompanied by the term "as selected," Architect will make selection.
 - 5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
- B. Product Selection Procedures:
 - 1. Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.

2. Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 3. Products:
 - a. Restricted List: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 - b. Nonrestricted List: Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed, or an unnamed product, that complies with requirements. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product.
 4. Manufacturers:
 - a. Restricted List: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 - b. Nonrestricted List: Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed, or a product by an unnamed manufacturer, that complies with requirements. Comply with requirements in "Comparable Products" Article for consideration of an unnamed manufacturer's product.
 5. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.
- C. Visual Matching Specification: Where Specifications require "match COR sample", provide a product that complies with requirements and matches COR sample. COR decision will be final on whether a proposed product matches.
1. If no product available within specified category matches and complies with other specified requirements, comply with requirements in Section 012500 "Substitution Procedures" for proposal of product.
- CI. Visual Selection Specification: Where Specifications include the phrase "as selected by COR from manufacturer's full range" or similar phrase, select a product that complies with requirements. COR will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

2.2 COMPARABLE PRODUCTS

- A. Conditions for Consideration: Architect will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, COR may return requests without action, except to record noncompliance with these requirements:
1. Evidence that the proposed product does not require revisions to the Contract Documents, that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.
 2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
 3. Evidence that proposed product provides specified warranty.
 4. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
 5. Samples, if requested.

PART 3 - EXECUTION (Not Used)

END OF SECTION 016000

SECTION 017300 - EXECUTION

PART 1 - GENERAL

1.1 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. Field engineering and surveying.
 - 3. Installation of the Work.
 - 4. Cutting and patching.
 - 5. Coordination of Owner-installed products.
 - 6. Progress cleaning.
 - 7. Starting and adjusting.
 - 8. Protection of installed construction.
- B. Related Requirements:
 - 1. Section 011000 "Summary" for limits on use of Project site.
 - 2. Section 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.
 - 3. Section 078413 "Penetration Firestopping" for patching penetrations in fire-rated construction.

1.2 QUALITY ASSURANCE

- A. Land Surveyor Qualifications: A professional land surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing land-surveying services of the kind indicated.
- B. 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 COR of locations and details of cutting and await directions from COR before proceeding. Shore, brace, and support structural element 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 COR opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

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

3.2 PREPARATION

- A. Existing Utility Information: Furnish information to local utility and Owner that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of Contractor, submit a request for information to COR 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 COR promptly.
- B. General: Engage a professional engineer to lay out the Work using accepted surveying practices.
 1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
 2. Establish limits on use of Project site.
 3. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
 4. Inform installers of lines and levels to which they must comply.
 5. Check the location, level and plumb, of every major element as the Work progresses.
 6. Notify COR when deviations from required lines and levels exceed allowable tolerances.
 7. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.

- C. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.
- D. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Architect.

3.4 INSTALLATION

- A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
 - 1. Make vertical work plumb and make horizontal work level.
 - 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
 - 3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
- D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
- E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.
- F. Tools and Equipment: 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 COR.
 - 2. Allow for building movement, including thermal expansion and contraction.
 - 3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with

integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

- I. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.
- J. 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: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.
- 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 and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
 - 4. Excavating and Backfilling: Comply with requirements in applicable Sections where required by cutting and patching operations.

5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
 6. Proceed with patching after construction operations requiring cutting are complete.
- H. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other work. Patch with durable seams that are as invisible as practicable. Provide materials and comply with installation requirements specified in other Sections, where applicable.
1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
 2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will minimize evidence of patching and refinishing.
 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.
 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.
- 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. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- B. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.
- C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Manufacturer's Field Service: Comply with qualification requirements in Section 014000 "Quality Requirements"

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 017419 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for the following:
 - 1. Disposing of non-hazardous demolition and construction waste.

1.2 DEFINITIONS

- A. Construction Waste: Building and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.
- B. Demolition Waste: Building and site improvement materials resulting from demolition or selective demolition operations.
- C. Disposal: Removal off-site of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.
- D. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.

1.3 ACTION SUBMITTALS

- A. Waste Management Plan: Submit plan within 30 days of date established for the Notice of Award.

1.4 INFORMATIONAL SUBMITTALS

- A. Waste Reduction Progress Reports: Concurrent with each Application for Payment, submit report. Include the following information:
 - 1. Material category.
 - 2. Generation point of waste.
 - 3. Total quantity of waste in **tons (tonnes)**.
 - 4. Quantity of waste salvaged, both estimated and actual in **tons (tonnes)**.
 - 5. Quantity of waste recycled, both estimated and actual in **tons (tonnes)**.
 - 6. Total quantity of waste recovered (salvaged plus recycled) in **tons (tonnes)**.
 - 7. Total quantity of waste recovered (salvaged plus recycled) as a percentage of total waste.
- B. Waste Reduction Calculations: Before request for Substantial Completion, submit calculated end-of-Project rates for salvage, recycling, and disposal as a percentage of total waste generated by the Work.

- C. Records of Donations: Indicate receipt and acceptance of salvageable waste donated to individuals and organizations. Indicate whether organization is tax exempt.
- D. Records of Sales: Indicate receipt and acceptance of salvageable waste sold to individuals and organizations. Indicate whether organization is tax exempt.
- E. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.
- F. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.
- G. Qualification Data: For waste management coordinator.

1.5 WASTE MANAGEMENT PLAN

- A. General: Develop a waste management plan according to ASTM E 1609 and requirements in this Section. Plan shall consist of waste identification, waste reduction work plan, and cost/revenue analysis. Distinguish between demolition and construction waste. Indicate quantities by weight or volume, but use same units of measure throughout waste management plan.
- B. Waste Identification: Indicate anticipated types and quantities of demolition and construction waste generated by the Work. Include estimated quantities and assumptions for estimates.
- C. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.
 - 1. Salvaged Materials for Reuse: For materials that will be salvaged and reused in this Project, describe methods for preparing salvaged materials before incorporation into the Work.
 - 2. Salvaged Materials for Sale: For materials that will be sold to individuals and organizations, include list of their names, addresses, and telephone numbers.
 - 3. Salvaged Materials for Donation: For materials that will be donated to individuals and organizations, include list of their names, addresses, and telephone numbers.
 - 4. Recycled Materials: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.
 - 5. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.
 - 6. Handling and Transportation Procedures: Include method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location where materials separation will be performed.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PLAN IMPLEMENTATION

- A. General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.
- B. Waste Management Coordinator: Engage a waste management coordinator to be responsible for implementing, monitoring, and reporting status of waste management work plan.
- C. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work occurring at Project site.
 - 1. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.

3.2 SALVAGING DEMOLITION WASTE

- A. Salvaged Items for Reuse in the Work:
 - 1. Clean salvaged items.
 - 2. Pack or crate items after cleaning. Identify contents of containers.
 - 3. Store items in a secure area until installation.
 - 4. Protect items from damage during transport and storage.
 - 5. Install salvaged items to comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make items functional for use indicated.
- B. Salvaged Items for Sale: Not permitted on Project site.
- C. Salvaged Items for Donation: Permitted on Project site
- D. Salvaged Items for Owner's Use:
 - 1. Clean salvaged items.
 - 2. Pack or crate items after cleaning. Identify contents of containers.
 - 3. Store items in a secure area until delivery to Owner.
 - 4. Transport items to Owner's storage area designated by Owner.
 - 5. Protect items from damage during transport and storage.

3.3 RECYCLING DEMOLITION AND CONSTRUCTION WASTE, GENERAL

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

- B. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall accrue to Contractor.
- C. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical according to approved construction waste management plan.
 - 1. Provide appropriately marked containers or bins for controlling recyclable waste until they are removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.
 - a. Inspect containers and bins for contamination and remove contaminated materials if found.
 - 2. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 - 3. Stockpile materials away from construction area. Do not store within drip line of remaining trees.
 - 4. Store components off the ground and protect from the weather.
 - 5. Remove recyclable waste from Owner's property and transport to recycling receiver or processor.

3.4 RECYCLING DEMOLITION WASTE

- A. Asphalt Paving: Grind asphalt to maximum size accepted by selected recycling facility.
- B. Asphalt Paving: Break up and transport paving to asphalt-recycling facility.
- C. Concrete: Remove reinforcement and other metals from concrete and sort with other metals.
 - 1. Pulverize concrete to maximum size accepted by selected recycling facility.
- D. Masonry: Remove metal reinforcement, anchors, and ties from masonry and sort with other metals.
 - 1. Pulverize masonry to maximum size accepted by selected recycling facility.
 - 2. Clean and stack undamaged, whole masonry units on wood pallets.
- E. Wood Materials: Sort and stack members according to size, type, and length. Separate lumber, engineered wood products, panel products, and treated wood materials.
- F. Metals: Separate metals by type.
 - 1. Structural Steel: Stack members according to size, type of member, and length.
 - 2. Remove and dispose of bolts, nuts, washers, and other rough hardware.
- G. Asphalt Shingle Roofing: Separate organic and glass-fiber asphalt shingles and felts. Remove and dispose of nails, staples, and accessories.

- H. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location. Remove edge trim and sort with other metals. Remove and dispose of fasteners.
- I. Acoustical Ceiling Panels and Tile: Stack large clean pieces on wood pallets and store in a dry location.
- J. Metal Suspension System: Separate metal members including trim, and other metals from acoustical panels and tile and sort with other metals.
- K. Carpet and Pad: Roll large pieces tightly after removing debris, trash, adhesive, and tack strips.
 - 1. Store clean, dry carpet and pad in a closed container or trailer provided by Carpet Reclamation Agency or carpet recycler.
- L. Carpet Tile: Remove debris, trash, and adhesive.
 - 1. Stack tile on pallet and store clean, dry carpet in a closed container or trailer provided by Carpet Reclamation Agency or carpet recycler.
- M. Piping: Reduce piping to straight lengths and store by type and size. Separate supports, hangers, valves, sprinklers, and other components by type and size.
- N. Conduit: Reduce conduit to straight lengths and store by type and size.

3.5 RECYCLING CONSTRUCTION WASTE

- A. Packaging:
 - 1. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.
 - 2. Polystyrene Packaging: Separate and bag materials.
 - 3. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site, break down pallets into component wood pieces and comply with requirements for recycling wood.
 - 4. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.
- B. Wood Materials:
 - 1. Clean Cut-Offs of Lumber: Grind or chip into small pieces.
 - 2. Clean Sawdust: Bag sawdust that does not contain painted or treated wood.
- C. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location.
 - 1. Clean Gypsum Board: Grind scraps of clean gypsum board using small mobile chipper or hammer mill. Screen out paper after grinding.

3.6 DISPOSAL OF WASTE

- A. General: Except for items or materials to be salvaged, recycled, or otherwise reused, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.
 - 1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
 - 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
- B. Burning: Do not burn waste materials.
- C. Burning: Burning of waste materials is permitted only at designated areas on Owner's property, provided required permits are obtained. Provide full-time monitoring for burning materials until fires are extinguished.
- D. Disposal: Remove waste materials and dispose of at designated spoil areas on Owner's property.
- E. Disposal: Remove waste materials from Owner's property and legally dispose of them.

3.7 SAMPLE FORMS

END OF SECTION 017419

SECTION 017700 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
 - 1. Substantial Completion procedures.
 - 2. Final completion procedures.
 - 3. Warranties.
 - 4. Final cleaning.
 - 5. Repair of the Work.
- B. Related Requirements:
 - 1. Section 017823 "Operation and Maintenance Data" for operation and maintenance manual requirements.
 - 2. Section 017839 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.
 - 3. Section 017900 "Demonstration and Training" for requirements for instructing Owner's personnel.

1.2 ACTION SUBMITTALS

- A. Product Data: For cleaning agents.
- B. Contractor's List of Incomplete Items: Initial submittal at Substantial Completion.
- C. Certified List of Incomplete Items: Final submittal at Final Completion.

1.3 CLOSEOUT SUBMITTALS

- A. Certificates of Release: From authorities having jurisdiction.
- B. Certificate of Insurance: For continuing coverage.
- C. Field Report: For pest control inspection.

1.4 MAINTENANCE MATERIAL SUBMITTALS

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

1.5 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 COR. 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 signature for receipt of submittals.
 - 5. Submit test/adjust/balance records.
 - 6. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
- 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. Advise Owner of pending insurance changeover requirements.
 - 2. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
 - 3. Complete startup and testing of systems and equipment.
 - 4. Perform preventive maintenance on equipment used prior to Substantial Completion.
 - 5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings specified in Section 017900 "Demonstration and Training."
 - 6. Advise Owner of changeover in heat and other utilities.
 - 7. Participate with Owner in conducting inspection and walkthrough with local emergency responders.
 - 8. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
 - 9. Complete final cleaning requirements, including touchup painting.

10. 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, COR will either proceed with inspection or notify Contractor of unfulfilled requirements. COR 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 COR, 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.

1.6 FINAL COMPLETION PROCEDURES

A. Preliminary Procedures: 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 COR Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by COR. Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
3. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.
4. Submit pest-control final inspection report and warranty.
5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems.

B. Inspection: Submit a written request for final inspection to determine acceptance. On receipt of request, COR will either proceed with inspection or notify Contractor of unfulfilled requirements. COR 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.

1.7 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. Use CSI Form 14.1A.

1. Organize list of spaces in sequential order, proceeding from lowest floor to highest floor.

2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
3. Submit list of incomplete items in the following format:
 - a. MS Excel electronic file. COR will return annotated copy.
 - b. PDF electronic file. COR will return annotated copy.

1.8 SUBMITTAL OF PROJECT WARRANTIES

- A. Time of Submittal: Submit written warranties on request of COR 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. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.
 1. Bind warranties and bonds in heavy-duty, 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.
- C. Provide additional copies of each warranty to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.
 1. Use cleaning products that comply with Green Seal's GS-37, or if GS-37 is not applicable, use products that comply with the California Code of Regulations maximum allowable VOC levels.

PART 3 - EXECUTION

3.1 FINAL CLEANING

- A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.
- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
 - 1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:
 - a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
 - b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
 - c. Rake grounds that are 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. Replace chipped or broken glass and other damaged transparent 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. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
 - o. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency.
 - p. 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 already show evidence of repair or restoration.
 - a. Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification.
 - 3. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.
 - 4. Replace burned-out bulbs, bulbs noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.

END OF SECTION 017700

SECTION 017823 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 SUMMARY

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

1.2 CLOSEOUT SUBMITTALS

- A. Manual Content: Operations and maintenance manual content is specified in individual Specification Sections to be reviewed at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.
 - 1. COR will comment on whether content of operations and maintenance submittals are acceptable.
 - 2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.
- B. Format: Submit operations and maintenance manuals in the following format:
 - 1. PDF electronic file. Assemble each manual into a composite electronically indexed file. Submit on digital media acceptable to COR.
 - a. Name each indexed document file in composite electronic index with applicable item name. Include a complete electronically linked operation and maintenance directory.
 - b. Enable inserted reviewer comments on draft submittals.
- C. Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 15 days before commencing demonstration and training. COR will return copy with comments.
 - 1. Correct or revise each manual to comply with COR comments. Submit copies of each corrected manual within 15 days of receipt of COR comments and prior to commencing demonstration and training.

PART 2 - PRODUCTS

2.1 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

- A. Directory: Prepare a single, comprehensive directory of emergency, operation, and maintenance data and materials, listing items and their location to facilitate ready access to desired information.
- B. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:
 - 1. Title page.
 - 2. Table of contents.
 - 3. Manual contents.
- C. Title Page: Include the following information:
 - 1. Subject matter included in manual.
 - 2. Name and address of Project.
 - 3. Name and address of Owner.
 - 4. Date of submittal.
 - 5. Name and contact information for Contractor.
 - 6. Name and contact information for Construction Manager.
 - 7. Name and contact information for COR.
 - 8. Name and contact information for Commissioning Authority.
 - 9. Names and contact information for major consultants to the COR that designed the systems contained in the manuals.
 - 10. Cross-reference to related systems in other operation and maintenance manuals.
- D. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
- E. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
- F. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.
 - 1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
 - 2. File Names and Bookmarks: Enable bookmarking of individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily

navigated file tree. Configure electronic manual to display bookmark panel on opening file.

- G. Manuals, Paper Copy: Will not be accepted.

2.2 EMERGENCY MANUALS

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

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

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

1. Fire.
2. Flood.
3. Gas leak.
4. Water leak.
5. Power failure.
6. Water outage.
7. System, subsystem, or equipment failure.
8. Chemical release or spill.

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

- D. Emergency Procedures: Include the following, as applicable:

1. Instructions on stopping.
2. Shutdown instructions for each type of emergency.
3. Operating instructions for conditions outside normal operating limits.
4. Required sequences for electric or electronic systems.
5. Special operating instructions and procedures.

2.3 OPERATION MANUALS

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

1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
2. Performance and design criteria if Contractor is delegated design responsibility.
3. Operating standards.
4. Operating procedures.
5. Operating logs.
6. Wiring diagrams.

7. Control diagrams.
8. Piped system diagrams.
9. Precautions against improper use.
10. License requirements including inspection and renewal dates.

B. Descriptions: Include the following:

1. Product name and model number. Use designations for products indicated on Contract Documents.
2. Manufacturer's name.
3. Equipment identification with serial number of each component.
4. Equipment function.
5. Operating characteristics.
6. Limiting conditions.
7. Performance curves.
8. Engineering data and tests.
9. Complete nomenclature and number of replacement parts.

C. Operating Procedures: Include the following, as applicable:

1. Startup procedures.
2. Equipment or system break-in procedures.
3. Routine and normal operating instructions.
4. Regulation and control procedures.
5. Instructions on stopping.
6. Normal shutdown instructions.
7. Seasonal and weekend operating instructions.
8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures.

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

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

2.4 PRODUCT MAINTENANCE MANUALS

- A. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.
- B. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.
- C. Product Information: Include the following, as applicable:
 1. Product name and model number.

2. Manufacturer's name.
3. Color, pattern, and texture.
4. Material and chemical composition.
5. Reordering information for specially manufactured products.

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

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

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

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

2.5 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

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

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

C. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:

1. Standard maintenance instructions and bulletins.
2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
3. Identification and nomenclature of parts and components.
4. List of items recommended to be stocked as spare parts.

D. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:

1. Test and inspection instructions.
2. Troubleshooting guide.
3. Precautions against improper maintenance.
4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
5. Aligning, adjusting, and checking instructions.
6. Demonstration and training video recording, if available.

- E. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
- F. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.
- G. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.
- H. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

PART 3 - EXECUTION

3.1 MANUAL PREPARATION

- A. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.
- B. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.
- C. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.
- D. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
- E. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.
 - 1. Do not use original project record documents as part of operation and maintenance manuals.
- F. Comply with Section 017700 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

END OF SECTION 017823

SECTION 017839 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for project record documents, including the following:
 - 1. Record Drawings.
 - 2. Record Specifications.
 - 3. Record Product Data.
- B. Related Requirements:
 - 1. Section 017823 "Operation and Maintenance Data" for operation and maintenance manual requirements.

1.2 CLOSEOUT SUBMITTALS

- A. Record Drawings: Comply with the following:
 - 1. Number of Copies: Submit one set of marked-up record prints to A/E.
 - 2. Number of Copies: Submit copies of record Drawings as follows:
 - a. Initial Submittal:
 - 1) Submit one paper-copy set(s) of marked-up record prints.
 - 2) Submit PDF electronic files of scanned record prints and one set(s) of file prints.
 - 3) Submit record digital data files and one set(s) of plots.
 - 4) COR will indicate whether general scope of changes, additional information recorded, and quality of drafting are acceptable.
 - b. Final Submittal:
 - 1) Submit one paper-copy set of marked-up record prints.
 - 2) Submit PDF electronic files of scanned record prints and one set of prints.
 - 3) Print each drawing, whether or not changes and additional information were recorded.
 - c. Final Submittal:
 - 1) Submit one paper-copy set(s) of marked-up record prints.
 - 2) Submit record digital data files and one set of record digital data file plots.
 - 3) Plot each drawing file, whether or not changes and additional information were recorded.

- B. Record Specifications: Submit annotated PDF electronic files of Project's Specifications, including addenda and contract modifications.
- C. Record Product Data: Submit annotated PDF electronic files and directories of each submittal.

PART 2 - PRODUCTS

2.1 RECORD DRAWINGS

- A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised Drawings as modifications are issued.
 - 1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.
 - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
 - b. Record data as soon as possible after obtaining it.
 - c. Record and check the markup before enclosing concealed installations.
 - 2. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
 - 3. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
 - 4. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
- B. Record Digital Data Files: Immediately before inspection for Certificate of Substantial Completion, review marked-up record prints with COR. When authorized, prepare a full set of corrected digital data files of the Contract Drawings, as follows:
 - 1. Format: Same digital data software program, version, and operating system as the original Contract Drawings.
 - 2. Format: DWG, Version 2013, Microsoft Windows operating system.
 - 3. Format: Annotated PDF electronic file with comment function enabled.
 - 4. Incorporate changes and additional information previously marked on record prints. Delete, redraw, and add details and notations where applicable.
 - 5. Refer instances of uncertainty to COR for resolution.
 - 6. COR will furnish Contractor one set of digital data files of the Contract Drawings for use in recording information.
- C. Format: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.

1. Record Prints: Organize record prints and newly prepared record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
2. Format: Annotated PDF electronic file with comment function enabled.
3. Record Digital Data Files: Organize digital data information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each digital data file.
4. Identification: As follows:
 - a. Project name.
 - b. Date.
 - c. Designation "PROJECT RECORD DRAWINGS."
 - d. Name of COR.
 - e. Name of Contractor.

2.2 RECORD SPECIFICATIONS

- A. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.
 1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
 3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
 4. Note related Change Orders, record Product Data, and record Drawings where applicable.
- B. Format: Submit record Specifications as annotated PDF electronic file or scanned PDF electronic file(s) of marked-up paper copy of Specifications.

2.3 RECORD PRODUCT DATA

- A. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.
 1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
 3. Note related Change Orders, record Specifications, and record Drawings where applicable.
- B. Format: Submit record Product Data as annotated PDF electronic file or scanned PDF electronic file(s) of marked-up paper copy of Product Data.

2.4 MISCELLANEOUS RECORD SUBMITTALS

- A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.
- B. Format: Submit miscellaneous record submittals as PDF electronic file or scanned PDF electronic file(s) of marked-up miscellaneous record submittals.

PART 3 - EXECUTION

3.1 RECORDING AND MAINTENANCE

- A. Recording: Maintain one copy of each submittal during the construction period for project record document purposes. Post changes and revisions to project record documents as they occur; do not wait until end of Project.
- B. Maintenance of Record Documents and Samples: Store record documents and Samples in the field office apart from the Contract Documents used for construction. Do not use project record documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project record documents for Architect's reference during normal working hours.

END OF SECTION 017839

SECTION 017900 - DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:
 - 1. Demonstration of operation of systems, subsystems, and equipment.
 - 2. Training in operation and maintenance of systems, subsystems, and equipment.
 - 3. Demonstration and training video recordings.

1.2 INFORMATIONAL SUBMITTALS

- A. Instruction Program: Submit outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.
 - 1. Indicate proposed training modules using manufacturer-produced demonstration and training video recordings for systems, equipment, and products in lieu of video recording of live instructional module.

1.3 QUALITY ASSURANCE

- A. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.
- B. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Section 014000 "Quality Requirements," experienced in operation and maintenance procedures and training.
- C. Preinstruction Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination." Review methods and procedures related to demonstration and training.

1.4 COORDINATION

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

- B. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by COR.

PART 2 - PRODUCTS

2.1 INSTRUCTION PROGRAM

- A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.
- B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:
 - 1. Basis of System Design, Operational Requirements, and Criteria: Include the following:
 - a. System, subsystem, and equipment descriptions.
 - b. Performance and design criteria if Contractor is delegated design responsibility.
 - c. Operating standards.
 - d. Regulatory requirements.
 - e. Equipment function.
 - f. Operating characteristics.
 - g. Limiting conditions.
 - h. Performance curves.
 - 2. Documentation: Review the following items in detail:
 - a. Emergency manuals.
 - b. Operations manuals.
 - c. Maintenance manuals.
 - d. Project record documents.
 - e. Identification systems.
 - f. Warranties and bonds.
 - g. Maintenance service agreements and similar continuing commitments.
 - 3. Emergencies: Include the following, as applicable:
 - a. Instructions on meaning of warnings, trouble indications, and error messages.
 - b. Instructions on stopping.
 - c. Shutdown instructions for each type of emergency.
 - d. Operating instructions for conditions outside of normal operating limits.
 - e. Sequences for electric or electronic systems.
 - f. Special operating instructions and procedures.
 - 4. Operations: Include the following, as applicable:

- a. Startup procedures.
 - b. Equipment or system break-in procedures.
 - c. Routine and normal operating instructions.
 - d. Regulation and control procedures.
 - e. Control sequences.
 - f. Safety procedures.
 - g. Instructions on stopping.
 - h. Normal shutdown instructions.
 - i. Operating procedures for emergencies.
 - j. Operating procedures for system, subsystem, or equipment failure.
 - k. Seasonal and weekend operating instructions.
 - l. Required sequences for electric or electronic systems.
 - m. Special operating instructions and procedures.
5. Adjustments: Include the following:
 - a. Alignments.
 - b. Checking adjustments.
 - c. Noise and vibration adjustments.
 - d. Economy and efficiency adjustments.
6. Troubleshooting: Include the following:
 - a. Diagnostic instructions.
 - b. Test and inspection procedures.
7. Maintenance: Include the following:
 - a. Inspection procedures.
 - b. Types of cleaning agents to be used and methods of cleaning.
 - c. List of cleaning agents and methods of cleaning detrimental to product.
 - d. Procedures for routine cleaning
 - e. Procedures for preventive maintenance.
 - f. Procedures for routine maintenance.
 - g. Instruction on use of special tools.
8. Repairs: Include the following:
 - a. Diagnosis instructions.
 - b. Repair instructions.
 - c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 - d. Instructions for identifying parts and components.
 - e. Review of spare parts needed for operation and maintenance.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 INSTRUCTION

- A. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Owner for number of participants, instruction times, and location.
- B. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
 - 1. COR will furnish an instructor to describe basis of system design, operational requirements, criteria, and regulatory requirements.
 - 2. Owner will furnish an instructor to describe Owner's operational philosophy.
 - 3. Owner will furnish Contractor with names and positions of participants.
- C. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.
 - 1. Schedule training with Owner with at least ~~seven~~ days' advance notice.
- D. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.
- E. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of **an oral** performance-based test.
- F. used as a component of training modules in same format as recordings of live training.

END OF SECTION 017900

SECTION 024119 - SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Demolition and removal of selected portions of building or structure.
2. Demolition and removal of selected site elements.
3. Salvage of existing items to be reused or recycled.

1.2 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition waste becomes property of Contractor.
- B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.
1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.3 PREINSTALLATION MEETINGS

- A. Predemolition Conference: Conduct conference at Project Site

1.4 INFORMATIONAL SUBMITTALS

- A. Engineering Survey: Submit engineering survey of condition of building.
- B. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property and dust control. Indicate proposed locations and construction of barriers.
- C. Schedule of selective demolition activities with starting and ending dates for each activity.
- D. Predemolition photographs or video.
- E. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician.

1.5 CLOSEOUT SUBMITTALS

- A. Inventory of items that have been removed and salvaged.

1.6 QUALITY ASSURANCE

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

1.7 FIELD CONDITIONS

- A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.
- B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
 - 1. Before selective demolition, Owner will remove the following items:
 - a. All equipment, furniture, casework, and accessories within the rooms effected by construction.
- C. Notify COR of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
- D. Hazardous Materials: It is expected that hazardous materials will be encountered in the Work.
 - 1. Hazardous materials shall be removed by a professional abatement company.
 - 2. If suspected hazardous materials are encountered that were not specified on drawings, do not disturb; immediately notify COR and Owner. Hazardous materials will be removed by Owner under a separate contract.
- E. Storage or sale of removed items or materials on-site is not permitted.
- F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
 - 1. Maintain fire-protection facilities in service during selective demolition operations.
- G. Arrange selective demolition schedule so as not to interfere with Owner's operations.

1.8 WARRANTY

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- B. Standards: Comply with ASSE A10.6 and NFPA 241.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that utilities have been disconnected and capped before starting selective demolition operations.
- B. Perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.
- C. Inventory and record the condition of items to be removed and salvaged.

3.2 PREPARATION

- A. Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction.

3.3 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

- A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.
- B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.
 - 1. Arrange to shut off utilities with utility companies.
 - 2. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
 - 3. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated on Drawings to be removed.
 - a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material and leave in place.

- c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
- d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
- e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
- g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material and leave in place.

3.4 PROTECTION

- A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
- B. Temporary Shoring: Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
- C. Remove temporary barricades and protections where hazards no longer exist.

3.5 SELECTIVE DEMOLITION

- A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
 - 1. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
 - 2. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
 - 3. 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.
 - 4. Maintain fire watch during and for at least 1 hour after flame-cutting operations.
 - 5. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
 - 6. Dispose of demolished items and materials promptly.
- B. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
- C. Removed and Salvaged Items:

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

D. Removed and Reinstalled Items:

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

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

3.6 CLEANING

A. Remove demolition waste 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. 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 051200 - STRUCTURAL STEEL

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. The work required under this heading shall include all labor, materials, tools, equipment and services necessary for and reasonably incidental to the fabrication and delivery to site as shown on the drawings and/or as herein specified.

1.2 RELATED DOCUMENTS

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

1.3 SUMMARY

- A. This Section includes structural steel and grout.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 1 Section "Quality Control" for independent testing agency procedures and administrative requirements.
 - 2. Division 5 Section "Metal Fabrications" for loose steel bearing plates and miscellaneous steel framing.

1.4 PERFORMANCE REQUIREMENTS

- A. Connections: Engineer structural steel connections required by the Contract Documents to be selected or completed by the fabricator to withstand design loadings indicated.
- B. Engineering Responsibility: Engage a fabricator who utilizes a qualified professional engineer to prepare calculations, Shop Drawings, and other structural data for structural steel connections.

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show fabrication details of structural-steel components.
 - 1. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.

2. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify high-strength bolted slip-critical, direct-tension, or tensioned shear/bearing connections.
3. Include Shop Drawings signed and sealed by a qualified professional engineer responsible for their preparation.
4. Shop Drawings shall be drawn at 1/8-inch equals 1'-0" minimum for plans and 3/4-inch equals 1'-0" minimum for sections. Contract Drawings shall not be reproduced in whole or in part for modification into Shop Drawings. Contract Drawings modified without approval will be returned without review.
5. Each sheet of the Shop Drawings shall bear the review stamp of the Contractor indicating their review and approval. Drawings without the Contractor's stamp will be returned without review.

C. Welding certificates.

D. Mill test reports.

1. Structural steel, including chemical and physical properties.
2. Bolts, nuts, and washers, including mechanical properties and chemical analysis.
3. Twist-off tension control bolts.
4. Shear stud connectors.
5. Shop primers.
6. Nonshrink grout.

E. Source quality-control test reports.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced Installer who has completed structural steel work similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.
- B. Fabricator Qualifications: Engage a firm experienced in fabricating structural steel similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to fabricate structural steel without delaying the Work.
 1. Fabricator must participate in the AISC Quality Certification Program and be designated an AISC-Certified Plant. In lieu of AISC Certification, a fabricator can demonstrate five similar size projects and scope from the past three years. Submit qualifications prior to bid.
 2. Comply with applicable provisions of the following specifications and documents:
 - a. AISC 303.
 - b. AISC 360.
 - c. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

- C. Professional Engineer Qualifications: A professional engineer who is legally authorized to practice in the jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for projects with structural steel framing that are similar to that indicated for this Project in material, design, and extent.
- D. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel."
 - 1. Present evidence that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.
- E. Comply with applicable provisions of AISC's "Code of Standard Practice for Steel Buildings and Bridges."
- F. Preinstallation Conference: Conduct conference at Project site.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver structural steel to Project site in such quantities and at such times to ensure continuity of installation.
- B. Store materials to permit easy access for inspection and identification. Keep steel members off ground by using pallets, platforms, or other supports. Protect steel members and packaged materials from erosion and deterioration.
 - 1. Store fasteners in a protected place. Clean and re-lubricate bolts and nuts that become dry or rusty before use.
 - 2. Do not store materials on structure in a manner that might cause distortion or damage to members or supporting structures. Repair or replace damaged materials or structures as directed.

1.8 SEQUENCING

- A. Supply anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, templates, instructions, and directions, as required, for installation.

PART 2 - PRODUCTS

2.1 STRUCTURAL-STEEL MATERIALS

- A. W-Shapes: ASTM A 992.
- B. Channels, Angles-Shapes: ASTM A 36.
- C. Plate and Bar: ASTM A 36, carbon steel angles.
- D. Cold-Formed Structural Steel Tubing: ASTM A 500, Grade B or C.

- E. Steel Pipe: ASTM A 53, Type E or S, Grade B.
 - 1. Weight Class: As indicated on Drawings.
 - 2. Finish: Black, except where indicated to be galvanized.
- F. Anchor Rods, Bolts, Nuts, and Washers: ASTM A 36.
- G. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy hex steel structural bolts, heavy hex carbon-steel nuts, and hardened carbon-steel washers.
 - 1. Finish: Plain, uncoated.
 - 2. Provide twist-off tension control bolts.
 - a. Finish: Plain, uncoated.
- H. Welding Electrodes: Comply with AWS requirements.

2.2 PRIMER

- A. Primer: SSPC-Paint 25, Type II, iron oxide, zinc oxide, raw linseed oil, and alkyd.
- B. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds and repair painting galvanized steel, with dry film containing not less than 93 percent zinc dust by weight, and complying with DOD-P-21035A or SSPC-Paint 20.

2.3 GROUT

- A. Non metallic, Shrinkage-Resistant Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage compensating agents, plasticizing and water-reducing agents, complying with ASTM C 1107, of consistency suitable for application, and a 30-minute working time.

2.4 FABRICATION

- A. Structural Steel: Fabricate and assemble structural steel in shop to greatest extent possible. Fabricate structural steel according to AISC specifications referenced in this Section and in Shop Drawings.
 - 1. Camber structural steel members where indicated.
 - 2. Identify high-strength structural steel according to ASTM A 6 and maintain markings until steel has been erected.
 - 3. Mark and match-mark materials for field assembly.
 - 4. Fabricate for delivery a sequence that will expedite erection and minimize field handling of structural steel.

5. Splicing structural steel members is prohibited unless shown otherwise.
 6. Complete structural steel assemblies, including welding of units, before starting shop-priming operations.
 7. Comply with fabrication tolerance limits of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for structural steel.
- B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
1. Plane thermally cut edges to be welded.
- C. Finishing: Accurately mill ends of columns and other members transmitting loads in bearing.
- D. Holes: Provide holes required for securing other work to structural steel framing and for passage of other work through steel framing members, as shown on Shop Drawings.
1. Cut, drill, or punch holes perpendicular to metal surfaces. Do not flame-cut holes or enlarge holes by burning. Drill holes in bearing plates.
 2. Weld threaded nuts to framing and other specialty items as indicated to receive other work.

2.5 SHOP CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
1. Bolts: ASTM A 325 high-strength bolts, unless otherwise indicated.
 2. Joint Type: Snug tightened.
- B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.
1. Assemble and weld built-up sections by methods that will maintain true alignment of axes without warp.

2.6 SHOP PRIMING

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

5. Galvanized surfaces.

- B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:

1. SSPC-SP 3, "Power Tool Cleaning."

- C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a dry film thickness of not less than 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

2.7 GALVANIZING

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

1. Structural steel indicated on Contract Documents.
2. All permanent exterior exposed structural steel and lintels.

2.8 SOURCE QUALITY CONTROL

- A. Owner may engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports.

1. Testing agency will conduct and interpret tests and state in each report whether test specimens comply with or deviate from requirements.
2. Provide testing agency with access to places where structural steel Work is being fabricated or produced so required inspection and testing can be accomplished.

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

- C. Additional testing, at Contractor's expense, will be performed to determine compliance of corrected Work with specified requirements.

- D. Shop-bolted connections will be inspected for use of tension control bolts.

- E. All full-penetration welds will be inspected and tested according to AWS D1.1 and the inspection procedures listed below, at testing agency's option.

1. Liquid Penetrant Inspection: ASTM E 165.
2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.

3. Radiographic Inspection: ASTM E 94 and ASTM E 142; minimum quality level "2-2T."
 4. Ultrasonic Inspection: ASTM E 164.
- F. In addition to visual inspection, shop-welded shear connectors will be tested and inspected according to requirements in AWS D1.1 for stud welding.
1. Bend tests will be performed when visual inspections reveal either less than a continuous 360-degree flash or welding repairs to any shear connector.
 2. Tests will be conducted on additional shear connectors when weld fracture occurs on shear connectors already tested, according to requirements of AWS D1.1.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Before erection proceeds, and with the steel erector present, verify elevations of concrete and masonry bearing surfaces and locations of anchorages for compliance with requirements.
- B. Do not proceed with erection until unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place, unless otherwise indicated.
 1. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

3.3 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and according to AISC specifications referenced in this Section.
- B. Provide rigid templates for anchor bolts.
- C. Base and Bearing Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting base and bearing plates. Clean bottom surface of base and bearing plates.
 1. Set base and bearing plates for structural members on wedges, shims, or setting nuts as required.
 2. Weld plate washers to top of base plate.

3. Tighten anchor bolts after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of base or bearing plate prior to packing with grout.
 4. Promptly pack grout solidly between bearing surfaces and base or bearing plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure.
 - a. Comply with manufacturer's instructions for proprietary grout materials.
 - D. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."
 - E. Align and adjust various members forming part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
 1. Level and plumb individual members of structure.
 2. Establish required leveling and plumbing measurements on mean operating temperature of structure. Make allowances for difference between temperature at time of erection and mean temperature at which structure will be when completed and in service.
 - F. Splice members only where indicated.
 - G. Remove erection bolts on welded, architecturally exposed structural steel; fill holes with plug welds; and grind smooth at exposed surfaces.
 - H. Do not use thermal cutting during erection.
 - I. Finish sections thermally cut during erection equal to a sheared appearance.
 - J. Do not enlarge unfair holes in members by burning or by using drift pins. Ream holes that must be enlarged to admit bolts.
- 3.4 FIELD CONNECTIONS
- A. Install and tighten high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
 1. Bolts: ASTM A 325 high-strength bolts, unless otherwise indicated.
 - B. Weld Connections: Comply with AWS D1.1 for procedures, appearance and quality of welds, and methods used in correcting welding work.
 1. Comply with AISC specifications referenced in this Section for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.
 2. Assemble and weld built-up sections by methods that will maintain true alignment of axes without warp.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage an independent testing and inspecting agency to perform field inspections and tests and to prepare test reports.
 - 1. Testing agency will conduct and interpret tests and state in each report whether tested Work complies with or deviates from requirements.
- B. Bolted Connections: Shop-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- C. Welded Connections: Field welds will be visually inspected according to AWS D1.1.
 - 1. In addition to visual inspection, field welds will be tested according to AWS D1.1 and the following inspection procedures, at testing agency's option:
 - a. Liquid Penetrant Inspection: ASTM E 165.
 - b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
 - c. Ultrasonic Inspection: ASTM E 164.
 - d. Radiographic Inspection: ASTM E 94.
- D. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

3.6 CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint. Apply paint to exposed areas using same material as used for shop painting.
- B. Apply by brush or spray to provide a minimum dry film thickness of 1.5 mils.

END OF SECTION 051200

SECTION 061053 - MISCELLANEOUS ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Framing with dimension lumber.
2. Rooftop equipment bases and support curbs.
3. Wood blocking and nailers.
4. Wood furring.
5. Utility shelving.
6. Plywood backing panels.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product.

1.3 INFORMATIONAL SUBMITTALS

A. Evaluation Reports: For the following, from ICC-ES:

1. Preservative-treated wood.
2. Fire-retardant-treated wood.
3. Power-driven fasteners.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

- A. Certified Wood: Lumber and plywood shall be certified as "FSC Pure" or "FSC Mixed Credit" according to FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship," and to FSC STD-40-004, "FSC Standard for Chain of Custody Certification."
- B. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
1. Factory mark each piece of lumber with grade stamp of grading agency.
- C. Maximum Moisture Content of Lumber: 15 percent for 2-inch nominal (38-mm actual) thickness or less, 19 percent for more than 2-inch nominal (38-mm actual) thickness unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

- A. Preservative Treatment by Pressure Process: AWP A U1; Use Category UC2 for interior construction not in contact with ground, Use Category UC3b for exterior construction not in contact with ground, and Use Category UC4a for items in contact with ground.
 - 1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
- B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.
- C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
- D. Application: Treat all miscellaneous carpentry unless otherwise indicated.
 - 1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
 - 2. Wood sills, blocking, and similar concealed members in contact with masonry or concrete.
 - 3. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.

2.3 FIRE-RETARDANT-TREATED MATERIALS

- A. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.
 - 1. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D 2898. Use for exterior locations and where indicated.
 - 2. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D 3201 at 92 percent relative humidity. Use where exterior type is not indicated.
 - 3. Design Value Adjustment Factors: Treated lumber shall be tested according to ASTM D 5664, and design value adjustment factors shall be calculated according to ASTM D 6841.
- B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Kiln-dry plywood after treatment to a maximum moisture content of 15 percent.
- C. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.
- D. Application: Treat all miscellaneous carpentry unless otherwise indicated.

2.4 MISCELLANEOUS LUMBER

- A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
 - 1. Blocking.
 - 2. Nailers.
 - 3. Rooftop equipment bases and support curbs.
 - 4. Cants.
 - 5. Furring.
 - 6. Grounds.
- B. Concealed Boards: 19 percent maximum moisture content of any of the following species and grades if used:
 - 1. Mixed southern pine or southern pine, No. 2 or No. 3 grade; SPIB.
 - 2. Eastern softwoods, No. 2 or No. 3 Common grade; NELMA.
 - 3. Northern species, No. 2 or No. 3 Common grade; NLGA.
 - 4. Western woods, Construction or No. 2 Common or Standard or No. 3 Common grade; WCLIB or WWPA.

2.5 PLYWOOD BACKING PANELS

- A. Equipment Backing Panels: Plywood, DOC PS 1, Exterior, A-C, Exterior, C-C Plugged Exposure 1, C-D Plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than 1/2-inch (13-mm) nominal thickness.

2.6 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
 - 1. Where carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.
- B. Screws for Fastening to Metal Framing: ASTM C 1002, length as recommended by screw manufacturer for material being fastened.
- C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

2.7 MISCELLANEOUS MATERIALS

- A. Adhesives for Gluing to Concrete or Masonry: Formulation complying with ASTM D 3498 that is approved for use indicated by adhesive manufacturer.

- B. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.025 inch (0.6 mm).

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.
- B. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry accurately to other construction. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.
- C. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels.
- D. Do not splice structural members between supports unless otherwise indicated.
- E. Comply with AWWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.
- F. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 - 1. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
 - 2. ICC-ES evaluation report for fastener.

END OF SECTION 061053

SECTION 078413 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Penetrations in fire-resistance-rated walls.
2. Penetrations in horizontal assemblies.
3. Penetrations in smoke barriers.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Product Schedule: For each penetration firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing and inspecting agency.

1. Engineering Judgments: Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping system, submit illustration, with modifications marked, approved by penetration firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly. Obtain approval of authorities having jurisdiction prior to submittal.

1.3 INFORMATIONAL SUBMITTALS

A. Product test reports.

1.4 CLOSEOUT SUBMITTALS

A. Installer Certificates: From Installer indicating that penetration firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.5 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."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics:

1. Perform penetration firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
2. Test per testing standards referenced in "Penetration Firestopping Systems" Article. Provide rated systems complying with the following requirements:
 - a. Penetration firestopping systems shall bear classification marking of a qualified testing agency.
 - 1) UL in its "Fire Resistance Directory."
 - 2) Intertek Group in its "Directory of Listed Building Products."
 - 3) FM Global in its "Building Materials Approval Guide."

PENETRATION FIRESTOPPING SYSTEMS

- B. Penetration Firestopping Systems: Systems that resist spread of fire, 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.
- C. Penetrations in Fire-Resistance-Rated Walls: Penetration firestopping systems with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of **0.01-inch wg (2.49 Pa)**.
 1. F-Rating: Not less than the fire-resistance rating of constructions penetrated.
- D. Penetrations in Horizontal Assemblies: Penetration firestopping systems with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of **0.01-inch wg (2.49 Pa)**.
 1. F-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated.
 2. T-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.
 3. W-Rating: Provide penetration firestopping systems showing no evidence of water leakage when tested according to UL 1479.
- E. Penetrations in Smoke Barriers: Penetration firestopping systems with ratings determined per UL 1479, based on testing at a positive pressure differential of **0.30-inch wg (74.7 Pa)**.
 1. L-Rating: Not exceeding **5.0 cfm/sq. ft. (0.025 cu. m/s per sq. m)** of penetration opening at and no more than **50-cfm (0.024-cu. m/s)** cumulative total for any **100 sq. ft. (9.3 sq. m)** at both ambient and elevated temperatures.

- F. Exposed Penetration Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, per ASTM E 84.
- G. VOC Content: Penetration firestopping sealants and sealant primers shall comply with the following limits for VOC content:
 - 1. Sealants: 250 g/L.
 - 2. Sealant Primers for Nonporous Substrates: 250 g/L.
 - 3. Sealant Primers for Porous Substrates: 775 g/L.
- H. Low-Emitting Materials: Penetration firestopping sealants and sealant primers shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- I. 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 system manufacturer and approved by qualified testing and inspecting agency for conditions indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

- 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. General: Install penetration firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications.
- C. 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.
 - 1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not forming permanent components of firestopping.
- D. Install fill materials by proven techniques to produce the following results:
 - 1. Fill voids and cavities formed by openings, forming materials, accessories and penetrating items to achieve required fire-resistance ratings.
 - 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.

3.2 IDENTIFICATION

- A. Wall Identification: Permanently label walls containing penetration firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches (76 mm) high and with minimum 0.375-inch (9.5-mm) strokes.
 - 1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 feet (4.57 m) from end of wall and at intervals not exceeding 30 feet (9.14 m).
- B. Penetration Identification: Identify each penetration firestopping system with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm) of penetration firestopping system edge so labels are visible to anyone seeking to remove penetrating items or firestopping systems. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
 - 1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
 - 2. Contractor's name, address, and phone number.
 - 3. Designation of applicable testing and inspecting agency.
 - 4. Date of installation.
 - 5. Manufacturer's name.
 - 6. Installer's name.

3.3 FIELD QUALITY CONTROL

- A. Owner will engage a qualified testing agency to perform tests and inspections according to ASTM E 2174.
- B. Where deficiencies are found or penetration firestopping system is damaged or removed because of testing, repair or replace penetration firestopping system to comply with requirements.
- C. Proceed with enclosing penetration firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

END OF SECTION 078413

SECTION 083113 - ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes access doors and frames for walls.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each type of access door and frame and for each finish specified.
- C. Product Schedule: For access doors and frames.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Access Doors and Frames: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection and temperature-rise limit ratings indicated, according to NFPA 252 or UL 10B.

2.2 ACCESS DOORS AND FRAMES

- A. Flush Access Doors with Exposed Flanges:
 - 1. Product described below is Basis-of-Design; All substitutions shall be equal to performance specifications listed below.
 - 2. Product Basis-of-Design: Larsen's L-DW 24x24
 - 3. Description: Face of door flush with frame, with exposed flange and concealed hinge.
 - 4. Locations: Wall (Gypsum Wall Board Substrate).
 - 5. Uncoated Steel Sheet for Door: Nominal 0.060 inch (1.52 mm), 16 gage, factory primer coat ready for field painting.
 - 6. Metallic-Coated Steel Sheet for Door: Nominal 0.064 inch (1.63 mm), 16 gage, factory primer coat ready for field painting.
 - 7. Frame Material: Same material, thickness, and finish as door
 - 8. Latch and Lock: Cam latch, key operated. Furnish (2) keys to owner upon substantial completion.

2.3 MATERIALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

- B. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A 879/A 879M, with cold-rolled steel sheet substrate complying with ASTM A 1008/A 1008M, Commercial Steel (CS), exposed.
- C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.
- D. Frame Anchors: Same material as door face.
- E. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.

2.4 FABRICATION

- A. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
- B. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish mounting holes, attachment devices and fasteners of type required to secure access doors to types of supports indicated.
- C. Latch and Lock Hardware:
 - 1. Quantity: Furnish number of latches and locks required to hold doors tightly closed.
 - 2. Keys: Furnish two keys per lock and key all locks alike.

2.5 FINISHES

- A. Painted Finishes: Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
 - 1. Factory Primed: Apply manufacturer's standard, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with manufacturer's written instructions for installing access doors and frames.
- B. Adjust doors and hardware, after installation, for proper operation.

END OF SECTION 083113

SECTION 092116.23 - GYPSUM BOARD SHAFT WALL ASSEMBLIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Gypsum board shaft wall assemblies.

1.2 ACTION SUBMITTALS

- A. Product Data: For each component of gypsum board shaft wall assembly.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.
- B. STC-Rated Assemblies: Provide materials and construction identical to those of assemblies tested according to ASTM E 90 and classified according to ASTM E 413 by a testing and inspecting agency.

2.2 GYPSUM BOARD SHAFT WALL ASSEMBLIES

- A. Fire-Resistance Rating: 2 hours.
- B. STC Rating: 51, minimum.
- C. Studs: Manufacturer's standard profile for repetitive members, corner and end members, and fire-resistance-rated assembly indicated.
 - 1. Depth: As indicated
 - 2. Minimum Base-Metal Thickness: 0.018 inch (0.45 mm)].
- D. Runner Tracks: Manufacturer's standard J-profile track with manufacturer's standard long-leg length, but at least 2 inches (51 mm) long and matching studs in depth.
 - 1. Minimum Base-Metal Thickness: Matching steel studs.
- E. Firestop Tracks: Provide firestop track at head of shaft wall on each floor level.
- F. Elevator Hoistway Entrances: Manufacturer's standard J-profile jamb strut with long-leg length of 3 inches (76 mm), matching studs in depth.

- G. Room-Side Finish: Gypsum board
- H. Shaft-Side Finish: As indicated.
- I. Insulation: Sound attenuation blankets.

2.3 PANEL PRODUCTS

- A. Panel Size: Provide in maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.
- B. Gypsum Shaftliner Board, Moisture- and Mold-Resistant Type X: ASTM C 1396/C 1396M; manufacturer's proprietary fire-resistive liner panels with moisture- and mold-resistant core and surfaces.
 - 1. Thickness: 1 inch (25.4 mm).
 - 2. Long Edges: Double bevel.
 - 3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.
- C. Gypsum Board: As specified in Section 092900 "Gypsum Board."

2.4 NON-LOAD-BEARING STEEL FRAMING

- A. Steel Framing Members: Comply with ASTM C 645 requirements for metal.
- B. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated.

2.5 AUXILIARY MATERIALS

- A. Trim Accessories: Material and shapes as specified in Section 092900 "Gypsum Board" that comply with gypsum board shaft wall assembly manufacturer's written recommendations for application indicated.
- B. Steel Drill Screws: ASTM C 1002 unless otherwise indicated.
- C. Track Fasteners: Power-driven fasteners of size and material required to withstand loading conditions.
- D. Sound Attenuation Blankets: As specified in Section 092900 "Gypsum Board."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Comply with requirements of fire-resistance-rated assemblies indicated, manufacturer's written installation instructions, and ASTM C 754 other than stud-spacing requirements.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, or mold damaged.
- C. Sprayed Fire-Resistive Materials: Patch or replace sprayed fire-resistive materials removed or damaged during installation of shaft wall assemblies. After application, remove only to extent necessary for installation of gypsum board shaft wall assemblies.
- D. Building Expansion Joints: Frame both sides of expansion joints with furring and other support.
- E. Install supplementary framing around openings and as required for blocking, bracing, and support of gravity and pullout loads of fixtures, equipment, handrails, and similar items.
 - 1. Elevator Hoistway: Provide jamb struts on each side of door frame.
- F. Penetrations: Install supplementary steel framing around perimeter of penetration behind boxes containing wiring devices, elevator call buttons, elevator floor indicators, and similar items.
- G. Isolate perimeter of gypsum panels from building structure, while maintaining continuity of fire-rated construction.
- H. Firestop Tracks: Install to maintain continuity of fire-resistance-rated assembly indicated.
- I. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by COR while maintaining fire-resistance rating of gypsum board shaft wall assemblies.
- J. Sound-Rated Shaft Wall Assemblies: Seal with acoustical sealant at perimeter of each assembly and at joints and penetrations.
- K. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch (3 mm) from the plane formed by faces of adjacent framing.
- L. Remove and replace panels that are wet, moisture damaged, or mold damaged.

END OF SECTION 092116.23

SECTION 092216 – NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Non-load-bearing steel framing systems for interior partitions.
2. Suspension systems for interior ceilings and soffits.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Evaluation reports for firestop tracks.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, according to ASTM E 119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated, according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

2.2 FRAMING SYSTEMS

- A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.
1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal unless otherwise indicated.
 2. Protective Coating: Coating with equivalent corrosion resistance of ASTM A 653/A 653M, G40 (Z120), hot-dip galvanized unless otherwise indicated.
- B. Studs and Runners: ASTM C 645.
1. Steel Studs and Runners:

- a. Minimum Base-Metal Thickness: As required by performance requirements for horizontal deflection
 - b. Depth: As indicated on Drawings
- C. Slip-Type Head Joints: Where indicated, provide the following:
 1. Clip System: Clips designed for use in head-of-wall deflection conditions that provide a positive attachment of studs to runners while allowing 1-1/2-inch (38-mm) minimum vertical movement.
 2. Single Long-Leg Runner System: ASTM C 645 top runner with 2-inch- (51-mm-) deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top runner and with continuous bridging located within 12 inches (305 mm) of the top of studs to provide lateral bracing.
 3. Double-Runner System: ASTM C 645 top runners, inside runner with 2-inch- (51-mm-) deep flanges in thickness not less than indicated for studs and fastened to studs, and outer runner sized to friction fit inside runner.
 4. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.
- D. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
- E. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
 1. Minimum Base-Metal Thickness: 0.0179 inch (0.455 mm).
- F. Cold-Rolled Channel Bridging: Steel, 0.0538-inch (1.367-mm) minimum base-metal thickness, with minimum 1/2-inch- (13-mm-) wide flanges.
 1. Depth: As indicated on Drawings.
 2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches (38 by 38 mm), 0.068-inch- (1.72-mm-) thick, galvanized steel.
- G. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
 1. Minimum Base-Metal Thickness: .0179 inch (0.455 mm).
 2. Depth: As indicated on Drawings.
- H. Resilient Furring Channels: 1/2-inch- (13-mm-) deep, steel sheet members designed to reduce sound transmission.
 1. Configuration: hat shaped.
- I. Cold-Rolled Furring Channels: 0.053-inch (1.34-mm) uncoated-steel thickness, with minimum 1/2-inch- (13-mm-) wide flanges.
 1. Depth: As indicated on Drawings.
 2. Furring Brackets: Adjustable, corrugated-edge-type steel sheet with minimum uncoated-steel thickness of 0.0329 inch (0.8 mm).
 3. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.59-mm-) diameter wire, or double strand of 0.048-inch- (1.21-mm-) diameter wire.

- J. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches (32 mm), wall attachment flange of 7/8 inch (22 mm), minimum uncoated-metal thickness of 0.0179 inch (0.455 mm), and depth required to fit insulation thickness indicated.

2.3 SUSPENSION SYSTEMS

- A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.59-mm-) diameter wire, or double strand of 0.048-inch- (1.21-mm-) diameter wire.
- B. Hanger Attachments to Concrete:
 - 1. Expansion Anchors: Fabricated from corrosion-resistant materials, with allowable load or strength design capacities calculated according to ICC-ES AC193 and ACI 318 greater than or equal to the design load, as determined by testing per ASTM E 488/E 488M conducted by a qualified testing agency.
 - 2. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with allowable load capacities calculated according to ICC-ES AC70, greater than or equal to the design load, as determined by testing per ASTM E 1190 conducted by a qualified testing agency.
- C. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.16 inch (4.12 mm) in diameter.
- D. Flat Hangers: Steel sheet, 1 by 3/16 inch (25 by 5 mm) by length indicated.
- E. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.0538 inch (1.367 mm) and minimum 1/2-inch- (13-mm-) wide flanges.
 - 1. Depth: 2-1/2 inches (64 mm).
- F. Furring Channels (Furring Members):
 - 1. Cold-Rolled Channels: 0.0538-inch (1.367-mm) uncoated-steel thickness, with minimum 1/2-inch- (13-mm-) wide flanges, 3/4 inch (19 mm) deep.
 - 2. Steel Studs and Runners: ASTM C 645.
 - a. Minimum Base-Metal Thickness: 0.0179 inch (0.455 mm).
 - b. Depth: As indicated on Drawings.
 - 3. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch (22 mm) deep.
 - a. Minimum Base-Metal Thickness: 0.0179 inch (0.455 mm).
 - 4. Resilient Furring Channels: 1/2-inch- (13-mm-) deep members designed to reduce sound transmission.
 - a. Configuration: hat shaped.

2.4 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards.
 - 1. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.
- B. Isolation Strip at Exterior Walls: Provide the following:
 - 1. Asphalt-Saturated Organic Felt: ASTM D 226/D 226M, Type I (No. 15 asphalt felt), nonperforated.
 - 2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch (3.2 mm) thick, in width to suit steel stud size.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C 754.
 - 1. Gypsum Plaster Assemblies: Also comply with requirements in ASTM C 841 that apply to framing installation.
 - 2. Portland Cement Plaster Assemblies: Also comply with requirements in ASTM C 1063 that apply to framing installation.
 - 3. Gypsum Veneer Plaster Assemblies: Also comply with requirements in ASTM C 844 that apply to framing installation.
 - 4. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.
- B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.
- C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
- D. Install bracing at terminations in assemblies.
- E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.2 INSTALLING FRAMED ASSEMBLIES

- A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
- B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

- C. Install studs so flanges within framing system point in same direction.
- D. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts that penetrate partitions above ceiling.
 - 1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
 - 2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
 - a. Install two studs at each jamb unless otherwise indicated.
 - b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch (13-mm) clearance from jamb stud to allow for installation of control joint in finished assembly.
 - c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
 - 3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
 - 4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
 - a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
 - 5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
 - 6. Curved Partitions:
 - a. Bend track to uniform curve and locate straight lengths so they are tangent to arcs.
 - b. Begin and end each arc with a stud, and space intermediate studs equally along arcs. On straight lengths of no fewer than two studs at ends of arcs, place studs 6 inches (150 mm) o.c.
- E. Direct Furring:
 - 1. Screw to wood framing.
 - 2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches (610 mm) o.c.
- F. Z-Shaped Furring Members:
 - 1. Erect insulation, specified in Section 072100 "Thermal Insulation," vertically and hold in place with Z-shaped furring members spaced 24 inches (610 mm) o.c.
 - 2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches (610 mm) o.c.

3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches (305 mm) from corner and cut insulation to fit.
- G. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch (3 mm) from the plane formed by faces of adjacent framing.

3.3 INSTALLING SUSPENSION SYSTEMS

- A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
- B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.
- C. Suspend hangers from building structure as follows:
 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
 - a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
 - a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.
 3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
 4. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
 5. Do not attach hangers to steel roof deck.
 6. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
 7. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
 8. Do not connect or suspend steel framing from ducts, pipes, or conduit.
- D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.
- E. Seismic Bracing: Sway-brace suspension systems with hangers used for support

- F. Example tolerance in "Installation Tolerances" Paragraph below is based on ASTM C 636 for acoustical ceilings.
- G. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet (3 mm in 3.6 m) measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION 092216

SECTION 092900 – GYPSUM BOARD

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior gypsum board.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each texture finish indicated on same backing indicated for Work.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

2.2 GYPSUM BOARD, GENERAL

- A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.3 INTERIOR GYPSUM BOARD

- A. Gypsum Board, Type X: ASTM C 1396/C 1396M.
1. Thickness: 5/8 inch (15.9 mm).
 2. Long Edges: Tapered and featured (rounded or beveled) for prefilling.

2.4 TRIM ACCESSORIES

- A. Interior Trim: ASTM C 1047.

1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized-steel sheet
2. Shapes:
 - a. Cornerbead.
 - b. Bullnose bead.
 - c. LC-Bead: J-shaped; exposed long flange receives joint compound.
 - d. L-Bead: L-shaped; exposed long flange receives joint compound.
 - e. U-Bead: J-shaped; exposed short flange does not receive joint compound.
 - f. Expansion (control) joint.
 - g. Curved-Edge Cornerbead: With notched or flexible flanges.

2.5 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C 475/C 475M.
- B. Joint Tape:
 1. Interior Gypsum Board: Paper.
- C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.
 1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
 2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.
 - a. Use setting-type compound for installing paper-faced metal trim accessories.
 3. Fill Coat: For second coat, use setting-type, sandable topping compound.
 4. Finish Coat: For third coat, use setting-type, sandable topping compound.
 5. Skim Coat: For final coat of Level 5 finish, use setting-type, sandable topping compound.

2.6 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.
- B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
- C. Steel Drill Screws: ASTM C 1002 unless otherwise indicated.
 1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick.
 2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

- D. Sound-Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
 - 1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
- E. Acoustical Joint Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
- F. Thermal Insulation: As specified in Section 072100 "Thermal Insulation."
- G. Vapor Retarder: As specified in Section 072600 "Vapor Retarders."

PART 3 - EXECUTION

3.1 APPLYING AND FINISHING PANELS

- A. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- B. Comply with ASTM C 840.
- C. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 1/4- to 1/2-inch- (6.4- to 12.7-mm-) wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- D. For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- E. Prefill open joints, rounded or beveled edges, and damaged surface areas.
- F. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.
- G. Cementitious Backer Units: Finish according to manufacturer's written instructions.

3.2 PROTECTION

- A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- B. Remove and replace panels that are wet, moisture damaged, and mold damaged.

END OF SECTION 092900

SECTION 099123 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes surface preparation and the application of paint systems on the following interior substrates:
 - 1. Steel and iron.
 - 2. Gypsum board.
 - 3. Plaster.

1.2 DEFINITIONS

- A. MPI Gloss Level 1: Not more than five units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.
- B. MPI Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
- C. MPI Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
- D. MPI Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.
- E. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.
- F. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.
- G. MPI Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
 - 1. Include Printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
- B. Samples: For each type of paint system and in each color and gloss of topcoat.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide product listed in the Interior Painting Schedule for the paint category indicated.

2.2 PAINT, GENERAL

- A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."
- B. Material Compatibility:
 - 1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 - 2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.
- C. VOC Content: Products shall comply with VOC limits of authorities having jurisdiction.
 - 1. Flat Paints and Coatings: 50 g/L.
 - 2. Nonflat Paints and Coatings: 150 g/L.
 - 3. Dry-Fog Coatings: 400 g/L.
 - 4. Primers, Sealers, and Undercoaters: 200 g/L.
 - 5. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.
 - 6. Zinc-Rich Industrial Maintenance Primers: 340 g/L.
 - 7. Pretreatment Wash Primers: 420 g/L.
 - 8. Floor Coatings: 100 g/L.
 - 9. Shellacs, Clear: 730 g/L.
 - 10. Shellacs, Pigmented: 550 g/L.
- D. Low-Emitting Materials: Interior paints and coatings shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- E. Colors: as selected by COR from manufacturer's full range

PART 3 - EXECUTION

3.1 EXAMINATION

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

- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 - 1. Concrete: 12 percent.
 - 2. Fiber-Cement Board: 12 percent.
 - 3. Masonry (Clay and CMUs): 12 percent.
 - 4. Wood: 15 percent.
 - 5. Gypsum Board: 12 percent.
 - 6. Plaster: 12 percent.
- C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- D. Proceed with coating application only after unsatisfactory conditions have been corrected.
 - 1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."
- B. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

3.4 INTERIOR PAINTING SCHEDULE

- A. Steel Substrates:
 - 1. Latex System, Alkyd Primer MPI INT 5.1Q or MPI INT 5.1QQ:
 - a. Prime Coat: Primer, alkyd, quick dry, for metal, MPI #76.
 - b. Prime Coat: Primer, alkyd, anti-corrosive, for metal, MPI #79.
 - c. Prime Coat: Shop primer specified in Section where substrate is specified.

- d. Intermediate Coat: Latex, interior, matching topcoat.
 - e. Topcoat: Latex, interior, flat (MPI Gloss Level 1), MPI #53.
 - f. Topcoat: Latex, interior (MPI Gloss Level 2), MPI #44.
 - g. Topcoat: Latex, interior (MPI Gloss Level 3), MPI #52.
 - h. Topcoat: Latex, interior (MPI Gloss Level 4), MPI #43.
 - i. Topcoat: Latex, interior, semi-gloss (MPI Gloss Level 5), MPI #54.
 - j. Topcoat: Latex, interior, gloss (MPI Gloss Level 6, except minimum gloss of 65 units at 60 degrees), MPI #114.
2. Latex over Shop-Applied Quick-Drying Shop Primer System MPI INT 5.1X:
- a. Prime Coat: Primer, quick dry, for shop application, MPI #275.
 - b. Intermediate Coat: Latex, interior, matching topcoat.
 - c. Topcoat: Latex, interior, flat (MPI Gloss Level 1), MPI #53.
 - d. Topcoat: Latex, interior (MPI Gloss Level 2), MPI #44.
 - e. Topcoat: Latex, interior (MPI Gloss Level 3), MPI #52.
 - f. Topcoat: Latex, interior (MPI Gloss Level 4), MPI #43.
 - g. Topcoat: Latex, interior, semi-gloss (MPI Gloss Level 5), MPI #54.
 - h. Topcoat: Latex, interior, gloss (MPI Gloss Level 6, except minimum gloss of 65 units at 60 degrees), MPI #114.
3. Institutional Low-Odor/VOC Latex System MPI INT 5.1S:
- a. Prime Coat: Primer, rust inhibitive, water based MPI #107.
 - b. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.
 - c. Topcoat: Latex, interior, institutional low odor/VOC, flat (MPI Gloss Level 1), MPI #143.
 - d. Topcoat: Latex, interior, institutional low odor/VOC (MPI Gloss Level 2), MPI #144.
 - e. Topcoat: Latex, interior, institutional low odor/VOC (MPI Gloss Level 3), MPI #145.
 - f. Topcoat: Latex, interior, institutional low odor/VOC (MPI Gloss Level 4), MPI #146.
 - g. Topcoat: Latex, interior, institutional low odor/VOC, semi-gloss (MPI Gloss Level 5), MPI #147.

- h. Topcoat: Latex, interior, institutional low odor/VOC, gloss (MPI Gloss Level 6), MPI #148.
4. High-Performance Architectural Latex System MPI INT 5.1R or MPI INT 5.1R:
 - a. Prime Coat: Primer, alkyd, quick dry, for metal, MPI #76.
 - b. Prime Coat: Primer, alkyd, anti-corrosive, for metal, MPI #79.
 - c. Prime Coat: Shop primer specified in Section where substrate is specified.
 - d. Intermediate Coat: Latex, interior, high performance architectural, matching topcoat.
 - e. Topcoat: Latex, interior, high performance architectural (MPI Gloss Level 2), MPI #138.
 - f. Topcoat: Latex, interior, high performance architectural (MPI Gloss Level 3), MPI #139.
 - g. Topcoat: Latex, interior, high performance architectural (MPI Gloss Level 4), MPI #140.
 - h. Topcoat: Latex, interior, high performance architectural, semi-gloss (MPI Gloss Level 5), MPI #141.
5. Water-Based Light Industrial Coating System MPI INT 5.1B:
 - a. Prime Coat: Primer, rust-inhibitive, water based MPI #107.
 - 1)
 - b. Intermediate Coat: Light industrial coating, interior, water based, matching topcoat.
 - c. Topcoat: Light industrial coating, interior, water based (MPI Gloss Level 3), MPI #151.
 - d. Topcoat: Light industrial coating, interior, water based, semi-gloss (MPI Gloss Level 5), MPI #153.
 - e. Topcoat: Light industrial coating, interior, water based, gloss (MPI Gloss Level 6), MPI #154.
6. Water-Based Dry-Fall System MPI INT 5.1C or MPI INT 5.1CC:
 - a. Prime Coat: Primer, alkyd, quick dry, for metal, MPI #76.
 - b. Prime Coat: Primer, alkyd, anti-corrosive, for metal, MPI #79.
 - c. Prime Coat: Shop primer specified in Section where substrate is specified.
 - d. Topcoat: Dry fall, latex, flat, MPI #118.

- e. Topcoat: Dry fall, water based, for galvanized steel, flat (MPI Gloss Level 1), MPI #133.
 - f. Topcoat: Dry fall, latex (MPI Gloss Level 3), MPI #155.
 - g. Topcoat: Dry fall, latex (MPI Gloss Level 5), MPI #226.
7. Alkyd System MPI INT 5.1E or MPI INT 5.1EE:
- a. Prime Coat: Primer, alkyd, quick dry, for metal, MPI #76.
 - b. Prime Coat: Primer, alkyd, anti-corrosive, for metal, MPI #79.
 - c. Prime Coat: Shop primer specified in Section where substrate is specified.
 - d. Intermediate Coat: Alkyd, interior, matching topcoat.
 - e. Topcoat: Alkyd, interior, flat (MPI Gloss Level 1), MPI #49.
 - f. Topcoat: Alkyd, interior (MPI Gloss Level 3), MPI #51.
 - g. Topcoat: Alkyd, interior, semi-gloss (MPI Gloss Level 5), MPI #47.
 - h. Topcoat: Alkyd, interior, gloss (MPI Gloss Level 6), MPI #48.
8. Alkyd over Surface-Tolerant Primer System MPI INT 5.1T:
- a. Prime Coat: Primer, metal, surface tolerant MPI #23.
 - b. Intermediate Coat: Alkyd, interior, matching topcoat.
 - c. Topcoat: Alkyd, interior, flat (MPI Gloss Level 1), MPI #49.
 - d. Topcoat: Alkyd, interior (MPI Gloss Level 3), MPI #51.
 - e. Topcoat: Alkyd, interior, semi-gloss (MPI Gloss Level 5), MPI #47.
 - f. Topcoat: Alkyd, interior, gloss (MPI Gloss Level 6), MPI #48.
9. Quick-Dry Enamel System MPI INT 5.1A:
- a. Prime Coat: Primer, alkyd, quick dry, for metal, MPI #76.
 - b. Intermediate Coat: Alkyd, quick dry, matching topcoat.
 - c. Topcoat: Alkyd, quick dry, semi-gloss (MPI Gloss Level 5), MPI #81.
 - d. Topcoat: Alkyd, quick dry, gloss (MPI Gloss Level 7), MPI #96.
10. Alkyd Dry-Fall System MPI INT 5.1D or MPI INT 5.1DD:
- a. Prime Coat: Primer, alkyd, quick dry, for metal, MPI #76.
 - b. Prime Coat: Primer, alkyd, anti-corrosive, for metal, MPI #79.
 - c. Prime Coat: Shop primer specified in Section where substrate is specified.

- d. Topcoat: Dry fall, alkyd, flat, MPI #55.
 - e. Topcoat: Dry fall, alkyd (MPI Gloss Level 3), MPI #89.
 - f. Topcoat: Dry fall, alkyd, semi-gloss (MPI Gloss Level 5), MPI #225.
11. Aluminum Paint System MPI INT 5.1M or MPI INT 5.1MM:
- a. Prime Coat: Primer, alkyd, quick dry, for metal, MPI #76.
 - b. Prime Coat: Primer, alkyd, anti-corrosive, for metal, MPI #79.
 - c. Prime Coat: Shop primer specified in Section where substrate is specified.
 - d. Intermediate Coat: Aluminum paint, matching topcoat.
 - e. Topcoat: Aluminum paint, MPI #1.
- B. Gypsum Board or and or Plaster Substrates:
1. Latex over Latex Sealer System MPI INT 9.2A:
- a. Prime Coat: Primer sealer, latex, interior, MPI #50.
 - b. Prime Coat: Latex, interior, matching topcoat.
 - c. Intermediate Coat: Latex, interior, matching topcoat.
 - d. Topcoat: Latex, interior, flat (MPI Gloss Level 1), MPI #53.
 - e. Topcoat: Latex, interior (MPI Gloss Level 2), MPI #44.
 - f. Topcoat: Latex, interior (MPI Gloss Level 3), MPI #52.
 - g. Topcoat: Latex, interior (MPI Gloss Level 4), MPI #43.
 - h. Topcoat: Latex, interior, semi-gloss (MPI Gloss Level 5), MPI #54.
 - i. Topcoat: Latex, interior, gloss (MPI Gloss Level 6, except minimum gloss of 65 units at 60 degrees), MPI #114.
- 1)
2. Latex over Alkyd Primer System (for Plaster Only) MPI INT 9.2K:
- a. Prime Coat: Primer sealer, alkyd, interior, MPI #45.
 - b. Intermediate Coat: Latex, interior, matching topcoat.
 - c. Topcoat: Latex, interior, flat (MPI Gloss Level 1), MPI #53.
 - d. Topcoat: Latex, interior (MPI Gloss Level 2), MPI #44.
 - e. Topcoat: Latex, interior (MPI Gloss Level 3), MPI #52.
 - f. Topcoat: Latex, interior (MPI Gloss Level 4), MPI #43.

- g. Topcoat: Latex, interior, semi-gloss (MPI Gloss Level 5), MPI #54.
 - h. Topcoat: Latex, interior, gloss (MPI Gloss Level 6, except minimum gloss of 65 units at 60 degrees), MPI #114.
 3. Institutional Low-Odor/VOC Latex System MPI INT 9.2M:
 - a. Prime Coat: Primer sealer, interior, institutional low odor/VOC, MPI #149.
 - b. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.
 - c. Topcoat: Latex, interior, institutional low odor/VOC, flat (MPI Gloss Level 1), MPI #143.
 - d. Topcoat: Latex, interior, institutional low odor/VOC (MPI Gloss Level 2), MPI #144.
 - e. Topcoat: Latex, interior, institutional low odor/VOC (MPI Gloss Level 3), MPI #145.
 - f. Topcoat: Latex, interior, institutional low odor/VOC (MPI Gloss Level 4), MPI #146.
 - g. Topcoat: Latex, interior, institutional low odor/VOC, semi-gloss (MPI Gloss Level 5), MPI #147.
 - h. Topcoat: Latex, interior, institutional low odor/VOC, gloss (MPI Gloss Level 6), MPI #148.
 4. High-Performance Architectural Latex System MPI INT 9.2B:
 - a. Prime Coat: Primer sealer, latex, interior, MPI #50.
 - b. Intermediate Coat: Latex, interior, high performance architectural, matching topcoat.
 - c. Topcoat: Latex, interior, high performance architectural (MPI Gloss Level 2), MPI #138.
 - d. Topcoat: Latex, interior, high performance architectural (MPI Gloss Level 3), MPI #139.
 - e. Topcoat: Latex, interior, high performance architectural (MPI Gloss Level 4), MPI #140.
 - f. Topcoat: Latex, interior, high performance architectural, semi-gloss (MPI Gloss Level 5), MPI #141.
 5. Alkyd over Latex Sealer System MPI INT 9.2C:
 - a. Prime Coat: Primer sealer, latex, interior, MPI #50.
 - b. Intermediate Coat: Alkyd, interior, matching topcoat.

- c. Topcoat: Alkyd, interior, flat (MPI Gloss Level 1), MPI #49.
- d. Topcoat: Alkyd, interior (MPI Gloss Level 3), MPI #51.
- e. Topcoat: Alkyd, interior, semi-gloss (MPI Gloss Level 5), MPI #47.
- f. Topcoat: Alkyd, interior, gloss (MPI Gloss Level 6), MPI #48.

END OF SECTION 099123

SECTION 230000 – MECHANICAL GENERAL CONDITIONS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. All drawings and applicable provisions of Division 0 Bidding Requirements and Division 1 General Requirements apply to work of this Section.
- B. Should a conflict arise between Section 230000 General Conditions and other Sections, the General and Supplementary Conditions of Division 1 shall take precedence.
- C. The mechanical work shall comply with all provisions of the architectural, plumbing, fire protection, mechanical and electrical drawings and specifications.
- D. The word "Contractor" as used in these specifications shall mean the person, firm or corporation contracting to do the described work.
- E. It shall be a part of this Contractor's bid that the submission of a proposal carries with it the agreement to all items and conditions referred to in the specifications and accompanying drawings.
- F. Rough-in for and connect, as shown on the drawings, facilities for equipment furnished by the Owner under a separate contract.

1.2 RULES AND REGULATIONS

- A. The rules, regulations, ordinances of all applicable governing bodies in force at the time of execution of the Contract shall become a part of these specifications. These shall include the requirements of state, county, city and also the local utility companies.
- B. All materials furnished and work performed shall be in compliance with the latest applicable codes.

1.3 PERMITS AND FEES

- A. Cost of all fees, permits or licenses that may be required for the performance of the Contract shall be included.

1.4 PLANS AND SPECIFICATIONS

- A. The specifications and the accompanying plans (architectural, site, structural, mechanical, electrical, fire protection and plumbing) are mutually explanatory and anything described or shown on one, but not on the other, shall be considered as if shown or described on both. The intention of the plans and specifications is to provide complete functioning systems in every respect. Contractor shall furnish all material and equipment and shall perform all labor to achieve this intent, whether or not such material or equipment is indicated herein. Whenever the term "provide" is used, it shall mean "furnish and install." If a conflict exists between the drawings and the specifications or between one specification and another specification or between one drawing and another drawing, the most demanding requirement shall apply unless otherwise authorized in writing by the Engineer.

- B. Data given herein and on the drawings is as exact as could be secured. Their absolute accuracy is not guaranteed and this Contractor shall obtain and verify exact locations, measurements, levels, space requirements, etc., at the site, and shall satisfactorily adapt the work to actual conditions at the building as constructed.
- C. The drawings shall be considered schematic and are not intended to indicate all changes in direction and necessary fittings to be installed by this Contractor. Ductwork, equipment, etc., shall be installed so all items clear the structure and other building elements and maintain appropriate clearances for access, service and maintenance.
- D. Some of the details on the plans are schematic or diagrammatic. These details are not intended to show all duct, fittings, etc., required to achieve the arrangement shown on the plan view, but instead are intended to show those items, such as curbs and sealing, etc., which are not shown on the plan view. This Contractor shall appropriately adapt these details to the actual conditions of the job.
- E. Routing of piping, location of equipment, and location of other devices are shown on plans for general guidance. This Contractor shall coordinate his work with other Contractors and shall provide necessary deviations in routing as far as 10 feet from those shown to provide systems as specified or implied, without interference and pursuant to these requirements at no additional cost to the Owner, Architect or Engineer.
- F. Contractor shall not scale the drawings. Refer to architectural and structural drawings for building construction and dimensions and to room finish schedule on architectural drawings for material, finish and construction method of walls, floors and ceilings in order to insure proper rough-in and installation of contractor's work.
- G. Changes, modifications or variations to the plans and specifications will be issued by the Engineer in writing.

1.5 DISCREPANCIES OR OMISSIONS

- A. During the bidding period, should a bidder find discrepancies or omissions in any of the documents or should he be in doubt as to their meaning, he should at once notify the Engineer who will, time permitting, issue a written instruction in the form of an addendum to all bidders of record. The Engineer will not be responsible for any oral explanations or interpretations of the documents.
- B. During construction, should a discrepancy or omission be found, it shall be brought to the attention of the Engineer at once for resolution.
- C. No changes in contract price will be allowed for minor changes in layout or location required to avoid interferences, obstructions, etc. Contract price changes will be considered only for changes in the scope of the project requirements. All such scope changes and price revisions must be authorized in writing.
- D. If discrepancies are found within the contract documents, the most demanding requirement shall take precedence unless otherwise agreed by the engineer in writing.

1.6 VISITING THE SITE

- A. This Contractor, before submitting bid, shall visit the site and become thoroughly acquainted with conditions under which the work will be performed.
- B. Failure to become fully acquainted with existing site conditions under which the work is to be performed will not be justification for additional compensation after the award of the contract.

1.7 HOISTING

- A. Contractor shall be responsible for hoisting of all materials and equipment furnished or installed under this Section of the Specifications, in accordance with all city, state and federal rules and regulations.

1.8 SHOP DRAWINGS

- A. Contractor shall submit shop drawings in compliance with the General and Special Conditions. Contractor shall field verify exact locations, measurements, and space availability at the site, etc. prior to fabricating materials and shall notify the Engineer of discrepancies in writing.
- B. The Contractor shall submit copies of all required Shop Drawings and material and equipment lists.
- C. Submittals shall be transmitted to SSC Engineering as paper documents, electronic documents via email attachments, or electronic documents via FTP file transfers.
 - 1. All submittals shall include a transmittal form identifying the project name, date, contents of submittal package, and names of subcontractor, manufacturer, and supplier.
 - 2. On an attached separate sheet clearly identify deviations from requirements in the Contract Documents, including minor variations and limitations.
 - 3. Paper submittals shall be sent to
SSC Engineering
Attention: Submittals
18207 Edison Ave.
Chesterfield, MO 63005
 - 4. Emails regarding submittals shall be sent to “submittals@sscengineering.com”.
- D. Documents transmitted in paper format shall be sent to the COR who will forward these to SSC. If approved by the COR prior to submitting documents, these documents may be submitted simultaneously to the COR and SSC. SSC will return all documents to the COR only regardless of how they were transmitted to SSC. Submit four (4) paper copies of all required Shop Drawings and material and equipment lists for the Engineer’s and Owner’s sole use. The Contractor shall submit additional paper copies that will be required for his own use and the Operation and Maintenance Manuals. The additional copies will be reviewed by the Engineer and returned to the Contractor marked accordingly.
- E. If SSC is the prime consultant and there is no COR, paper documents shall be transmitted directly to SSC.

- F. Documents transmitted as email attachments shall be sent simultaneously to the COR and SSC. SSC will return one (1) electronic copy of these documents to the COR only.
- G. Documents transmitted via FTP file transfers shall be retrieved from the FTP site after SSC has received an email notification that these documents have been posted to the site. SSC will return one (1) electronic copy of these documents to the COR only unless another procedure is agreed to in writing by the COR and the Engineer.
- H. Contractor shall review and correct all shop drawings before they are submitted. Shop drawings shall bear the signed and dated approval stamp of this Contractor.
- I. Shop drawings shall include the plan mark used on the plans.
- J. Valve and fitting shop drawings shall indicate the intended service.
- K. Equipment shop drawings shall give capacities at conditions specified and shall include manufacturer's catalog numbers and cuts. Shop drawings shall be clearly marked; shall indicate all accessories, items, conditions, etc., which are being furnished; and shall indicate that all conditions of the plans and specifications are being met. Wiring diagrams shall be submitted.
- L. Submittals which do not provide the required information will be returned unchecked.
- M. Contractor shall be responsible for deviations, errors and omissions, quantities, and coordination dimensions in submittals, and this responsibility shall not be relieved by Engineers' review of submittals.
- N. This Contractor shall coordinate each submittal with the contract documents, work of other contractors, and job site conditions.
- O. The Contractor shall not be relieved of responsibility for deviations from requirements of the Contract Documents by the Engineer's approval of Shop Drawings, Product Data, Samples or similar submittals unless the Contractor has specifically informed the Engineer in writing of such deviation at the time of submittal and (1) the Engineer has given written approval to the specific deviation as a minor change in the Work, or (2) a Change Order or Construction Change Directive has been issued authorizing the deviation. The Contractor shall not be relieved of responsibility for errors or omissions in Shop Drawings, Product Data, Samples or similar submittals by the Engineer's approval thereof.

1.9 RELEASE OF CAD FILES

- A. See "Release of CAD Files" at the end of this section.

1.10 OPERATING AND MAINTENANCE INSTRUCTIONS AND MANUALS

- A. Upon completion of the job, the installing contractors and major suppliers shall instruct the Owner's representatives in the proper operation and maintenance of the systems installed. The installing Contractors shall submit documentation indicating the date of instruction; names and organization of persons providing and receiving the instructions; systems the instructions covered; and materials received.

- B. Contractor shall also submit four (4) complete hard copy sets and one (1) electronic copy of properly bound operating manuals to the Engineer for review. These manuals shall include the following:
1. Include a Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
 2. Complete set of shop drawings.
 3. Copies of all submittals.
 4. Parts lists, wiring diagrams, piping diagrams, etc.
 5. Manufacturers' operating and maintenance instructions.
 6. As-built drawings.
 7. Written operating and maintenance instructions for the system. This is a written version of Paragraph "1" above.
 8. Copies of warranties.
 9. Parts lists for each piece of equipment and name of local supplier.

1.11 AS-BUILT RECORD DRAWINGS

- A. During construction, a separate set of plans at the jobsite shall be maintained by the Contractor to keep a record of all changes of locations. See additional requirements in General Conditions and Supplementary Conditions.
- B. Locations of piping, ductwork and other concealed facilities are to be shown by the Contractor if and when they differ from the drawings. Underground piping shall be dimensioned on those drawings.
- C. "As built" drawings are to be submitted to COR/Engineer for review prior to the time of request for final payment. Submit as-built record drawings in accordance with the General Conditions.
- D. For drawings that SSC has furnished to the contractor in CAD format, contractor shall prepare "As Built" drawings in CAD format. "As built" drawings in CAD format are to be submitted to COR/Engineer, in addition to marked up paper documents for review prior to the time of request for final payment. Submit as-built record drawings in accordance with the General Conditions.

1.12 GUARANTEE AND WARRANTY

- A. This Contractor shall guarantee and warrant all equipment, materials, workmanship, installation, etc., for a period of one year in accordance with the General Conditions. This one-year warranty shall commence on satisfactory completion of final punch list items. Satisfactory completion of the final punch list will be determined by the Engineer. If the Owner accepts a portion(s) of the project earlier than the rest, such as partial beneficial occupancy, that portion's warranty shall begin on the date it is accepted as substantially complete. A project may have multiple warranty periods in these certain cases and will be fully coordinated between the Owner, the COR and the Engineer.

- B. During the guarantee period, this Contractor shall make all required repairs and replacements, and shall provide all necessary service, labor, tools, materials, parts, etc., required at no additional cost to the Owner.

PART 2 - PRODUCTS

2.1 MATERIAL SUBSTITUTION

- A. Equipment selection has been based on one manufacturer to establish the desired type, style, quality, performance, etc. When other manufacturers are listed as equally acceptable, the product of those manufacturers will be accepted if their product complies with these specifications and drawings. The listing of a manufacturer does not relieve that manufacturer from complying with the specifications and drawings.
 - 1. For manufacturers other than those listed, the Contractor shall prepare and submit to the COR/Engineer for review, a proposal to provide a substitution. Proposal shall be submitted minimum ten (10) working days before the bid date and written approval shall be received from the COR/Engineer before including the substitution in the bid. Substantiate that the substitution complies with the intent of the Project Documents and include sufficient information of the changes required so that a judgment may be rendered.
 - 2. Proposal shall include a drawing originated by the Contractor. The design shall show the intended installation to the same level of detail as that of the original design in addition to catalog cut, assembly manual, or other generic documents printed by the manufacturer or their representative.
 - 3. Prior to submitting the proposal, the Contractor shall notify all other contractors whose work is affected and request details and pricing of their respective changes. This information along with the Contractor's details shall be transmitted to the Architect/Engineer for approval.
 - 4. If the proposal is accepted, the Contractor shall compensate other trades which are affected by said proposal.
- B. All equipment and materials are subject to the review and approval of the Engineer and COR.
- C. All differences in cost involved in using an equally acceptable manufacturer shall be included in this Contractor's bid. This contractor shall be responsible for any and all engineering and installation variations due to the substituted equipment. These include structural, electrical, architectural, plumbing, mechanical, fire protection, etc. changes.
- D. Deviations from these specifications are not solicited and are not encouraged. If a deviation between the specifications or drawings and items bid does exist, then that deviation must be clearly itemized and explained on the bid form.
- E. Solvent based adhesives or sealants shall not be substituted for water based adhesives or sealants.

PART 3 - EXECUTION

3.1 GENERAL

- A. Contractor shall provide all material, equipment, labor, services, and supplies, required to execute all work shown on the mechanical drawings; described in these specifications; or made necessary by the work shown on the drawings and/or described in these specifications.
- B. Contractor shall schedule all work and furnish the required materials in such a manner that the work may progress from start to finish in an expeditious and efficient manner without undue interruption. This Contractor shall also schedule his work to coordinate with the construction staging for this project.
- C. Contractor shall hire the proper trades to accomplish the work described on the drawings or in the specifications.

3.2 COORDINATION OF TRADES

- A. Prior to the fabrication or installation of any materials, Contractor shall review the drawings indicating work to be performed by each trade. If conflicts occur, they shall be brought to the attention of the Engineer for resolution.
- B. If Contractor installs the work without coordinating with the other trades, then, if requested by the Owner, COR, or Engineer, Contractor shall remove and rework some installed work to resolve a conflict, and such change shall be done at no change in contract price.
- C. The Contractor supplying the equipment shall furnish all motors and components which are part of the equipment.
- D. Control wiring is defined as that wiring which conducts electrical energy at a voltage of less than 100 volts. Interlock wiring is defined as that wiring which performs a control function, but at a voltage of 100 volts or greater. All other wiring shall be considered power wiring.
- E. The Electrical Contractor shall provide power wiring to, and including connection to the equipment. Unless specifically noted otherwise, all interlock wiring shall be provided by the Temperature Control Contractor. Unless noted otherwise, the control wiring shall be provided by the Contractor furnishing the controlled equipment.
- F. Unless noted otherwise, the Electrical Contractor shall provide all starters, disconnects, switches, push-button stations, etc., except those which are furnished with the equipment as a part of a factory-assembled package. Heater elements for overload relays on magnetic motor starters (except the starters factory pre-wired with equipment) shall be sized, furnished and installed by the Electrical Contractor. Magnetic motor starters for mechanical equipment (except starters factory pre-wired with equipment such as chillers and packaged air conditioners) shall be provided by the Electrical Contractor. Magnetic motor starters will be provided with:
 - 1. Auxiliary contacts as required by the interlocks defined on the drawings or in the specifications.
 - 2. Control Power Transformer - 120 volt secondary, minimum 40 Volt Amps.
- G. Each Contractor furnishing motor-operated equipment shall furnish a list of motor characteristics to the Electrical Contractor so that properly sized heater elements may be

provided. The list shall include equipment identification by name and by number, the full load current, locked rotor current, voltage rating, and suggested service factor to compensate for operating duty cycle and ambient temperatures.

- H. Unless specifically noted otherwise, pilot controllers (aquastats, flow switches, pressure switches, etc.) shall be furnished and mounted by the Contractor furnishing the controlled equipment.
- I. Unless specifically noted otherwise, thermal wells for temperature control system sensors shall be provided by the Temperature Control Contractor and installed by the Mechanical Contractor.
- J. Unless specifically noted otherwise, control valves and control dampers shall be furnished by the Temperature Control Contractor and installed by the Mechanical Contractor.
- K. Electrical Work For Mechanical Equipment: Electrical Contractor shall wire all mechanical equipment furnished by various contractors in accordance with the following general provisions:
 - 1. Power wiring from panel to motor controllers, relays, etc., and from controller to motor terminals per equipment manufacturer's wiring diagram.
 - 2. Receive, unload, set and align all separately shipped motors. Adjust and align drive and adjust belt tension.
 - 3. Field lubricate all motors prior to initial operation of same.
 - 4. Install individual motor starters specifically called for to be furnished by other Contractors when not a factory pre-wired component.
- L. HVAC Contractor shall provide the following:
 - 1. All motors, disconnect switches or control devices specifically called for.
 - 2. Automatic control and interlock wiring diagrams as called for in the specifications.
 - 3. Complete and accurate wiring diagrams to Electrical Contractor for all equipment requiring electrical power wiring including motor terminal connection diagrams.
 - 4. Adjustable motor bases and all bolts and nuts required for installation of base and motor.
 - 5. Supervision of Electrical Contractor in lubrication of motors to eliminate possibility of motor starting or operating without proper lubrication and control systems.

3.3 PROTECTION OF EQUIPMENT AND WORK

- A. This Contractor shall, at all times, protect and preserve all materials, supplies, equipment, piping, etc., from damage due to weather, corrosion, dirt, vandalism, theft, etc., and shall further provide all enclosures or special protection as indicated by circumstances.
- B. Should any of the materials, equipment, etc., be damaged as a result of his negligence, then this Contractor shall be held responsible for all such damage and costs incurred for repair or replacement.

3.4 CONSTRUCTION STAGING

- A. See schedule in Division 0 and Division 1. This Contractor shall cooperate with and coordinate to plan and schedule the work to satisfy the schedule.
- B. All work shall be so arranged that electrical power, sewer, water, and other services are available to the building at all times, except for short periods of interruption necessary for the performance of new work. Interruptions shall not be requested until the new services are complete and ready for final connection.
- C. All interruptions shall be scheduled and services shall not be interrupted without written approval of the Owner's Representative. Notification to the Owner's Representative shall include the exact time and estimated duration of any interruption.
- D. Ducts which are shown to be installed or demolished in subsequent phases that are needed for earlier phases to make the earlier phase operational shall be installed or demolished in the earlier phase during non-business hours. Any diffusers that straddle phase areas shall be temporarily moved to the adjacent ceiling to remain in service and shall be permanently moved to the correct location before substantial completion. Where later phase work is performed in an earlier phase, contractor shall remove and replace ceilings as required to perform the work.

3.5 DEMOLITION OF FACILITIES

- A. General
 - 1. The demolition work shall consist of removal of mechanical equipment, ductwork, and related piping pertaining to the installation and modifications of the heating, ventilating and air conditioning systems as indicated on the drawings.
 - a. Piping to Be Removed: Drain piping and remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
 - c. Ducts to Be Removed: Remove portion of ducts indicated to be removed to an existing joint in the duct, unless otherwise indicated, and cap remaining ducts with same or compatible ductwork material or cap with polyethylene film sealed to duct with duct tape.
 - d. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
 - e. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - f. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - g. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
 - 2. Contractor shall note the project is a renovation to an existing building. The building shall remain in operation at all times during the construction. Contractor shall allow

adequate overtime and supervision to allow for work that is required by the owner to be performed after normal operating hours.

3. Demolition drawings provided are representative of existing conditions, prepared from previous design drawings and field surveys, but may not be all inclusive of existing conditions at the present time. The Contractor shall be responsible to field verify actual existing conditions and remove all items, whether indicated on drawings or not, as required for new work.
4. Contractor shall review the drawings, specifications and existing job conditions and shall include in his bid all demolition work as required and as shown on the mechanical drawings.
5. Where items are removed, utilities and the area from which the items have been removed shall be left in such a manner that they are safe to both people and property.
6. Before disconnection of any systems, advance approved arrangements shall be made to prevent interference with utility services to rooms and structures not otherwise affected by work under this contract.
7. All mechanical equipment to be reused shall be disconnected, marked and protected where necessary.

B. Existing Conditions

1. Contractor shall exercise great caution when performing demolition work to prevent damage to existing systems or items of work that are to remain. If Contractor damages, removes or destroys an existing system which is to remain, Contractor shall repair or replace that system to its original condition.
2. Unless specifically stated otherwise on the plans, where access to mechanical, plumbing, and fire protection items is required, Contractor shall provide the required access by removing ceilings, cutting openings, etc., as required. Prior to cutting openings, this Contractor shall outline the openings and shall obtain approval from and shall cut openings in the manner directed by the Owner's Representative. Demolition work shall also include the removal and replacement of walls as required for installation or removal of equipment.
3. Repair of openings is a part of this Contractor's work. Work shall be performed by the proper trades. Materials which are removed, damaged, or soiled shall be replaced with new materials. Ceilings and walls shall be repaired and restored to as close to the original condition as possible. This shall include replacement of surface finish materials such as paint, plaster, drywall, ceiling tile, etc.
4. Repair of floor openings and trenches is a part of this Contractor's work. Floors shall be repaired to match the level and surface finish of the existing concrete and flooring finishes.
5. Areas shall be repaired with materials matching those which have been removed.

6. Contractor shall repair streets, sidewalks, parking lots and reseed grassed areas which have been altered by his work.

C. Protection

1. During demolition operations, all persons and property shall be protected. This Contractor shall be responsible for the erection of any barriers, fences, guard rails, enclosures, chutes, and shoring to protect all persons and property.
2. Contractor shall minimize any spread of dust, debris and flying particles. Demolition shall not interfere with the surrounding equipment, personnel, or buildings.
3. Where necessary, this Contractor shall provide temporary enclosures to be sure that the area is secured, safe and weatherproofed.

CI. Disposition of Material

1. Those items of material and equipment to be removed by this Contractor and designated to become the property of the Owner, shall be delivered to an on-site location designated by the Owner.
2. All other materials and equipment removed shall become the property of this Contractor and shall be removed from the job site and legally disposed of.

CII. Hazardous Materials

1. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify COR, Engineer, and Owner. Owner will remove hazardous materials under a separate contract.
2. Hazardous Materials: Hazardous materials are present in construction to be selectively demolished. A report on the presence of hazardous materials is on file for review and use. Examine report to become aware of locations where hazardous materials are present. Do not disturb hazardous materials or items suspected of containing hazardous materials except under procedures specified elsewhere in the Contract Documents. Hazardous material remediation is specified elsewhere in the Contract Documents.
3. Where insulation containing hazardous materials is removed from piping and equipment, it shall be replaced with new insulation. See specification 230200, Mechanical Insulation.

3.6 MAINTENANCE OF WORK AREAS

- A. During the project, this Contractor shall maintain his work area in an organized manner, shall not allow debris to accumulate, and shall store equipment, tools and supplies in a manner which shall not cause interference with the activities of others engaged on the project.
- B. Open ends of pipe, ductwork, equipment, and specialties shall be kept properly closed during construction and installation so as to avoid contamination.

3.7 CLEANING AND CLEANUP

- A. Upon completion of this work, the Contractor shall clean all pipe, ductwork, fixtures, and equipment. Contractor shall leave all work in a finished, clean, and satisfactory working condition.
- B. Each contractor shall be responsible for his own cleanup to a central location designated by the Owner. Contractor shall periodically remove all rubbish, crating, unused material, outfall, and any other debris created by him during the course of the work.

END OF SECTION 230000

RELEASE OF CAD FILES

The drawings prepared by SSC Engineering have been prepared using AUTOCAD 2018. Files for plan drawings prepared by SSC Engineering will be made available to the successful HVAC, plumbing, electrical and fire protection contractor by email; no other drawings will be released. The files will have background files bound in, borders and title blocks removed, and all notes, details, diagrams, and schedules removed. A release form must be signed. Utilization of these documents for the development of shop drawings and submittals does not relieve the contractor from any of his responsibilities herein.

Release form that must be signed:

As requested, SSC Engineering will provide _____ (name of contractor) with electronic CAD files of the requested (M, E, P, FP) floor or ceiling plans on the terms set forth below. While SSC is not required under its contract to provide or update these electronic files for this purpose, they are being made available as a convenience to the contractor and as a substantial time saver in the preparation of submittals for this project.

The files contain information through the date when the drawings were issued for bidding and may or may not contain information from the addenda. The company using these files shall be responsible for the coordination of the information contained therein with the Plans, Specifications and other Contract Documents. In the event of any ambiguity, discrepancy or conflict between the information within the electronic files and the Contract Documents, the Contract Documents shall be used.

SSC will not be responsible for any error or malfunction in the translation, interpretation or use of this electronic information once it has been provided to the contractor. SSC does not assume any responsibility arising out of the use or adaptation of the information contained in these files or the sufficiency of any drawings prepared based upon the information included within. By accepting these drawing files, the contractor agrees to hold the Engineer harmless with regard to any errors or omissions in the drawing files. Nothing included in this release shall modify any requirements or responsibilities of either party under their respective contracts.

Signing below indicates understanding and acceptance of these terms. Upon receipt of a signed letter or fax, SSC will release the electronic CAD files.

Project Name and Number: _____

Specific Drawings Request: _____

Acknowledged and Agreed:

Company

Version of AutoCAD used

Name (Must be an officer of the Company)

E-mail address

Title

Maximum e-mail attachment size

Date

SECTION 230010 – BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. This section covers basic mechanical materials and methods for the systems listed below and applies to work of those sections. Provide Basic Mechanical Material and Methods as indicated and required.

- 1. Mechanical

1.2 RELATED DOCUMENTS:

- A. All drawings and applicable provisions of Division 0 Bidding Requirements and Division 1 General Requirements apply to work of this Section.
- B. Section 230000 - Mechanical General Conditions.

PART 2 - PRODUCTS

2.1 PRODUCT CRITERIA

- A. Material and equipment shall be the standard product of a manufacturer regularly engaged in the manufacture of the product for at least 5 years.
- B. Products shall be supported by a service organization which maintains an inventory of repair parts and is located within 100 miles of the jobsite.

2.2 MATERIALS AND STANDARDS

- A. All equipment and materials furnished by this Contractor shall be new, and where two or more items of the same kind are required, they shall be the product of the same manufacturer.
- B. All materials, equipment, operations, procedures and installation of all materials and equipment shall conform to:

ADA	Americans with Disabilities Act
ASME	American Society of Mechanical Engineers
UL	Underwriters' Laboratories, Inc.
NFPA	Applicable sections of the National Fire Protection Association
NEMA	National Electrical Manufacturers Association
OSHA	Occupational Safety and Health Administration
NEC	National Electrical Code
AMCA	Air Moving and Conditioning Association
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers
ARI	Air Conditioning and Refrigeration Institute
ANSI	American National Standards Institute, Inc.
ASTM	American Society for Testing Materials
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association
IPCEA	Insulated Power Cable Engineers Association

HEW	U.S. Department of Health, Education and Welfare
PDI	Plumbing and Drainage Institute
NSF	National Sanitation Foundation
IEEE	Institute of Electrical and Electronic Engineers
AWWA	American Water Works Association

- C. All materials used shall be applied in compliance with the manufacturer's recommendations. If a discrepancy occurs between the application of materials as called for on the drawings or in the specifications and the manufacturer's recommendations, this discrepancy shall be called to the Engineer's attention before materials are purchased or applied.

D. Abbreviations

1. ACC	Air Cooled Condenser	36. CLG	Ceiling
2. AC	Air Conditioning Unit	37. CO	Cleanout
3. AD	Area Drain	38. CPVC	Chlorinated Polyvinyl Chloride
4. ADJ	Adjustable		
5. AF	Anti-Freeze	39. CR	Condenser Water Return
6. AFF	Above Finished Floor	40. CS	Condenser Water Supply
7. AHU	Air Handling Unit	41. CT	Cooling Tower
8. AI	Analog Input	42. CU	Condensing Unit
9. AO	Analog Output	43. CUH	Cabinet Unit Heater
10. AP	Access Panel	44. CWP	Condenser Water Pump
11. APD	Air Pressure Drop (In WC)	45. D	Drain
12. ASA	Air Separator	46. DF	Drinking Fountain
13. B	Boiler	47. DIA	Diameter
14. BB	Air Blender	48. DB	Dry Bulb Temperature
15. BDD	Backdraft Damper	49. DDC	Direct Digital Control
16. BFP	Back Flow Preventor	50. DI	Digital Input
17. BHP	Brake Horsepower	51. DISC	Disconnect
18. BTU	British Thermal Units	52. DN	Down
19. BOD	Bottom of Duct	53. DO	Digital Output
20. BOP	Bottom of Pipe	54. DS	Downspout
21. BOS	Bottom of Steel	55. DW	Dishwasher
22. BW	Backwater Valve	56. DSD	Duct Smoke Detector Supply
23. C	Coil		
24. CAP	Capacity	57. DSR	Duct Smoke Detector Return
25. CONN	Connected		
26. CV	Control Valve	58. DX	Direct Expansion
27. CC	Cooling Coil	59. E	Exhaust Register/Grille
28. CC	Center to Center	60. EA	Exhaust Air
29. CFM	Cubic Feet per Minute	61. EAT	Entering Air Temperature
30. CH	Chiller	62. EDB	Entering Dry Bulb Temperature
31. CHP	Chilled Water Pump		
32. CHR	Chilled Water Return	63. EJ	Expansion Joint
33. CHS	Chilled Water Supply	64. ELS	Electrical Contractor
34. CI	Cast Iron	65. EWB	Entering Wet Bulb Temperature
35. CL	Center Line		

66.	EWT	Entering Water Temperature	110.	GI	Grease Interceptor
67.	EFF	Efficiency	111.	GC	General Contractor
68.	ET	Expansion Tank	112.	GUH	Gas Unit Heater
69.	ECH	Electric Cabinet Heater	113.	GWH	Gas Water Heater
70.	EF	Exhaust Fan	114.	H	Hood
71.	EG	Ethylene Glycol	115.	H-CW	Hot and Cold Water
72.	EC	Electrical Contractor	116.	HB	Hose Bibb
73.	EMS	Energy Management System	117.	HD	Hose Drain
74.	ESP	External Static Pressure	118.	HR	Hour
75.	ESV	Emergency Shut-Off Valve	119.	HP	Heat Pump
76.	EUH	Electric Unit Heater	120.	HP	Horsepower
77.	EWC	Electric Water Cooler	121.	HPC	High Pressure Condensate
78.	EWB	Electric Water Heater	122.	HPS	High Pressure Steam
79.	EXT	Existing	123.	HR	Hot Water Supply (HVAC)
80.	EXH	Exhaust	124.	HS	Hot Water Supply (HVAC)
81.	FA	Fresh Air	125.	HU	Humidifier
82.	FCE	Furnace	126.	HWP	Hot Water Pump
83.	FCO	Floor Cleanout	127.	HX	Heat Exchanger
84.	FCU	Fan Coil Unit	128.	IE	Invert Elevation
85.	FD	Fire Damper (HVAC)	129.	IH	Intake Hood
86.	FD	Floor Drain (Plumbing)	130.	IN	Inches
87.	FDC	Fire Department Connection	131.	INST	Installed
88.	FH	Floor Hydrant	132.	IRH	Infra-red Heater
89.	FHV	Fire Hose Valve	133.	KW	Kilowatt
90.	FDR	Filter Drier	134.	LAT	Leaving Air Temperature
91.	FHC	Fire Hose Cabinet	135.	LDB	Leaving Dry Bulb Temperature
92.	FIN	Finish	136.	LWB	Leaving Wet Bulb Temperature
93.	FLR	Floor	137.	LWT	Leaving Water Temperature
94.	FM	Factory Mutual	138.	LRA	Locked Rotor Amps
95.	FPM	Feet per Minute	139.	LAV	Lavatory
96.	FT	Feet	140.	LPC	Low Pressure Condensate
97.	FTU	Fan Terminal Unit	141.	LPG	Liquid Propane Gas
98.	FURN	Furnished	142.	LPS	Low Pressure Steam
99.	FLA	Full Load Amps	143.	LWCO	Low Water Cut-Off
100.	FOB	Flat on Bottom	144.	MAU	Make-up Air Unit
101.	FOT	Flat on Top	145.	MAX	Maximum
102.	FPC	Fire Protection Contractor	146.	MC	Mechanical Contractor
103.	FS	Floor Sink	147.	MCC	Motor Control Center
104.	FSW	Flow Switch	148.	MD	Motorized Damper
105.	FTR	Finned Tube Radiator	149.	MIN	Minimum
106.	G	Gas	150.	MBH	1000 Btu/Hr.
107.	GAL	Gallons	151.	MPC	Medium Pressure Condensate
108.	GALV	Galvanized	152.	MPS	Medium Pressure Steam
109.	GEN	Generator			

153.	MSB	Mop Service Basin	197.	SAG	Supply Air Grille
154.	MV	Mixing Valve	198.	SAN	Sanitary
155.	MSWB	Main Switch Board	199.	SB	Shower Basin
156.	NO	Normally Open	200.	SD	Smoke Damper
157.	NC	Normally Closed	201.	SC	Storm Conductor
158.	NO.	Number	202.	SF	Supply Fan
159.	NF	Non-Fused	203.	SW	Switch
160.	NTS	Not to Scale	204.	STL	Steel
161.	O	Oil	205.	SG	Sight Glass
162.	OA	Outside Air	206.	SH	Shower
163.	OED	Open End Duct	207.	SP	Static Pressure
164.	OS	Oil Separator	208.	SPC	Sprinkler Contractor
165.	OV	Outlet Velocity	209.	SQ	Square
166.	OF	Overflow	210.	ST	Storm
167.	P	Pump	211.	ST	Steam
168.	PC	Plumbing Contractor	212.	SV	Solenoid Valve
169.	POC	Point of Connection	213.	SS	Soil Stack
170.	PIB	Power Induction Box	214.	TC	Temperature Controller
171.	PD	Pressure Drop	215.	TDR	Time Delay Relay
172.	PD	Pump Discharge (Steam)	216.	TDV	Triple Duty Valve
173.	PD	Pump Discharge-Steam Condensate	217.	TG	Transfer Grille
174.	PG	Propylene Glycol	218.	TF	Transfer Fan
175.	PTAC	Packaged Terminal A.C. Unit	219.	TOP	Top of Pipe
176.	PVC	Polyvinyl Chloride	220.	TS	Tamper Switch
177.	R	Return Air Grille	221.	TS	Temperature Sensor
178.	RA	Return Air	222.	TSP	Total Static Pressure
179.	RAD	Radiator	223.	TW	Tempered Water
180.	RAG	Return Air Grille	224.	TWU	Thru Wall A.C. Unit
181.	RD	Roof Drain	225.	TXV	Thermal Expansion Valve
182.	RF	Relief Fan	226.	UH	Unit Heater (Hydronic)
183.	RG	Refrigerant Hot Gas	227.	UR	Urinal
184.	RH	Relief Hood	228.	V	Vent
185.	RPM	Revolutions Per Minute	229.	VAV	Variable Air Volume Box
186.	RP	Recirculating Pump	230.	VD	Volume Damper
187.	RND	Round	231.	VFD	Variable Frequency Drive
188.	RL	Rain Leader	232.	VTR	Vent Thru Roof
189.	RL	Refrigerant Liquid	233.	W	Waste
190.	RBPB	Reduced Pressure Back Flow Prevention	234.	WB	Wet Bulb Temperature
191.	RS	Refrigerant Suction	235.	WPD	Water Pressure Drop (Ft. H2O)
192.	RTU	Roof Top Unit	236.	WC	Water Column
193.	RV	Relief Valve	237.	WC	Water Closet
194.	S	Sink (Plumbing)	238.	WCO	Wall Cleanout
195.	S	Supply Air Grille (HVAC)	239.	WH	Wall Hydrant
196.	SA	Supply Air	240.	YH	Yard Hydrant
			241.	ZD	Zone Damper

2.3 PREFABRICATED ROOF CURBS

- A. Prefabricated curbs shall be heavy-gage, galvanized steel with mitered and welded corners; 1-1/2-inch-thick, rigid, fiberglass insulation adhered to inside walls; built-in cant and mounting flange for flat roof decks; and 2-inch wood nailer. Provide 14 inches high where no other height is indicated. Curbs shall be Thycurb TC-3 for roof decks that are not surface insulated, and Thycurb TC-1 for decks that are surface insulated.
- B. Equivalent products, complying with these specifications, by the following manufacturers are acceptable:
 - 1. Pate
 - 2. Thybar
 - 3. Roof Products & Systems

2.4 MISCELLANEOUS MATERIALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36. Interior applications shall be galvanized steel or black steel. Exterior applications shall be galvanized steel.
- B. Strut systems shall be painted steel equal to B-Line Systems or Unistrut. Where used in exterior applications, the materials shall be galvanized steel.

2.5 ACCESS PANELS SHALL COMPLY WITH THE FOLLOWING:

- A. Access panels shall be constructed of heavy gauge steel with factory applied prime coat of baked enamel.
- B. Panel doors shall be attached to the frame with concealed hinges.
- C. Cam locks shall be provided in not less than the following quantities:

Panel Height (Opposite side of hinges)

0 to 18"	1 cam lock
18-1/16" to 30"	2 cam locks
30-1/16" to 48"	3 cam locks
48-1/16" to 60"	4 cam locks

Panel Width

0 to 18"	No cam locks on top or bottom
18-1/16" to 30"	1 cam lock top and bottom
30-1/16" to 48"	2 cam locks top and bottom

- D. On the panel height, one of the cam locks described above shall be a key operated cylinder lock in lieu of the cam lock. One key shall operate all panels.
- E. Cam locks shall have tamper-proof heads. Provide 10 tools to the owner.
- F. For masonry, tile or wallboard surfaces, provide access panels with extruded aluminum frames, 3/4" border, aluminum piano hinges, screwdriver-operated cam lock, brushed satin

aluminum finish. Final painting to match interior decor by others. Paintable finish to be provided when the adjacent construction is paintable.

- G. Access panels will not be required in accessible type ceilings.
- H. For plastered ceiling or wall, concealed flange, recessed door panel to receive plaster by others, continuous hinges, flush latch, white prime coat finish. Final painting to match interior decor by others.
- I. For Fire Rated Partition - Access doors in fire rated walls shall be 1-1/2 hour (B) rated and shall bear the UL label. Doors shall be fabricated of steel and shall be provided with baked enamel prime coat over a phosphate coating. Doors shall be Milcor or approved equal.
- J. For locations concealed from public, snap catch latches may be used.
- K. Manufacturer - Panels shall be equal to Inryco/Milcor type K for plaster, type DW for drywall, type M for masonry.

2.6 SLEEVES

A. Exterior And Foundation Walls:

- 1. All piping through exterior walls, new concrete walls, or new foundation walls shall pass through sleeves which shall be large enough to allow for caulking and sealant materials. No sleeves shall be permitted through concrete structural members unless indicated on the structural drawings or approved by the Structural Engineer. Sleeves shall be cut smooth and flush with each side of the wall.
 - a. Sleeves above grade shall be Schedule 40 PVC pipe.
 - b. Sleeves below grade shall be cast iron or Schedule 40 PVC pipe.
- 2. All piping passing through existing concrete or foundation walls shall pass through core drilled holes which shall be large enough to allow for caulking material.
- 3. All duct openings through exterior walls shall be sleeved with 20 gage galvanized steel sheet metal with flanges turned away from the opening on both sides unless otherwise indicated on the drawings. Space between sleeve and duct shall be packed with fiberglass and sealed on both sides.

B. Interior Walls And Partitions:

- 1. Fire Rated Walls:
 - a. Piping through fire rated interior walls and partitions shall pass through either Schedule 40 black steel or 20 gauge galvanized steel sheet metal sleeves (18 gauge sheet metal sleeves shall be installed if required by the U.L. classification). Schedule 40 steel pipe sleeves shall be used when required for structural purposes. Sleeves are not required for automatic control tubing.
 - b. Duct through fire rated interior walls and partitions shall be connected to sleeves with fire dampers. See section 230900, Air Distribution.

2. Non Rated Partitions:

- a. Concealed Locations: Sleeves are not required for piping or ducts unless otherwise indicated on the drawings.
- b. Visible Locations except in boiler, utility, or equipment rooms:
 - 1) Openings between duct and wall shall be covered with 24 gage galvanized steel sheet metal angles to form an escutcheon over the opening.
 - 2) Openings between pipes and wall shall be covered with escutcheons. Where required, special deep-type escutcheons shall be used. Escutcheons shall be chrome plated, one-piece or split-pattern, and secured in place.
3. Mechanical Room Walls and other locations indicated on the drawings: Duct openings shall be sleeved with 22 gauge galvanized steel sheet metal with flanges turned away from the opening on both sides. Space between sleeve and duct shall be packed with fiberglass and sealed on both sides.

C. Floors:

1. Piping through floors shall pass through schedule 40 carbon steel pipe sleeves, extending from the bottom of the slab to 2 inches above floor.
2. For existing concrete floors an oversized hole shall be core drilled. A flange shall be welded to the outside of the sleeve and the sleeve grouted in place. See details on the plans.

2.7 BACKING & SEALANTS:

A. Backing and sealant for piping and ducts passing through floors, plaster ceilings, partition, and walls shall be as follows:

1. Backing Material:
 - a. A pure ceramic fiber made of alumina-silica; "Cerafiber- FS" by Manville or equal.
 - b. Insulation: Glass fiber type, non- combustible.
2. Sealant: Gun Grade. An 1-part neutral- and basic-curing Silicone sealant, "790" by Dow Corning Corporation;"Spectrem 1 (Basic)" by Tremco, or SilPruf LM SCS2700 by GE Silicones.
3. Mechanical Seal: Link-Seal or approved equal. A modular mechanical sealing assembly consisting of interlocking rubber links shaped to fill the annular space between the pipe and sleeve; corrosion-protected carbon steel bolts, nuts, and pressure plates. After the assembly is positioned in the sleeve, tightening the bolts shall cause the rubber links to provide a watertight seal between the pipe and the sleeve. Seal assembly shall be sized as recommended by the manufacturer. Provide sleeves of proper diameters.
4. Fire Retardant Sealants: Products used shall be U.L. Classified and approved for the application. Products shall produce non-toxic fumes and shall be PCB and asbestos free. Subject to compliance with requirements, provide fire retardant sealant products from one of the following: 1) "SpecSeal" by Specified Technologies Inc. 2) 3M, 3) Chase Technology Corporation, 4) Link-Seal, 5) Pyro-Pac by Thunderline Corporation, 6) "Fyre

Seal” by Tremco, 7) Pensil 100 by General Electric, 8) Pensil by STI, or 9) "Flameseal" by G. S. Nelson Electric.

- a. Acrylic 1-part silicone rubber, gun applied, fire retardant elastic sealant, "Fyre Seal" by Tremco.
- b. Silicon foam sealant, CTC PR-855 by Chase Technology Corporation.
- c. Fire stop putty. "Flameseal" by G. S. Nelson Electric.
- d. Intumescence Sealant (SpecSeal SSS100) shall be one-part, two stage intumescent latex compound, expands a minimum of 8 times when exposed to 230°F to >1000°F, thixotropic. Sealant shall be capable of caulking or troweling on to vertical surfaces or overhead. Sealant shall be water-based, sandable, paintable, red in color, and safe for contact with plastics.
- e. Flexible Sealant (SpecSeal LC150) shall be one-part, latex-based compound, flexible and non-shrinking when dry, thixotropic. Sealant shall be capable of caulking or troweling on to vertical surfaces or overhead. Sealant shall be water-based, sandable, paintable, blue in color, and safe for contact with plastics.
- f. Flexible Silicone Sealant (SpecSeal Pensil 300) shall be one-part, neutral curing silicone, completely water resistant, contain no solvents nor inorganic fibers, allow movement of +/-50%. Sealant shall be auto-bonding, ozone and UV resistant, chemical resistant and capable of caulking or troweling on to vertical surfaces or overhead.
- g. Intumescence Putty (SpecSeal Firestop Putty) shall be one-part, two stage intumescent, non-hardening compound, expands a minimum of 5 times when exposed to 230°F to >1000°F. Putty shall be soft and pliable with aggressive adhesion, contain no water-soluble intumescent ingredients, water-based, sandable, paintable, red in color, and safe for contact with plastics.
- h. Putty Pads (SpecSeal Firestop Putty Pads) shall be one-part, two stage intumescent, non-hardening compound, expands a minimum of 5 times when exposed to 230°F to >1000°F. Putty shall be soft and pliable with aggressive adhesion, contain no water-soluble intumescent ingredients, water-based, sandable, paintable, red in color, and safe for contact with plastics.
- i. Pillows (SpecSeal Firestop Pillows) shall be an intumescent pillow heat sealed in a fire-retardant poly bag with a monolithic core encapsulated by flexible intumescent coating and shall expand when exposed to 230°F to >1000°F.
- j. Mortar (SpecSeal Firestop Mortar) shall be light weight, fast drying, portland cement based, wet mortar density shall be ≤ 52 lb./cu.ft., dry mortar density shall be ≤ 45 lb./cu.ft., approved for combustible and noncombustible penetrants, have chemical adhesion, and be red in color.

- k. Silicone Foam (SpecSeal Pensil Silicone Foam) shall be two-part, silicone, room temperature curing foam, completely water resistant, contain no solvents nor inorganic fibers, allow movement of expansion, contraction and vibration.
 - l. Intumescent Collars (SpecSeal Firestop Collar) shall be factory assembled collar utilizing a molded two stage flexible intumescent insert, insert shall expand a minimum of 15 times when exposed to 230°F to >1000°F, suitable for CPVC, ABS, ABS Foam Core, and FRPP pipes.
 - m. Intumescent Wrap Strips
 - 1) (SpecSeal Firestop Red Wrap Strip) shall be highly flexible, two-stage intumescent material and shall expand a minimum of 15 times when exposed to 230°F to >1000°F.
 - 2) (SpecSeal Series Blu Wrap Strip) shall be highly flexible, two-stage intumescent material and shall expand a minimum of 30 times when exposed to 230°F to >1000°F.
 - n. Intumescent coatings (SpecSeal Cable Coating) shall be water based, intumescent coating, expand a minimum of 5 times its dry applied thickness, flexible, water and weather-resistant film, contain no solvents or inorganic fibers. Coating shall be thixotropic and be capable of being applied by brush application or by airless spray.
 - o. Urethane Joint Sealants
 - 1) Subject to compliance with requirements, provide one of the following:
 - a) Pacific Polymers International, Inc.; Elasto-Thane 230 LM Type II.
 - b) Polymeric Systems, Inc.; PSI-901.
 - c) Approved equal.
5. Single-Component, Nonsag, Urethane Joint Sealant: ASTM C 920, Type S, Grade NS, Class 50, for Use NT.

2.8 FIRE PROOFING ON STRUCTURE:

- A. Where fire proofing is existing or has been applied to the structure by others and the work of this contractor damages or removes this fire proofing while making attachments to the structure, this contractor shall include cost to repair the fire proofing to its original condition.

2.9 LINTELS:

- A. Unless otherwise indicated on plans, all lintels required for the support of building construction above pipes, boxes, panels, ducts, etc., shall be furnished and installed by the Contractor requiring the opening.
- B. Lintels furnished shall be ASTM A 36 structural steel angles, channels, or tees of proper size and sections for the load being supported.

2.10 CUTTING

- A. Each Contractor shall be responsible for any cutting required for openings for conduits, pipes, ducts, etc., if sleeves or openings are not otherwise provided. Under no circumstances shall any structural members, load bearing walls, or footings be cut without first obtaining written permission from the Structural Engineer. All cutting and patching shall be done at the expense of the contractor requiring the cutting.
- B. Cutting shall be limited to the size necessary for working conditions. When cutting surfaces are difficult or costly to replace, such as glazed tile, wood paneling, etc., each contractor shall obtain the Owner's approval in advance of the cutting and patching.

2.11 PATCHING:

- A. Concrete or concrete block surfaces - Patch the opening with concrete, finished smooth with adjacent surface. Painting is the responsibility of the contractor doing the cutting and patching.
- B. Drywall or plastered surfaces - Patch with filler compound. Painting is the responsibility of the contractor doing the cutting and patching.
- C. Surfaces with finishing materials such as tiled, paneled, stone or marble surfaces - Patch the opening with cement or plaster to the underside of final finishing material. Final patching is the responsibility of the contractor doing the cutting and patching.

2.12 PIPING and EQUIPMENT SYSTEMS MARKERS

- A. Markers shall be by Allen Systems, Inc., W.H. Brady Co.- Signmark Div., Industrial Safety Supply Co., Inc. or equal.
- B. Pipe banding shall consist of 1" wide single tape wrapped completely around the circumference of the pipe or insulation.
- C. All color coding shall comply with ANSI A13.1 1975.
- D. Pipe markers shall be manufacturer's standard pre-printed, semi-rigid plastic, snap-on type or vinyl, pressure-sensitive type with permanent adhesive.
- E. Valve tags shall be brass, plastic laminate, or plastic valve tags that are 1½" diameter or square. Indicate piping system abbreviation in ¼" high letters and sequenced valve numbers with ½" high letters. Provide manufacturer's standard solid brass or plated steel chain, or plated steel S-hooks of the sizes required for attachment of tags to valves.
- F. Equipment markers shall be manufacturer's standard laminated plastic type. Include the following, matching terminology on schedules as closely as possible: 1) Name, 2) Tag Number, and 3) Equipment Service. Provide approximate 2½" x 4" markers for control devices, dampers, and valves; and 4½" x 6" for equipment.

2.13 CEMENT GROUT

- A. Grout: ASTM C 1107, Grade B, factory-mixed and -packaged, non-shrink and nonmetallic, dry, hydraulic-cement grout.

1. Characteristics: Post hardening and volume adjusting; recommended for both interior and exterior applications.
2. Properties: Non-staining, noncorrosive, and nongaseous.
3. Design Mix: 5000-psi, 28-day compressive strength.

2.14 CONCRETE

A. Reinforcing Materials

1. Reinforcing and Joint Dowel Bars: Deformed steel bars, ASTM A 615, Grade 40, unless otherwise indicated. Furnish metal expansion caps for one end of each dowel bar. Design caps with one end closed and a minimum length of 3" to allow bar movement of not less than 1" unless otherwise indicated.
2. Welded Wire Mesh: Welded plain cold-drawn, ASTM A 185. Furnish in flat sheets, not rolls.

B. Concrete Materials

1. Portland Cement: ASTM C 150, Type II with tricalcium aluminate content of less than 5%.
2. Coarse aggregate shall be clean, hard, durable, uncoated limestone conforming to ASTM C-33. Use size "67" throughout with no more than one percent flint and chert by weight (i.e., when the amount of flint and chert are added together, this quantity shall be less than 1% of the coarse aggregate weight).
3. Water: Potable.
4. Air-Entraining Admixture: ASTM C 260.
5. Water-Reducing Admixture: ASTM C 494, Type A.
6. Membrane-Forming Curing Compound: ASTM C 309, Type I unless other type acceptable to Engineer.

C. Proportioning and Design of Mixes

1. Prepare design mixes for concrete in accordance with applicable provisions of ASTM C 94. Use an independent testing facility for preparing and reporting proposed mix designs. The testing facility may be the same as used for field quality control testing.
2. Submit written reports to Engineer of the proposed mix at least 15 days prior to start of work. Do not begin concrete production until mixes have been reviewed by Engineer.
3. Design mixes to provide normal weight concrete with the following properties: 3500 psi 28-day compressive strength.
4. Adjustment to Concrete Mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant, at no additional cost to Owner and as accepted by Engineer. Laboratory test data for revised mix design and strength results must be submitted to and accepted by Engineer before using in work.

D. Admixtures

1. Use air-entraining admixture. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having air content within following limits: 2% to 4% air.

2. Use admixtures for water-reducing and set-control in strict compliance with manufacturer's directions.

E. Slump Limits

1. Proportion and design mixes to result in concrete slump at point of placement at not less than 1" and not more than 4".

2.15 MISCELLANEOUS MATERIALS

- A. Powder-Actuated Drive-Pin Fasteners: Powder-actuated-type, drive-pin attachments with pull-out and shear capacities appropriate for supported loads and building materials where used. Acceptable manufacturers: Gunnebo Fastening Corp., Hilti, Inc., ITW Ramset/Red Head., or Masterset Fastening Systems, Inc.
- B. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.
- C. Drilled Inserts: Self-drilling expansion shields and machine bolt expansion anchors: permitted in concrete not less than four inches thick. Applied load shall not exceed one-fourth the proof test load listed by the manufacturer. Phillips Red-head, wedge anchors or equal.
- D. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars, black and galvanized.
- E. Bolts and nuts, except as required for piping applications, shall be carbon steel in accordance with ASTM A 307 and shall be cadmium-plated, zinc-coated steel, or Type 304 stainless steel. Each bolt shall be provided with neoprene and cadmium-plated steel washers under the heads.

PART 3 - EXECUTION

3.1 EQUIPMENT SUPPORTS

- A. This Contractor shall provide all bases, concrete inserts, anchor bolts, and structural steel to support the equipment, ductwork, piping, etc installed by him. Any equipment legs, guy wire, anchors, etc., or any pipe that passes through the roof shall be sealed by a method approved by the COR.
- B. Provide concrete housekeeping pads a minimum of 3-½" high, unless detailed otherwise, under all equipment, pumps, etc., in equipment rooms that have piping containing water. The horizontal distance from the equipment support to the edge of the pad shall be at least 2", but not more than 4". All exposed edges of each pad shall be ½" chamfer and all surfaces shall be smooth. The housekeeping pads shall be reinforced with wire mesh and shall be doweled to the floor.
- C. Plywood backboards shall be provided for all wall mounted equipment and controls (with the exception of surface mounted cabinets). Backboards shall be constructed of 3/4" plywood grade B-C. The "B" face shall be exposed. All boards shall be painted before attachment of any surface equipment.

- D. Provide prefabricated roof curbs or rails for roof mounted equipment except where otherwise indicated on the drawings.
- E. Curbs and rails shall be set on the roof structure and shall have a vertical insulation stop equal to the thickness of the roof insulation. (Field verify insulation for each curb and rail.) Install roof curbs and rails level and plumb, in accordance with manufacturer's written instructions. Coordinate with other elements of the work, including installation of roof deck, substrates, vapor barriers, roof insulation, roofing and flashing, as required to insure that the roof system is waterproof and weather tight.
 - 1. Anchor curbs and rails securely to supporting structural substrates with bolts or by welding, adequate to withstand lateral and thermal stresses as well as inward and outward loading pressures.
 - 2. Secure equipment to roof curbs with cadmium-plated screws or bolts or hardware approved by the Engineer. Install 3/8" thick sponge type gasket on top of curb to seal gaps between equipment and curb, unless otherwise approved by the Engineer.

3.2 PIPE STAND INSTALLATION

- A. Pipe Stands: Details on the drawings show a low type support. In general, provide this type. Where the elevation of the roof changes or where the piping is required to slope, provide an adjustable type support that can accommodate the different support heights needed to maintain the proper pipe elevation above the roof.
- B. Assemble components and mount on smooth roof surface. Do not penetrate roof membrane. Apply adhesive indicated on drawings between base and roof.

3.3 PIPE AND DUCT PROTECTION DURING CONSTRUCTION

- A. Protect pipe and duct interiors with plastic plugs or plastic sheeting during construction to protect from moisture, construction debris and dust, and other foreign materials.

3.4 DRIVE AND COUPLING GUARD

- A. Contractor shall provide coupling or belt guards on all drives which do not have guards factory installed. Belt guards shall enclose drive on all sides, shall have a hole for making tachometer readings, and shall comply with requirements of governing agencies including OSHA.

3.5 BUILDING OPENINGS FOR ADMISSION OF EQUIPMENT

- A. Contractor shall ascertain from his examination of the architectural and structural drawings and the facility whether any special temporary openings or supports in the building for the admission of apparatus furnished under the Contract will be necessary. The Contractor shall pay all costs of making such openings or providing such supports.

3.6 CUTTING AND PATCHING

- A. All cutting necessary for installation of the work and any required patching that results therefrom shall be done by the proper trade involved and shall be included in the work of this Contractor. Columns, beams, girders or other structural members shall not be cut. No openings shall be cut without written approval of the Owner's Representative.

- B. Before cutting or drilling holes in floors, verify the location of reinforcing steel bars and embedded electrical conduits to avoid cutting same. X ray floors where necessary to verify such locations. Contact the Engineer before proceeding with cutting if such obstructions interfere with the locations of planned holes.

3.7 ACCESS

- A. All control devices, equipment, specialties, valves, plumbing traps, etc., shall be so located as to provide for easy access and proper clearance for operation, maintenance, and repair. Provide access panels where indicated or required.
- B. Where items are located above non-accessible ceilings, in or behind walls, or in other similar concealed areas, contractor whose equipment requires access shall provide access panels.
- C. Contractor shall obtain approval of COR/Engineer of location of access panels that are not indicated on plans.

3.8 PAINTING

- A. All pieces of mechanical equipment shall be factory finished machinery-grey or standard color as furnished by the manufacturer, or as called for in the technical section. Scratches shall be touched up in the field after equipment is installed with a paint which matches the original color.
- B. All sheet metal plenums that are visible through an air device shall have the inside of the plenum painted flat black.
 - 1. This Contractor shall paint the following items:
 - 2. Items specified under "Demolition and restoration of facilities", Section 230000 shall be painted.
 - 3. No other painting is required unless specifically called for on the plans.

3.9 SLEEVES AND ESCUTCHEONS

- A. This Contractor shall be responsible for locating, placing and maintaining in proper position all sleeves required for the work. In the event that failure to do so requires cutting and patching of finished work, it shall be done at this Contractor's expense.
- B. Sleeves in foundation walls or footings shall be as detailed on the plans.
- C. Where pipes pass through existing concrete floors or walls, the hole shall be core drilled. If sleeves are shown on the plans or details, they shall be grouted in place.
- D. Where pipes and ducts pass through fire walls, plaster or drywall shall be applied around the outside of the sleeve to seal between sleeve and wall.
- E. The internal diameter/dimensions of sleeves shall be 1" to 2" larger than the outside diameter/dimensions of the pipe, duct or insulation. Insulation shall be continuous through sleeves except for ducts with fire dampers. This space is sufficient to allow some movement of the pipes or ducts without cracking the sealant.

- F. The space between the pipes/ducts and the sleeve shall be sealed as follows:
1. Exterior walls above grade: Caulking shall be applied to a minimum 3" total depth. Sealant shall then be applied on both sides of the wall opening to a minimum ½" in depth, finishing flush with the wall.
 2. Exterior walls below grade: The space between the pipe and the core drilled hole or sleeve shall be completely filled. Provide mechanical seal and install in accordance with manufacturer's instructions.
 3. Openings in floors or roofs: Caulking shall be applied from the upper side to a minimum depth of 3" recessed ½" below the finished floor or roof. This ½" recess shall then be filled with sealant to flush with finished floor or roof.
 4. Interior Non-Rated Walls/Partitions:
 - a. Concealed locations: Limit the size of the space between the wall and the outside of the pipe or duct to 1" maximum. The space between the duct or pipe and the wall may be left open.
 - b. Visible Locations: Openings between duct and wall shall be covered with 24 gage galvanized steel sheet metal angles to form an escutcheon to cover the opening. Openings between pipes and wall shall be covered with chrome plated escutcheons.
 5. Interior Fire-Rated Walls/Partitions/Floors/Ceilings:
 - a. Where pipes pass through rated assemblies (walls, floors, ceilings, etc.,) the pipes shall be sealed per approved methods to meet U.L. Classifications, see the details on the drawings.
 - b. Where ducts pass through fire rated interior assemblies (walls, floors, ceilings, etc.,) the ducts shall be connected to sleeves with fire dampers. See section 230900, Air Distribution and details on the drawings.
- G. Shop drawings shall be submitted on all fire resistant materials and methods.

3.10 PIPING AND EQUIPMENT SYSTEMS MARKERS

- A. All piping shall be identified with color coded banding. This color banding shall be applied at the following locations:
1. Adjacent to each valve.
 2. At each branch or riser take-off.
 3. Where piping goes through floors, walls or ceilings.
 4. On horizontal pipe runs at 80 foot intervals, but not less than one per room.
- B. Pipe marking shall also include printed markers indicating the service and flow arrows indicating direction of flow.
- C. Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory-fabricated equipment units, plumbing fixture faucets, convenience and lawn-watering hose bibs, and shut-off valves at plumbing fixtures. List each tagged valve in valve schedule for each piping system and include valve schedule in O & M Manual.

- D. Provide equipment markers on all scheduled equipment. Provide manufacturer's standard laminated plastic markers. Provide approximate 2½" x 4" markers for control devices, dampers, and control valves; and 4½" x 6" for equipment. Include the A) Name and Plan Number and B) Equipment Service, matching terminology on schedules as closely as possible.

END OF SECTION 230010

SECTION 230050 - MOTORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Three phase electric motors (except hermetic motors for chillers which are specified with the chiller).

1.2 RELATED DOCUMENTS

- A. All drawings and applicable provisions of Division 0 Bidding Requirements and Division 1 General Requirements apply to work of this Section.
- B. Section 230000 - Mechanical General Provisions.
- C. Other sections with equipment requiring electric motors.

1.3 REFERENCES

- A. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
- B. AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
- C. ANSI/IEEE 112 - Test Procedure for Polyphase Induction Motors and Generators.
- D. ANSI/NEMA MG 1 - Motors and Generators.
- E. ANSI/NFPA 70 - National Electrical Code.

1.4 SUBMITTALS

- A. Submit product data under provisions of Section 230000.
- B. Submittal shall clearly identify the following features for motors to be powered by a VFD:
 - 1. Nameplate with raised or stamped letters on stainless steel or aluminum nameplate.
 - 2. Class H insulation along with frame and end bells of steel construction OR Class F insulation along with frame and end bells of cast iron construction.
 - 3. Premium efficiency.
 - 4. Rated for VFD and across line starting.
 - 5. Shaft grounding brush or ring.
 - 6. Special magnetic wire windings to withstand 1600 v spikes from IBGT drives per NEMA MG1-31.
 - 7. NEMA Design B.
 - 8. Isolated bearings for motors over 100 hp.
 - 9. Bearing type: Sealed.
 - 10. Bearings L-10 life min. 40,000 hours.

1.5 REGULATORY REQUIREMENTS

- A. Conform to all applicable electrical codes.

1.6 WARRANTY

- A. Provide one year manufacturer's warranty under provisions of Section 230000.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Three phase motors to be used with variable frequency drives shall be as manufactured by:
1. Toshiba model EQP Global SD or equal
 2. Baldor
 3. General Electric
 4. Marathon
 5. Siemens
 6. TECO-Westinghouse Motor Co.
 7. U.S. Motors
 8. WEG Electric Motors Corp

2.2 GENERAL CONSTRUCTION AND REQUIREMENTS

- A. Electrical Service: Refer to Electrical Section for required electrical characteristics.
- B. Motors: Design for continuous operation in 40°C environment and for temperature rise in accordance with ANSI/NEMA MG 1 limits for insulation class, Service Factor, and motor enclosure type. In general, motors smaller than 3/4 HP shall be single phase and motors 3/4 HP and larger shall be 3 phase, 60 cycle service. All motors shall be wound for the voltages indicated. Manufacturer's standard motors will be considered provided they are properly selected for the operating characteristics of the driven machine.
- C. Visible Nameplate: Raised or stamped letters on stainless steel or aluminum indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, Service Factor, Power Factor, efficiency. Premium efficiency motor nameplates to display NEMA nominal efficiency, guaranteed minimum efficiency, full load power factor and maximum allowable kVAR for power factor correction capacitors.
- D. Electrical Connection: Conduit connection boxes, threaded for conduit. For fractional horsepower motors where connection is made directly, provide conduit connection in end frame.
- E. Bearings: Motors shall be equipped with ball or roller bearings and where conditions of service require; suitable end thrust bearings shall be incorporated in bearing design. All bearings shall be constructed to prevent lubrication leakage into the motor under normal or excess lubrication.
1. Permanently lubricated bearings rated for minimum AFBMA 9, L-10 life of 40,000 hours shall be acceptable except where equipment specifications require grease lubricated motors. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Grease lubricated motors shall be equipped

with Alemite or Zerk grease and relief fittings. Lubrication instructions shall be furnished with each motor.

2. Bearings shall have a maximum of 45 deg. C rise at rated horsepower for 4 and 6 pole motors and a maximum of 50 deg. C rise for 2 pole motors.

- F. Explosion-Proof Motors (where indicated): UL approved and labeled for hazard classification, with over temperature protection.

2.3 THREE PHASE POWER - INDUCTION MOTORS (FOR USE WITH VARIABLE FREQUENCY DRIVES)

- A. Motors shall be Inverter Rated, Premium Efficiency design and shall be labeled "Inverter Rated" and shall be suitable for a variable torque application with a 20:1 turndown ratio. Nominal efficiency and minimum guaranteed efficiency shall be stamped on the nameplate of the motor.
- B. Design for continuous operation in 40°C environment, and for temperature rise in accordance with ANSI/NEMA MG 1 Part 31. Manufacturer's standard motors will be considered provided they are properly selected for the operating characteristics of the driven machine.
 1. Comply with 31.4.3.1 Starting Requirements: Motors shall be designed to allow both across the line starting and VFD use.
 2. Motors shall be rated "inverter-duty" per NEMA Standard, MG1, Part 31.4.4.2.
 3. Comply with 31.4.4.3 Shaft Voltages and Bearing Insulation: Provide motor shaft grounding apparatus that will protect bearings from damage from stray currents.
 4. Shaft Grounding Device: Motors larger than 1 HP shall be provided with a shaft grounding brush or conductive micro fiber shaft grounding ring. Shaft grounding device shall be solidly bonded to the grounded motor frame per manufacturer's recommendations.
 - a. Provide grounding devices by the following manufacturers:
 - 1) Grounding Brush: Sohre Turbomachinery, Inc.
 - 2) Grounding Ring: EST-Aegis.
 5. Motors larger than 100 HP shall have electrically isolated bearings in addition to shaft grounding to prevent stray current damage. Insulate both motor bearings to prevent current flow and isolate all mechanical load and/or auxiliary equipment bearings (such as tachometers).
- C. Starting Torque: Between one and one and one-half times full load torque.
- D. Starting Current: Six times full load current.
- E. Power Output, Locked Rotor Torque, Breakdown or Pullout Torque: NEMA Design B characteristics.

- F. Design, Construction, Testing, and Performance: Conform to ANSI/NEMA MG 1 for Design B motors. Motors shall operate successfully at rated load under the various combination of frequency and voltage variations as specified in NEMA MG 1.
- G. INSULATION SYSTEM - The winding insulation system shall be rated Class F or better. System components such as slot liners, wedges, and phase separators shall be Class F or class H and the whole insulation system to be of non-hygroscopic materials. Inter-phase insulation paper shall be used.
 - 1. Triple coat magnet wire or advanced design magnet wire shall be used. Wound stators with insulating materials in position shall be oven baked to drive-off residual moisture, then dipped in Class H varnish and baked again to cure the varnish. A minimum of two dip and bake cycles is required.
 - 2. The full load temperature rise (of the windings) when the motor is operated on sine wave power shall be measured by resistance and shall be within Class B allowable limits.
 - 3. The entire insulation system shall be capable of withstanding the 1600V spikes experienced with dV/dt IGBT waveforms as defined in NEMA MG1 -1993, Part 31.
- H. Testing Procedure: In accordance with ANSI/IEEE 112, Test Method B. Load test motors to determine freedom from electrical or mechanical defects and compliance with performance data.
- I. Motor Frames: NEMA standard T-frames and end brackets: grade 25 cast iron.
 - 1. Motors with steel frames are acceptable if furnished with Class H insulation in lieu of Class F insulation.
- J. Sound Power Levels: To ANSI/NEMA MG 1 - 1987 (Revised Jan. 1989).
- K. Nominal Efficiency: Meet or exceed values listed below at full load and rated voltage when tested in accordance with ANSI/IEEE 112.
- L. Nominal Power Factor: Meet or exceed values listed below at full load and rated voltage when tested in accordance with ANSI/IEEE 112.
- M. Motor Performance Schedule:

3 Phase/For VFD'S/Premium Energy Efficient/Open Drip Proof or TEFC

HP	RPM (Syn)	NEMA Frame	Min. Percent Efficiency	Percent Power Factor
1	1800	143T	86.5	81
1-1/2	1800	145T	87.5	81
2	1800	145T	87.5	79
3	1800	182T	87.5	79
5	1800	184T	88.5	85
7-1/2	1800	213T	89.5	84
10	1800	215T	90.2	86
15	1800	256T	91.2	82
20	1800	256T	92.4	86

30	1800	286T	93.0	83
40	1800	324T	94.1	83

2.4 THREE PHASE POWER - INDUCTION MOTORS (FOR USE ON A COOLING TOWER)

- A. Motors shall meet the requirements for “Three Phase Power - Induction Motors (for Use with Variable Frequency Drives)” defined above plus:
- B. Motor shall comply with the additional requirements of standard IEEE 841-2009; Standard for Petroleum and Chemical Industry-Premium-Efficiency, Severe-Duty, Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors-Up to and Including 500 hp.

2.5 NEMA MOTOR SERVICE FACTORS

A. Open Motors

HP	3600 RPM	1800 RPM	1200 RPM	900 RPM
1/6 – 1/3	1.35	1.35	1.35	1.35
1/2	1.25	1.25	1.25	1.15
3/4	1.25	1.25	1.15	1.15
1	1.25	1.15	1.15	1.15
1.5 – 150	1.15	1.15	1.15	1.15

B. Totally Enclosed Motors

HP	3600 RPM	1800 RPM	1200 RPM	900 RPM
1.5 – 150	1.0	1.0	1.0	1.0

PART 3 - EXECUTION

3.1 APPLICATION

- A. Motors located indoors shall be open drip-proof type, except where specifically noted otherwise.
- B. Motors exposed to the outdoors shall be totally enclosed motors unless otherwise indicated.
- C. Cooling tower motors shall be totally enclosed, severe duty motors unless otherwise indicated in the cooling tower specification.
- D. Single phase and three phase motors shall be energy efficient type with performance as indicated above.
- E. Motors powered by Variable Frequency Drives (VFDs) shall be either ODP or TEFC and be premium efficient type with performance as indicated above.

3.2 SHAFT GROUNDING DEVICE INSTALLATION

- A. Grounding devices shall be installed in accordance with the device manufacturer's written installation instructions.
- B. Devices shall be installed by the motor manufacturer.

END OF SECTION 230050

SECTION 230075 – VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of variable frequency drive (VFD) work required by this section is indicated on the schedules and by requirements of this section.

1.2 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of variable frequency drives, of types and capacities required, whose products have been in satisfactory use in similar service for not less than five (5) years.
- B. Regulatory Requirements:
 - 1. Furnish materials in conformance with applicable latest publications at the date shown on the drawings of the following, unless otherwise noted:
 - a. National Electrical Code, current edition.
 - b. National Electrical Manufacturers' Association Standards, ICS 1970 (REX. 1975) Industrial Controls.
 - c. Underwriter's Laboratories, Inc. Standard UL 508.
 - d. IEEE 519-1992-Line Notching and Distortion Guidelines.

1.3 SUBMITTALS

- A. Submit under provisions of Section 230000, "Mechanical General Conditions ".
- B. Submit shop drawings indicating dimensions, weights, required clearances, and methods of assembly of components.
- C. Submit manufacturer's technical product data including rated capacities, dimensions, weights, accessories, required clearances, electrical requirements, and wiring diagrams, and location and size of field connections.
- D. In addition, the drive manufacturer shall submit a line distortion program to the engineer indicating adherence to IEEE 519-1981, at the time of submittal.

1.4 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Section 230000, "Mechanical General Conditions ".

1.5 WARRANTY

- A. Provide two year warranty for parts and labor under provisions of "General Conditions."

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver products to job site. Handle units carefully to prevent damage. Do not install damaged components; replace with new.
- B. Factory assemble entire unit. For shipping, disassemble into as large as practical sub-assemblies so that minimum amount of field work is required for reassembly.

1.7 RELATED DOCUMENTS

- A. All drawings and applicable provisions of Division 0 Bidding Requirements and Division 1 General Requirements apply to work of this Section.
- B. Section 230000 - Mechanical General Conditions.

1.8 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with requirements, provide variable frequency drive of one of the following:
 - 1. Reliance Electric Company
 - 2. Yaskawa
 - 3. York
 - 4. Toshiba
 - 5. Baldor
 - 6. GE - Fuji
 - 7. Danfoss

PART 2 - PRODUCTS

- 2.1 The VFD's shall be rated for 208 Vac, 230Vac, or 480Vac input voltage as indicated on the schedule. The VFD shall provide microprocessor-based control of 3-phase induction motors.
- 2.2 The VFD shall be a solid-state design, utilizing PWM (pulse-width modulation) to convert utility input power to an adjustable frequency output.
 - A. The VFD shall utilize soft-switching IGBTs (insulated gate bipolar transistors). The drive shall be capable of operating a NEMA MG-1, part 31 type motor with a drive-to-motor distance of up to 300' without the use of load side filters.
 - B. The controllers' full load current ratings shall be based on a variable torque application, 110% overload for 1 minute, in a maximum 50° C ambient environment.
 - C. The VFD's shall have efficiency at full load and speed greater than 96%. Efficiency shall exceed 90% at 50% speed and load.
 - D. The VFD's shall be suitable for use on circuits delivering up to 100,000 AIC RMS symmetrical, 480V maximum.
 - E. The VFD's shall start into a spinning load, when required, without fault.
 - F. The VFD's shall be able to operate with an IGBT switching frequency up to 15kHz for drives below 30 hp @ 460v, up to 10kHz for drives greater than 30 hp up to 100 hp @ 460v, and up to 6kHz for all drives over 100 hp @ 460v.

- 2.3 Enclosure - shall require front access only with top or bottom cable entry. NEMA 1, wall mount enclosures shall be standard for VFD ratings of 30 through 75 horsepower. VFD ratings greater than 75 horsepower to be wall or floor mounted NEMA 1 enclosure.
- 2.4 The variable frequency controller shall have the following basic features:
- A. Hand - Off - Auto switch or include this function into keypad.
 - B. Speed selection.
 - C. Independently timed acceleration and deceleration including delay on start up.
 - D. 12-66 Hz controlled speed range.
 - E. Annunciator contact for remote indication of VFD fault condition.
 - F. Unit shall be UL listed and have the UL label affixed.
- 2.5 Variable frequency drives shall be fully compatible with NEMA Design B premium efficiency motors with open-drip proof or TEFC enclosures. Motors shall not exhibit overheating, excessive noise or vibration due to the variable frequency drive throughout the range of operation. Coordinate motors and VFDs if required.
- 2.6 The variable frequency controller shall include the following protective circuits and features:
- A. Door Mounted Status Panel:
 - 1. Under-voltage.
 - 2. Over-voltage.
 - 3. Over-current.
 - 4. Over-temperatures.
 - 5. Phase loss.
 - B. Desaturation circuit to drive inverter section transistor base current to zero in event of inverter switch overcurrent.
 - C. D-C bus discharge circuit for protection of operating and service personnel.
 - D. Five-cycle regulator control power dip ride-through.
 - E. DV/DT and DI/DT protection for high power handling semiconductors.
 - F. Insensitive to incoming power phase sequence.
 - G. Fast acting current limiting input fuses.
 - H. "Isolated" process follower circuit (4 to 20 ma).
 - I. All live power equipment shall be covered by protective shields to ensure the safety of operating personnel.
- 2.7 THE VARIABLE FREQUENCY CONTROLLER SHALL HAVE THE FOLLOWING ADJUSTMENTS
- A. Maximum frequency - 45 to 66 Hz.
 - B. Minimum frequency - 12 to 15 Hz.
 - C. Acceleration - 2 to 500 seconds.
 - D. Deceleration - 2 to 500 seconds.

- E. Voltage Offset - 0 to 60 volts for 460 volt controllers.
- 2.8 The variable frequency drive shall be designed and constructed to operate within the following service conditions.
- A. Elevation to 3300 ft. without derating.
 - B. Ambient Temperature Range 32°F (0°C) to 122°F (50°C).
 - C. Atmosphere - non-condensing relative humidity to 95%.
 - D. D-C Line Voltage Variation -10% to +10%.
- 2.9 General options and modifications shall be designed for installation within standard enclosure. This design shall maintain VFD UL Listing and CSA Certification and eliminates complicated field installations. These general options shall be factory installed and shall include:
- A. Input Disconnect shall be a Fused Disconnect to provide a positive disconnect between the controller and all phases of the incoming A-C line. This disconnect shall be mounted inside the controller enclosure and include a through-the-door interlocking handle with provisions for padlocking. All components shall be in one panel.
 - B. Motor Overload - shall contain a thermal overload relay designed to protect one A-C motor, operated on controller output from extended overload operation. Heaters to be sized and supplied by the Electrical Contractor before VFD start-up.
 - C. Current and Frequency display shall be provided to indicate the output frequency and output current.
 - D. Provide ball bearing cooling fans. Drive shall activate cooling fan only when internal drive temperature exceeds setpoint.
 - E. Full-Time Current Limit - shall provide the VFD with current limit control of both motoring current and regeneration current. The adjustment range of the motoring current control shall be approximately 50 to 100% of the VFD maximum sine wave current rating. Regenerating current limit to be 80 to 110%.
 - F. Provide a quick means for monitoring the different signals within the controller for start-up and troubleshooting through a connection to a laptop computer.

PART 3 - EXECUTION

- 3.1 The Mechanical Contractor shall have overall responsibility for this equipment. Assignment of tasks for handling, setting, etc., shall be divided and coordinated between the Mechanical and Electrical Contractors to meet jurisdictional requirements in accordance with General Conditions. Mount the variable speed drive on wall or floor where indicated.
- 3.2 All wiring and connections for power, interlock with air handling unit motors, controls, etc., shall be performed by the Electrical Contractor in accordance with the manufacturer's installation instructions.
- 3.3 The mechanical contractor shall supply written documentation to VFD manufacturer that all power control, sequencing and process signals are available and connected to VFD, all motors are installed, wired and coupled to the process, and all instrumentation, drawings, and

instructional manuals on related equipment is available prior to VFD representative visit to site.

- 3.4 Provide start-up services for the variable frequency drives from the manufacturer. Service shall include inspection, final adjustment, operational checks, and a final report for record purpose and shall be performed by local factory employed service engineers. Contractor shall coordinate with manufacturer and provide one (1) week notice prior to start-up of units.
- 3.5 Provide services of manufacturer's technical representative for one 4-hour day to instruct Owner's personnel in operation and maintenance of variable frequency drives. Contractor shall schedule training with Owner's representatives and shall notify manufacturer, engineer, and Owner's representative two (2) weeks prior to training when training shall occur.

END OF SECTION 230075

SECTION 230076 – VARIABLE FREQUENCY DRIVES FOR NEW CHILLERS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Provide a variable frequency drive (VFD) for a new chiller as indicated in the chiller specification.

1.2 QUALITY ASSURANCE

- A. Regulatory Requirements: Furnish materials in conformance with applicable latest publications at the date shown on the drawings of the following, unless otherwise noted:
 - 1. National Electrical Code, current edition.
 - 2. National Electrical Manufacturers' Association Standards, ICS 1970 (REX. 1975) Industrial Controls.
 - 3. Underwriter's Laboratories, Inc. Standard UL 508.
 - 4. IEEE 519-1992-Line Notching and Distortion Guidelines.

1.3 SUBMITTALS

- A. Submit under provisions of Section 230000, "Mechanical General Conditions".
- B. Submit shop drawings indicating dimensions, weights, required clearances, and methods of assembly of components.
- C. Submit manufacturer's technical product data including rated capacities, dimensions, weights, accessories, required clearances, electrical requirements, and wiring diagrams, and location and size of field connections.
- D. In addition, the drive manufacturer shall submit a line distortion program to the engineer indicating adherence to IEEE 519-1992, at the time of submittal.

1.4 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Section 230000 - Mechanical General Conditions.

1.5 WARRANTY

- A. Provide one year manufacturer's warranty under provisions of Section 230000.

1.6 RELATED DOCUMENTS

- A. All drawings and applicable provisions of Division 0 Bidding Requirements and Division 1 General Requirements apply to work of this Section.
- B. Section 230000 - Mechanical General Conditions.
- C. Section 230707 - Centrifugal Chillers.

PART 2 - PRODUCTS

2.1 GENERAL

- A. The drive shall be a solid-state adjustable frequency controller. Line filtration equipment shall reduce line distortion to less than 5%. Added filtration devices external to drive shall be made known at the time of bid.
- B. This specification describes AC Voltage Source PWM Variable Frequency Drives in the power range from 100 HP to 700 HP used for chiller. Include software and hardware to insure system reliability and proper system integration between the chiller controller and VFD.
- C. Provide communications between the chiller controller and VFD to initiate starter commands such as start/stop of the compressor and to safely shut down the chiller if communications are lost.
- D. The chiller drive shall be powered from a 460 Volt, three-phase, 60 Hz bus, with a maximum voltage variation of $\pm 5\%$ and maximum frequency fluctuation of $\pm 2\text{Hz}$. The VFD output voltage shall be varied proportionally to the output frequency up to the nominal 60-hertz. Above 60 hertz, the output voltage shall be constant and shall not exceed input voltage.
- E. The variable frequency drive shall be unit mounted on the chiller and shall be air, water, or refrigerant cooled to maintain the proper heat sink temperature in the drive at all load conditions.

2.2 RATINGS

- A. Service Conditions
 - 1. Input power shall be 460 VAC, ± 5 percent, 3 Phase, 60 Hz, ± 2 Hz.
 - 2. Ambient temperature operating range of -10 to 40°C .
 - 3. Storage temperature range of -10 to 50°C .
 - 4. Relative humidity of 0 to 95%, non-condensing.
 - 5. Acceleration at 0.5 G maximum (20-50Hz). Amplitude at 0.1 mm maximum (50-100 Hz).
 - 6. Operating altitude of 0 to 3300 feet above sea level.
- B. Power ratings shall be determined based on amperage and horsepower for operating a chiller motor driving a centrifugal load with a torque versus speed characteristic proportional to the square of the speed ratio of operating speed over motor full load speed. Motor base frequency shall be 60 Hz at rated load. Motor design speed shall be 3550 rpm.
- C. Operating output frequency range shall be 65% to 100% of motor speed.
- D. The VFD shall be capable of 100% full load continuous output with 115% overload rating for 110 seconds.
- E. Minimum drive efficiency shall be 97 percent at motor base speed and rated torque. Losses shall include all control power and cooling system losses associated with the drive. Filter losses (including Harmonic filters) if any shall be listed separately.
- F. Displacement power factor shall be 95 percent throughout the entire operating speed range as measured at drive input terminals.

- G. Output frequency drift shall not exceed ± 0.5 percent of maximum frequency.

2.3 CONSTRUCTION

- A. Fixed utility power (voltage and frequency) shall be converted to a variable voltage and frequency.
- B. The drive shall consist of three basic power sections. The first, a converter section consisting of a full-wave fixed diode bridge rectifier, shall convert incoming fixed voltage/frequency to a fixed DC voltage. The second section, a DC Link, shall filter and smooth the converted DC voltage. The third section, a transistorized inverter and control regulator, shall convert the fixed DC voltage to a sinusoidal wave, pulse width modulated (PWM) waveform.
- C. The drive shall employ PWM modulation to minimize motor heating. An asynchronous carrier shall be employed to eliminate torque pulsations. Switching frequency shall be adjustable.
- D. A DC Link reactor may be included for each rating to minimize harmonic distortion and maximize input power factor.
- E. The drive shall be housed in a unit mounted cabinet, formed, assembled, front accessible, and braced, general-purpose indoor enclosure rated NEMA 250, Type 1.
- F. Enclosures shall be single or multi-bay, sheet steel with hinged access doors and a lockable through the door handle operator mechanism.
- G. Modular component design and arrangement shall accommodate quick replacement of power devices. Control boards shall be interchangeable throughout the power range.
- H. Construction safety features shall include:
 - 1. Provisions to padlock main disconnect handle in the "OFF" position.
 - 2. Mechanical interlock to prevent opening cabinet door with disconnect in the "ON" position, or moving disconnect to the "ON" position while the door is open.
 - 3. Warning signs on terminals that are energized with the power disconnect "OFF".
- I. A branch circuit fused disconnect for a chiller oil pump shall be provided. Oil pump motor voltages shall be 460-480 volt, 3 phase.
- J. Contactors shall be magnetic air break units, rated for continuous duty, with arc extinguishing devices, and auxiliary contacts.

2.4 OPERATOR INTERFACE

- A. The operator interface shall be at the chiller control panel and shall consist of a door-mounted digital keypad/display, capable of controlling the drive and setting the drive parameters. The digital display shall be minimum 2-line, 20-character and display:
 - 1. Frequency in Hertz
 - 2. Line side voltage
 - 3. Line side current

4. Line side power factor
 5. KW
 6. KWH
 7. Operating Configuration and faults
 8. Load side voltage
 9. Load side current
- B. The digital keypad shall allow operators to enter numerical settings. Settings shall be field adjustable. All setup operations and adjustments shall be digital, stored in non-volatile (EEPROM) memory. Variables stored in EEPROM shall be transferable to new and spare boards. Variables shall be protected from unauthorized adjustment by a personal lockout code.
- C. The digital keypad shall provide VFD configuration. Key functions shall include:
1. Adjustment of output frequency and programming parameters.
 2. Manual/Off/Auto keys for selection of control mode.
 3. Run and Stop keys for starting and stopping in the manual mode.
 4. Fault clear/reset key.
 5. Key to enter the program mode and adjust parameters.
 6. Key for changing parameters in the program mode.

2.5 OPERATIONAL AND PROTECTIVE FEATURES

- A. Drive operation and control shall be configurable for the following list of parameters:
1. Torque boost
 2. Maximum voltage level
 3. Multiple Volts/Hertz modes
 4. Minimum and maximum speed
 5. Upper and Lower speed limits
 6. Two independently adjustable rates of acceleration and deceleration. Rates shall be selectable as linear, S-curve, or C-curve
 7. Stopping mode selection of coast to stop, controlled ramp stop, or DC injection braking with provisions for start frequency, braking voltage, and braking time
 8. PID set-point control selection with adjustable gains and lag constant
 9. Multi-speed run selection
 10. Jog
 11. Automatic fault latch reset
 12. Automatic restart
 13. Multiple programmable run patterns
 14. 3 points of critical frequency avoidance with adjustable bandwidths
 15. Speed scaling
- B. VFD control board shall have provisions to accept remote dry contact closures for start, stop, forward, reverse, multi-speed run, customer interlock, and external reset.

- C. Analog process follower input shall accept a remote isolated speed reference of 4-20mA, 0-5VDC, 0-10VDC, or potentiometer. Bias and gain (direct or reverse acting) shall be provided through the keypad.
- D. Analog outputs rated 0-1.0 ma DC or 0-7.5 VDC shall be provided proportional to current and frequency.
- E. Remote fault indication shall be provided with a form C contact (1 NO, 1 NC).
- F. Two 24 VDC open collector outputs shall be available to indicate drive running and speed conditions.
- G. Short circuit and input protective features shall include:
 - 1. High-speed current limiting fuses rated 200,000 AIC specifically designed for solid state applications.
 - 2. Solid state instantaneous over-current trip.
 - 3. Under-voltage (UV) DC bus monitoring protection.
 - 4. Over-voltage (OV) DC bus monitoring protection.
 - 5. Voltage or current phase reversal protection.
 - 6. Phase failure and phase unbalance protection.
- H. Internal protective features shall include:
 - 1. Transient surge protection; Transistor over-temperature and over-current protection; Current limit comparator circuit to automatically phase back the output current and frequency to prevent excessive currents from damaging motor insulation; DC bus fuse protection; DC bus over-voltage trip.
- I. Output protective feature shall include:
 - 1. Inverse time motor overload protection; Adjustable from 10% to 100%; Static over-speed protection; Stall protection on overload with inverse time over-current trip; Current limit adjustable from 10% to 120%; Load-end short circuit protection; Load-end ground fault protection; Load-end over-current protection.
- J. The VFD shall be capable of starting into a rotating motor and recover to normal operation.

2.6 CHILLER CONTROL INTERFACE

- A. The VFD shall be provided with a factory installed and wired control interface including pilot and control relays. All connection points shall be wired to terminal strips and/or appropriate hardware within the VFD enclosure as necessary.
- B. A control power transformer with fused disconnect shall be provided.
- C. A feedback signal proportional to operating frequency shall be provided.
- D. A 4-20 ma isolated signal shall be the primary speed reference.
- E. Necessary hardware and wiring shall be provided for interfacing the following functions:

1. Fault contact input.
2. Remote start contact.
3. Spare safety contact.
4. Chilled Water Pump.
5. Condenser Water Pump.
6. Tower Fan.
7. Alarming.
8. Shunt Trip Interface.

F. Communication port shall be wired to terminals for customer connection.

2.7 CONTROL WIRING

- A. Wiring shall be 600 volt, stranded copper, 90°C, color-coded insulation. No. 16 AWG minimum (120 VAC control power only).
- B. Terminations shall be crimp type wire lugs. Identification shall be with sleeve type markers at each termination point. Provide numbered terminal blocks for external connections.
- C. VFD control power shall be 120 VAC, fused. A control power transformer shall be provided. All control circuits shall be isolated from power circuits.

2.8 DIAGNOSTIC AND FAULT CAPABILITY

- A. The following conditions shall cause an orderly drive shutdown and lockout.
 1. Over-current at start-up
 2. Over-current at acceleration or deceleration
 3. Over-current while running
 4. Instantaneous over-current
 5. Over-voltage from power supply or generated during acceleration
 6. Motor overload
 7. VFD Over-temperature
 8. External fault and Ground Fault
 9. Blown input fuse
 10. Control Power supply failure
 11. ROM or EEPROM abnormality
 12. External Fault
- B. A Tripped Status Monitor shall be available for displaying abnormal VFD conditions. Each of the trip statuses shall be stored in non-volatile EEPROM and be available for viewing. Trips shall remain in memory until replaced or cleared.
- C. An Input Monitor shall display status codes when contact closures are placed across the input terminals.
- D. An Output Monitor shall display status codes of the open collector outputs.
- E. Door mounted meters shall be provided. Meters shall have a 1 ½ inch minimum scale. Current transformers and potential transformers shall have fuse protection and be of the appropriate accuracy and burden. Alternatively, a digital readout may be provided.

1. Voltmeter - three phase.
2. Ampere meter - three phase.

2.9 FINISH AND COLOR

- A. The finish and color shall be manufacturer's standard color applied over a primer and rust inhibitor for both interior and exterior of the enclosure.

2.10 FACTORY TESTS

- A. Upon completion of manufacture, the drive shall be subjected to a complete factory test to demonstrate compliance with the specifications. Component failure during testing will require repeating any test associated with the failure to demonstrate proper operation.
- B. The manufacturer shall submit two (2)-certified copies of the test report to the purchaser.

PART 3 - EXECUTION

- 3.1 Factory installs the variable frequency drive on the chiller.
- 3.2 Provide start-up services for the variable frequency drives from the manufacturer. Service shall include inspection, final adjustment, operational checks, and a final report for record purpose and shall be performed by local factory employed service engineers.
- 3.3 Provide services of manufacturer's technical representative for one 8-hour day to instruct Owner's personnel in operation and maintenance of variable frequency drives during the commissioning of the chiller.

END OF SECTION 230076

SECTION 230100 – INSTALLATION OF MECHANICAL PIPING

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Furnish all labor, material, services and related items for the HVAC water systems shown on the plans and/or specified herein. These systems shall include:
 - 1. Chilled Water
 - 2. Condenser Water
 - 3. Condensate Drains
 - 4. Make-up Water
 - 5. Refrigerant Relief Piping
 - 6. Heating Hot Water

1.2 RELATED DOCUMENTS

- A. All drawings and applicable provisions of Division 0 Bidding Requirements and Division 1 General Requirements apply to work of this Section.
- B. Section 230000 - Mechanical General Conditions.
- C. Section 230010 - Basic Mechanical Materials and Methods.
- D. Section 230020 - Vibration Isolation and Seismic Restraints.
- E. Section 230110 - HVAC Water Systems Piping.
- F. Section 230200 - Mechanical Insulation.
- G. Section 230910 - Start-up, Cleaning and Testing.
- H. Section 230920 - Water Treatment Systems.
- I. Section 230930 - Testing and Balancing.
- J. Section 230960 - Temperature Controls.

1.3 REFERENCES

- A. ANSI/ASME Sec 9 - Welding and Brazing Qualifications.
- B. ANSI/ASME 31.9 - Building Services Piping.
- C. MSS SP-58-2009. Manufacturers Standardization Society Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application and Installation.

1.4 QUALITY ASSURANCE

- A. Valves: Manufacturer's name and pressure rating marked on valve body.
- B. Welding Materials and Procedures: Conform to ANSI/ASME Sec 9.
- C. Welders Certification: In accordance with ANSI/ASME Sec 9.
- D. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS) Compliance: Comply with the various MSS Standard Practices referenced.

1.5 SUBMITTALS

- A. Submit the following in accordance with Section 230000.

1. Product data, including installation instructions for each type of support and anchor. Submit pipe hanger and support schedule showing Manufacturer's figure number, size, location, and features for each required pipe hanger and support. Indicate which piping systems each component will be applied to.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

- A. Hangers and support components shall be factory fabricated of materials, design, and manufacturer complying with MSS SP-58 except as modified herein.
 1. Hangers: Types 5 and 12 shall not be used.
 2. Hangers: Type 3 shall not be used on insulated piping.
 3. C-Clamps: Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and have both locknuts and retaining devices, furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.
 4. Angle Attachments: Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.
 5. Hangers: Type 24 shall be used only on trapeze hanger systems or on fabricated frames.
- B. Components shall have galvanized or cadmium plated coatings where installed for piping and equipment that will not have field-applied finish.
- C. Pipe supports shall be compatible with the pipe being supported to prevent galvanic corrosion. All supports for copper piping shall be copper coated hangers conforming in general to the above specification. Where copper pipes are separated from hangers by pipe insulation, hangers do not need to be copper coated.
- D. Saddles and hangers for insulated piping:
 1. Type 39 saddles shall be used on all insulated pipe 12 inches and larger when the temperature of the medium is above 60 degrees F. Type 39 saddles shall be welded to the pipe.
 2. Type 40 shields shall:
 - a. be used on all insulated pipes less than 12 inches.
 - b. be used on insulated pipes larger than 12 inches when the temperature of the medium is 60 degrees F or less.
 - c. have a wooden insert for pipes 2 inches and larger, and for smaller pipe when the insulation shows signs of being visibly compressed, or distorted. Insulation jacket shall be sealed at the insert to provide continuity of the vapor barrier.
 - 1) In lieu of the wooden blocks, this Contractor may provide rigid insulation saddle, equal to Fee and Mason Fig. 71, consisting of rigid urethane foam insulation with vapor barrier jacket and thermal conductivity of 0.13 BTU/HR/FT²/°F/IN @ 75°F. Insulation saddle length shall be 6" for pipes 6" and smaller. Thickness shall be the same as pipe insulation.

- d. distribute the loading on the bearing area of the insulation in accordance with the following minimum dimensions covering 180° of arc:

PIPE SIZE (INCHES)	GALVANIZED IRON	
	SADDLE LENGTH (INCHES)	GAUGE THICKNESS
1/2 to 4	12	16
6	18	16
8 and 10	24	14

- E. The hangers or supports for piping with vapor barriers shall be located outside the insulation and the vapor barrier must be left undisturbed for pipes 10 inches and smaller.
- F. Pipe supports shall be equal to B-Line model numbers hereinafter listed. Equal products by Unistrut or Grinnell are acceptable. (Grinnell numbers are shown in parentheses)
1. Clevis Hanger Fig. B 3100 or B3104 (260 or 65)
 2. Adjustable Swivel Ring Fig. B 3170 (9)
 3. Adjustable Swivel Roller Fig. B 3110 (181)
 4. Adjustable Roller Support Fig. B 3114 or Fig. B 3122 ((171 OR 177)
 5. Riser Clamp (Standard Duty) Fig. B 3373 (261)
 6. Riser Clamp (Heavy Duty) Fig. (40)
 7. Offset Clamp Fig. B 3148 (103)
 8. Wall Bracket (Light Duty) Fig. B 3068 (194)
 9. Wall Bracket (Medium Duty) Fig. B 3065 (195)
 10. Stand with Base Fig. B 3088 or Fig. B 3088T (62 OR 63)
 11. U-Bolts Fig. B 3188 (137)
 12. Structural Attachments:
 - Beam clamps: B 3031(92), B 3033(93), B 3034(94), B 3050(133), B 3045(217) and retaining straps for seismic applications
 - Angle Iron Beam Clamp: B 3046
 - Bar Joist: B 3059
 - Concrete Inserts: B 2500 (281), B 2505 or 2506(285), or B 3014(282)
 - Drilled Inserts: Phillips Red-head, wedge anchors

2.2 PREFABRICATED PIPE STANDS

- A. See Section 230010.

2.3 MISCELLANEOUS MATERIALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36.
- B. Pipe Alignment Guides: Factory fabricated, of cast semi-steel or heavy fabricated steel, consisting of bolted two-section outer cylinder and base with two-section guiding spider that bolts tightly to pipe. Length of guides shall be as recommended by manufacturer to allow indicated travel.

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPING

- A. All pipe shall be run parallel to or at right angles to walls, beams or columns. Pipe shall be run as direct as possible, avoiding unnecessary offsets, and maintaining maximum headroom. Shortcut diagonal methods will not be allowed.
- B. Piping drawings are to be considered schematic and are not intended to indicate all changes in direction and necessary fittings to be furnished and installed. Provide reducers/increasers at connections to equipment as required to match the equipment. Pipe and fittings shall be installed so that all pipe and/or insulation completely clears all nearby structures and piping.
- C. All piping shall be supported from the building structures by means of approved hangers and supports. Piping shall be supported to maintain required grading and pitch of lines, to prevent vibration and excessive deflections, and to secure piping in place.
- D. Piping shall be arranged to allow for expansion and contraction. Provide expansion loops, guides and anchors where indicated on the drawings.
- E. Install branch connections to mains using Tee fittings in main with take-off out the bottom of the main, except for up-feed risers which shall have take-off out the top of the main line except branch take-offs shall be made with swing connections where required to avoid stress at these points. Tees shall not be installed in a bullhead arrangement.
- F. At swing connections, offsets, expansion loops, etc., pipes shall be cold sprung into place before welding to compensate for fifty percent (50%) of the expansion.
- G. Pipes shall not be hung from other piping or from equipment of other trades. Hanger rods and piping shall not pierce ductwork.
- H. Pipe supports shall be structurally capable of carrying the pipe or pipes supported by them and shall be capable of vertical adjustment after installation of piping.
- I. Piping at all equipment and control valves shall be supported to prevent strains or distortions in the connected equipment and control valves. Piping shall be installed and supported to allow for removal of equipment, valves and accessories with minimum dismantling and without requiring additional supports after these items are removed.
- J. Install unions in pipes 2-1/2 inch and smaller at final connections to each piece of equipment and at valves, strainers, traps, etc., and elsewhere as indicated. Unions are not required on flanged devices. Install flanges on valves, apparatus, and equipment having 3 inch and larger connections.
- K. Dissimilar metals in the piping system shall be separated with dielectric unions or insulating flange sets.
- L. Provide plugged tees at all low points, except where drain valves are called for to allow for system drainage. All pipe lines shall be pitched to equipment traps and/or outlets. All horizontal mains shall be graded to have a pitch of at least 1" in 40'-0" in the direction of flow unless otherwise noted. Eccentric couplings, pitched fittings, etc., shall be installed where necessary to eliminate pockets.

- M. Provide manual air vents at all high points to allow bleeding of air from the system. Where gauge cocks are shown at coils, etc., these gauge cocks may serve as the air vent at that location.
- N. Factory fabricated fittings, similar to Bonney Forge Weldolet, Threadolet, Socklolet, or Elbolet may be used for branch connections to mains where branch size is less than main's size.
- O. Welding shall be performed by individuals who are currently qualified under procedures certified as acceptable by the National Certified Pipe Welding Bureau. Individuals must be prepared to provide current qualification certificates upon request. All work shall be done in accordance with the latest revised edition of the ASME Code for Pressure Piping requirements.
- P. Lines subject to rapid changes in flow rate shall be anchored to prevent excessive movement or vibration.
- Q. Drain lines shall be terminated over floor drains to direct the flow vertically into the floor drain. Provide elbows where required. Cut openings in the floor drain strainer where needed to prevent splash-out. Provide clean outs at changes in direction of more than 45 degrees and at maximum 75 feet spacing along the line.

3.2 PIPE JOINT CONSTRUCTION

- A. Soldered Joints: Comply with the procedures contained in the AWS "Soldering Manual."
- B. Brazed Joints: Comply with the procedures contained in the AWS "Brazing Manual."
 - 1. CAUTION: Remove stems, seats, and packing of valves and accessible internal parts at piping specialties before brazing.
 - 2. Fill the pipe and fittings during brazing, with an inert gas (ie., nitrogen or carbon dioxide) to prevent formation of scale.
 - 3. Heat joints using oxy-acetylene torch to proper and uniform temperature.
- C. Threaded Joints: Conform to ANSI B1.20.1, tapered pipe threads for field cut threads. Join pipe fittings and valves as follows:
 - 1. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
 - 2. Align threads at point of assembly.
 - 3. Apply appropriate tape or thread compound to the external pipe threads (except where dry seal threading is specified).
 - 4. Assemble joint wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.
 - a. Damaged Threads: Do not use pipe with threads which are corroded or damaged. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.
- D. Welded Joints: Comply with the requirement in ASME Code B31.9-"Building Services Piping."

- E. Flanged Joints: Align flanges surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.
- F. Grooved Joints: Assemble joints in accordance with fitting manufacturers written instructions.
- G. Press-Joint Fittings: Copper and copper alloy press fittings shall conform to material requirements of ASME B16.18 or ASME B 16.22 and performance criteria of IAPMO PS 117. All copper press fittings, couplings and specialties shall be the products of a single manufacturer. Installation tools shall be as recommended by the fittings manufacturer.

3.3 INSTALLATION OF HANGERS AND SUPPORTS

- A. Install hangers, supports, clamps and attachments, complete with necessary inserts, bolts, rods, nuts, washers, and other accessories, to support piping from building structure; comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping supported together on field-fabricated, heavy-duty trapeze hangers where possible. Install supports with maximum spacings complying with MSS SP-58.
- B. Install building attachments within concrete or to structural steel. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert to forms. Where concrete with compressive strength less than 2,500 psi is indicated, install reinforcing bars through openings at top of inserts. Where inserts are omitted, drill through concrete slab and provide thru-bolt with recessed square steel plate and nut recessed into and grouted flush with slab in locations where nut, etc. will interfere with other work or be a tripping hazard and above slab in other locations.
- C. Hangers and supports shall be provided as required to eliminate vibration and excessive deflection, but in no case over the following centers, unless specifically indicated otherwise on the drawing. Rod sizes for individual pipe lines shall not be less than the following schedule:

(STL = Steel , CU = Copper)

PIPE SIZE (INCHES)	MAXIMUM HANGER SPACING (FEET)	MINIMUM ROD SIZE (INCHES)	MAXIMUM HANGER SPACING (FEET)	MINIMUM ROD SIZE (INCHES)
	STL	STL	CU	CU
1/2	7	3/8	5	3/8
3/4	7	3/8	5	3/8
1	7	3/8	5	3/8
1-1/4	7	3/8	8	3/8
1-1/2	9	3/8	8	3/8
2	10	3/8	8	3/8
2-1/2	11	1/2	8	1/2
3	12	1/2	10	1/2
3-1/2	13	1/2	10	1/2
4	14	5/8	10	1/2

5	16	5/8
6	17	3/4
8	19	7/8
10	22*	7/8

*Maximum spacing for insulated pipe shall be 20 feet.

1. An additional hanger shall be installed at every change in direction of piping.
- D. When trapeze type hangers are used to support two or more pipes, rods shall be used for vertical hanger members and angles, channels, Unistrut or tee sections for horizontal hanger members. The material used shall be sized to support the load without excessive deflection. Spacing of trapeze hangers shall be based on the smallest pipe supported on the trapeze hanger. Rod sizes and spacing for trapeze hangers shall be based on supported weight and load carrying capacity of attachment device. Size trapeze bar for allowable loads indicated in SMACNA HVAC Duct Construction Manual (2005), Table 4-3, or as otherwise approved by the Engineer.
 - E. Hanger rods shall have double nuts and lockwashers at all connections.
 - F. Piping at walls shall be supported with wall brackets; vertical pipes shall be supported with riser clamps.
 - G. Contractor shall verify loading on hangers, hanger rods and structural attachments. Loading on the assembly shall not exceed 75% of the manufacturer's rating for any component of the assembly. If loading does exceed the 75%, then hanger spacing shall be reduced.
 - H. Steam, condensate, and high temperature heating hot water piping shall be mounted on roller supports. Where required for achieving pitch, etc., roller supports shall be vertically adjustable.
 - I. Chilled water piping >8" shall be mounted on a roller support or otherwise noted on the plans.
 - J. Heating hot water piping less than 220° F shall be mounted on roller supports a) if the drawings indicate expansion joints are required or b) if otherwise noted on the plans. Where required for achieving pitch, etc., roller supports shall be vertically adjustable
 - K. Piping shall not be supported from joist bridging or a roof metal deck.
 - L. Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 1 foot from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 5 feet apart at valves. Pipe hanger loads in excess of 50 pounds, suspended from steel joists, shall have the hanger loads suspended from panel points. Pipe supports for PVC piping shall be maximum 4 feet on centers. Where local codes require closer spacing than indicated on the plans or specifications, the supports shall conform to the local code requirements. For buildings built with steel joists before 1985, pipe supports shall be attached to the top leg of the joist.
 - M. Vertical pipe shall be supported at each floor, except at slab-on-grade, and at intervals of not more than 15 feet, not more than 8 feet from end of risers, and at vent terminations.

- N. Pipe Guides: Type 35 guides using steel reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided where required to allow longitudinal pipe movement. Lateral restraints shall be provided as required. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.
 - O. Steel Slides: Where steel slides do not require provisions for restraint of lateral movement, an alternate guide method may be used. On piping 4 inches and larger with medium 60 degrees F or greater, a Type 39 saddle may be welded to the pipe and freely rest on a steel plate. On piping under 4 inches, a Type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate.
 - P. High Temperature Guides with Cradles: Where there are high system temperatures and welding to piping is not desirable, the Type 35 guide shall include a pipe cradle, welded to the guide structure and strapped securely to the pipe. The pipe shall be separated from the slide material by at least 4 inches, or by an amount adequate for the insulation, whichever is greater.
- 3.4 Exterior Wall Penetrations: Seal pipe penetrations through exterior walls using sleeves and mechanical sleeve seals. Pipe sleeves smaller than 6 inch shall be steel; pipe sleeves 6-inch and larger shall be sheet metal. See additional requirements in Section 230010.
 - 3.5 Fire Barrier Penetrations: Where pipes pass through fire rated walls, partitions, ceilings, and floors, maintain the fire rated integrity. Refer to Section 230010 for sealants and materials.
 - 3.6 Provide seismic bracing in accordance with Section 230020 and details shown on drawings for piping and specialties where indicated or required by the local building code.
 - 3.7 Provide thermometers, thermometer sockets, and thermal wells where indicated on the drawings or in the specifications. Install in tees or in extra heavy nipples welded to the pipe or as indicated on the drawings. Install thermal wells for temperature control system temperature sensors (furnished under Section 230960 - Temperature Control Systems) and where indicated on the drawings. Coordinate the location of temperature sensor wells with the temperature control contractor and the Engineer.
 - 3.8 Install control valves and pressure sensors in accordance with the manufacturer's instructions where indicated on the drawings or in the specifications. Install taps and shut off valves for pressure sensors for temperature control system sensors (furnished under Section 230960 - Temperature Controls) and where indicated on the drawings.
 - 3.9 Provide pressure gauges and test plugs where indicated on the drawings or in the specifications.
 - 3.10 Dielectric unions shall be provided at the following locations:
 - A. At the connection of copper and steel piping.
 - B. At the connection of steel piping to copper coils.

END OF SECTION 230100

SECTION 230110 – HVAC WATER SYSTEMS PIPING

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Furnish all labor, material, services and related items for the HVAC water systems shown on the plans and/or specified herein. These systems shall include:
 - 1. Chilled Water
 - 2. Condenser Water
 - 3. Condensate Drains
 - 4. Make-up Water
 - 5. Refrigerant Relief Piping

1.2 RELATED WORK

- A. All drawings and applicable provisions of Division 0 Bidding Requirements and Division 1 General Requirements apply to work of this Section.
- B. Section 230000 - Mechanical General Conditions.
- C. Section 230010 - Basic Mechanical Materials and Methods.
- D. Section 230020 - Vibration Isolation and Seismic Restraints.
- E. Section 230100 - Installation of Mechanical Piping.
- F. Section 230200 - Mechanical Insulation.

1.3 REFERENCES

- A. ANSI/ASME Sec 9 - Welding and Brazing Qualifications.
- B. ANSI/ASME B16.3 - Malleable Iron Threaded Fittings Class 150 and 300.
- C. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
- D. ASTM A234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
- E. ASTM B88 - Seamless Copper Water Tube.

1.4 REGULATORY REQUIREMENTS

- A. Conform to ANSI/ASME 31.9.

1.5 QUALITY ASSURANCE

- A. Valves: Manufacturer's name and pressure rating marked on valve body.
- B. Welding Materials and Procedures: Conform to ANSI/ASME Sec 9.
- C. Welders Certification: In accordance with ANSI/ASME Sec 9.
- D. Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 (NFPA 255) method.

1.6 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 230000.
- B. Include data on pipe materials, pipe fittings, valves, specialties and accessories. Each submittal shall be clearly marked for the service(s) intended.
- C. Indicate seismic restraint locations including both lateral and transverse bracing on each shop drawings and described on product data. Indicate each restraint type as described on product data.

PART 2 - PRODUCTS

2.1 Manufacturer: Subject to compliance with requirements, provide hydronic piping system products from one of the following:

- A. Grooved Mechanical Joint Pipe, Fittings, and Couplings:

Victaulic Company of America.
Anvil (formerly Grinnell) Corp.
Tyler Pipe Co.
Or Approved Equal.

- B. Pump Suction Diffusers:

FLANGED:
Bell & Gossett ITT; Fluid Handling Div.
Amtrol, Inc.
Armstrong Pumps, Inc.
Taco, Inc.

GROOVED MECHANICAL JOINT:
Victaulic Company of America
Approved Equal

- C. Dielectric Waterway Fittings:
Victaulic Company of America
Approved equal

- D. Dielectric Unions:
Perfection Corp.
Watts Regulator Co.

- E. Dielectric Nipples:
Elster Perfection.
Grinnell Mechanical Products.
Matco-Norca, Inc.
Precision Plumbing Products, Inc.
Victaulic Company.

- F. Circuit Setter/Balancing Valves:
Bell & Gossett
Taco

Armstrong
Macon

G. Auto Flow Control Valves:

Griswold
Bell & Gossett
Approved equal

H. Ball Valves:

Nibco
Watts
Crane
Hammond
Stockham
James Bury
Gemini
Contramatics

I. Butterfly Valves, Swing check valves, and Spring check valves:

Nibco
Jenkins
Centerline
Crane
Demco
DeZurik
Keystone
Hammond
Stockham

GROOVED MECHANICAL JOINT:

Victaulic
Anvil (formerly Grinnell) Corp.
Nibco

J. Triple Duty Valves:

Bell & Gossett
Taco
Armstrong

K. Relief Valves:

Watts
Bell & Gossett
Taco
Armstrong

L. Pressure Regulating Valves:

Watts
Mueller
Stockholm

- M. Y-Pattern Strainers:
 - Armstrong Machine Works
 - Keckley
 - Illinois
 - Muessco
 - Metraflex Co.
 - Nibco
 - Spirax Sarco.
 - Victaulic Co. of America
 - Anvil
- N. Basket Strainers:
 - Crane Co.
 - Keckley
 - Illinois
 - Muessco
 - Metraflex Co.
 - Spirax Sarco.
 - Victaulic Company of America
 - Anvil
- O. Wafer Type Flow Elements:
 - Bell & Gossett
 - Taco
- P. Automatic Air Vent:
 - Bell & Gossett, ITT
 - TACO, Inc.
 - Armstrong
- Q. Flexible Connectors Type (1):
 - Flexonics
 - Anaconda
 - Metraflex
- R. Flexible Connectors Type (2):
 - Resistoflex
 - Thermo-Tech
 - Metraflex
 - Garlock
- S. Thermometers:
 - Palmer
 - Trerice
 - Weiss
 - Jay
 - Marsh
 - Weksler

- T. Pressure Gages:
Marsh
Weiss
U.S. Gauge
Weksler
Trerice
- U. Test Plugs:
Universal Lancaster, Lancaster, Ohio
Peterson Equipment Co., Inc.
MG Piping Products Co.
Sisco, A Spedco, Inc. Co.
Trerice (H.O.) Co.
Watts Regulator Co.
- V. Expansion Joints:
Flexonics
Anaconda
Adsko
Metraflex
- W. Pipe Alignment Guides:
Adsko
Metraflex
Anvil

2.2 All components, including pipe, fittings, valves, pumps, coils, heat exchangers, etc., used in the hot, chilled, condenser or make-up water systems shall be suitable for a continuous operating pressure of not less than 125 PSIG.

2.3 Schedule of pipe system materials for heating, chilled and condenser water systems.

ITEM	2-1/2" AND UNDER SCREWED	3" AND OVER FLANGED AND WELDED
Pipe	Type (1) or (2)	Type (2)
Fittings	Type (1)(150 lb)	Type (2)
Unions and Flanges	Type (1)(150 lb)	Type (2)
Dielectric Unions	Type (8)	Type (9)
Dielectric Nipples	Type (10)	
Stop Valves	Type (6)	Type (4)
Check Valves	Type (1)	Type (6)
Joint Materials	Type (1)	Type (2)
Flange Bolts	Not Applicable	Type (1)
Y Type Strainers	Type (1)	Type (2)
Basket Type Strainers	Not Applicable	Type (2)
Manual Air Vents	Type (1) or (2)	Type (1) or (2)
Automatic Air Vents	Type (3)	Type (3)
Flow Measurement	Not Applicable	Type (1)
Manual Balancing Valves	Type (1)	Type (1)

Expansion System Water Volume	Type (1)	Type (1)
Flexible Connector	Type (1)	Type (2)

- A. For chilled and hot water lines 2" and smaller (including heat recovery piping), this contractor may, at his option, may use either:

1. Hard drawn Type L copper Type (7) with wrought or cast bronze fittings Type (7). Joints shall be soldered with 95-5 solder using #50 petrolatur flux. If used, valves shall comply with valve specifications, but shall be solder type in lieu of threaded.
2. Hard drawn Type L copper Type (7) with press fit fittings Type (8). Joints shall be Press-Joint Fittings. All copper press fittings, couplings and specialties shall be the products of a single manufacturer. Installation tools shall be as recommended by the fittings manufacturer. If used, valves shall comply with valve specifications, but shall be press fit type in lieu of solder or threaded.

2.4 Schedule of pipe system materials for heat pump loop water system.

ITEM	2-1/2" AND UNDER SCREWED	3" AND OVER FLANGED AND WELDED
Pipe	Type (7)	Type (7) or (2)
Fittings	Type (7) or (8)	Type (8) or (2)
Unions and Flanges	Type (1)(150 lb)	Type (2)
Dielectric Unions	Type (7)	Type (9) or (7)
Dielectric Nipples	Type (10)	
Stop Valves	Type (5) or (9)	Type (5) or (9)
Check Valves	Type (4)	Type (6)
Joint Materials	Type (3) or (4)	Type (3) or (4) or (2)
Flange Bolts	Not Applicable	Type (1)
Y Type Strainers	Type (1) or (3)	Type (1) or (2) or (3)
Manual Air Vents	Type (1) or (2)	Type (1) or (2)
Automatic Air Vents	Type (3)	Type (3)
Manual Balancing Valves	Type (1)	Type (1)
Flexible Connector	Type (1)	Type (1)

2.5 Schedule of pipe materials for copper condensate drain piping.

<u>ITEM</u>	
Pipe	Type (8)
Fittings	Type (7) or Type (8)

2.6 Schedule of pipe materials for plastic condensate drain piping.

<u>ITEM</u>	
Pipe	Type (3)
Fittings	Type (3) or Type (4)

2.7 Schedule of pipe materials for make-up water.

ITEM

Pipe
Fittings Type (7)
 Type (7) or Type (8)

2.8 PIPE

- A. Type (1) - Carbon steel pipe ASTM-A106 continuous weld electric-weld, or seamless Schedule 40, USAS B31.1.
- B. Type (2) - Carbon steel pipe ASTM-A53 Grade B, electric-welded or seamless, Schedule 40, USAS B-31.1.
- C. Type (7) - Type L hard drawn copper.
- D. Type (8) - Type DWV hard drawn copper.

2.9 FITTINGS

- A. Type (1) - Malleable iron, screwed 150 lbs. Standards: ASA B16.3, threads ASA B2.1; material ASTM A-47 Grade 32510.
- B. Type (2) - Seamless carbon Steel Grade B standard weight butt-weld fittings, Standards: ASA B16.9; material ASTM A234.
- C. Type (7) - Wrought or cast bronze solder type fittings. T-drill fittings not acceptable.

2.10 UNION AND FLANGES

- A. Type (1) - Malleable iron unions, 150 lbs. Standards: Threads ASA B2.1; Material ASTM A-47, Grade 32510, ASA B16.3, Ground joint bronze-to-iron or bronze-to-bronze.
- B. Type (2) - Forged carbon steel flange weld neck type, bored to match Schedule 40, 150 lb. ASA-B16.5, raised face, materials ASTM A181, Grade 1.
- C. Type (7) - All bronze or brass, suitable for 150 psi working pressure.
- D. Type (8) - Dielectric union, malleable iron ASTM A197 or brass and bronze ASTM B-16 and ASTM B-844, or 250 psi ANSI B16.39, threaded ANSI B2.1. Watts 3000 Series.
- E. Type (9) - Dielectric flanges, iron rated for 125 psi ANSI B16.42, Watts 2200 series (iron pipe thread to iron pipe thread), or 3100 series (iron pipe thread to copper solder joint).
- F. Type (10) - Dielectric Nipples: Electroplated steel nipple. Complying with ASTM F 1545. Pressure Rating: 300 psig at 225 deg F. End Connections: Male threaded or grooved. Lining: Inert and noncorrosive, propylene. Standard: IAPMO PS 66.

2.11 JOINT MATERIAL OR GASKETS

- A. Type (1) - Thread sealing compound compatible with water, or teflon tape.
- B. Type (2) - Flanged joints, water, Garlock red rubber style 22, Manville or equal.
- C. Type (3) - Solder Joints: Joints shall be soldered with 95-5 solder using #50 petrolatur flux.

2.12 FLANGE BOLTS AND NUTS

- A. Type (1) - Carbon steel machine bolts ASTM A-307 Grade A, heavy series hex nuts ASTM A-194 Grade 1, ASAI B1.1 and B18.2.

2.13 VALVES – GENERAL

- A. Each valve shall be shell and seat tested by the manufacturer.
- B. All valves of the same type shall be of the same manufacture.
- C. Valves shall not contain asbestos.
- D. Operator features:
 - 1. Handwheels, fastened to valve stem, for valves other than quarter turn.
 - 2. Lever handles, on quarter-turn valves 6-inch and smaller, except for plug valves. Plug valves shall have square heads; furnish one wrench for every 10 plug valves (minimum 3).
 - 3. Gear drive operators, on quarter-turn valves 8-inch and larger.
 - 4. Malleable iron chain wheel operator and chain for valves located more than 7 feet above the floor except for valves located above ceilings; provide chains for operation at 5 feet above floor.
- E. Extended Stems: Where insulation is indicated or specified, provide extended stems arranged to receive insulation.
- F. Shop drawings shall be submitted on all valves. Each submittal shall be clearly marked for the service intended.
- G. Model numbers used for each type of valve shall establish the desired type, quality and materials of construction. Products equal to the valve specified and meeting these specifications, by the manufacturers listed above are equally acceptable.

2.14 STOP VALVES

- A. Type (4) - Nibco LD-2000, iron body butterfly valve, lug type, aluminum-bronze disc, stainless steel stem and disc screws, Buna N stem seals, EDPM replaceable seat, extended neck, infinite position lever handle with memory stop, comply with MSS-SP-67, suitable for dead end service at full pressure rating of valve. Valves above 6" NPS shall have a gear operator. 150 psi WP, 50 to 275°F.
- B. Type (5) - Nibco S-595-Y- 66, 3 pc. bronze ball valve, teflon seat and seals, full port, stainless steel ball and stem, solder ends, comply with MSS-SP-110. 600 psi WOG.
- C. Type (6) - Nibco T-585-70-66, 2 pc. bronze ball valve, teflon seats and seals, full port, stainless steel ball and stem, threaded ends, comply with MSS-SP-110. 150 psi steam, 600 psi WOG.
- D. Type (7) - Nibco GD-4765 or Victaulic Series 700/701, iron body butterfly valve, grooved type, aluminum-bronze disc, stainless steel stem and disc screws, Buna N stem seals, EDPM encapsulated disc, extended neck, infinite position lever handle with memory stop, comply

with MSS-SP-67, suitable for dead end service at full pressure rating of valve. Valves above 6" NPS shall have a gear operator. 150 psi WP, 50 to 275°F.

- E. Type (8) - Nibco F-617-0, Gate valve, iron body bronze mounted, OS&Y, flanged ends, Class 125, comply with MSS-SP-70.
- F. Type (9) - 2 pc., bronze ball valve, teflon seats and seals, full port, stainless steel ball and stem, press fit ends, comply with MSS-SP-110. 150 psi steam, 600 psi WOG. VALVES MUST HAVE A STAINLESS STEEL BALL AND STEM.
- G. Type (10) - Nibco PFD-2000, iron body butterfly valve, lug type, press x press female ends, aluminum-bronze disc, stainless steel stem and disc screws, EPDM stem seals, EPDM molded in seat, extended neck, infinite position lever handle with memory stop, comply with MSS-SP-67, suitable for dead end service at full pressure rating of valve. 2-1/2" to 4" NPS. 200 psi WP, 250°F maximum.

2.15 CHECK VALVES

- A. Type (1) - Nibco T-413-Y, bronze swing check, Class 125, ASTM B-62 body, TFE seat, threaded ends, comply with MSS-SP-80, 125 psi steam, 250 psi WOG.
- B. Type (4) - Nibco PF-413-Y, bronze swing check, Class 125, ASTM B-62 body, TFE seat, press fit ends, comply with MSS-SP-80, 125 psi steam, 250 psi WOG.
- C. Type (5) - Nibco S-413-Y, bronze swing check, Class 125, ASTM B-62 body, TFE seat, solder ends, comply with MSS-SP-80, 125 psi steam, 250 psi WOG.
- D. Type (6) - Nibco W910-W or W920-W, wafer type, ASTM A126 Class B or A48 iron body, bronze disc plates, rubber seat, comply with MSS-SP-71, non-asbestos gaskets, stainless steel hinge pins, stop pins and spring, suitable for continuous duty at 125 psi and 250°F.

2.16 RELIEF VALVES

- A. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labeled. 150 PSIG WP. Relief pressure setting 30 to 150 psig as indicated on the plans. Watts model 174A or equal.

2.17 PRESSURE REGULATING VALVES

- A. Bronze body, screwed-end, adjustable outlet pressure, nitrile diaphragm and seat, stainless spring, capacities ASME certified and labeled, 200 psig inlet pressure maximum, 25 to 75 psig outlet, 150°F maximum fluid temperature. Diaphragm and seat material available for fluid temperatures to 250°F. Watts model N45 or equal.

2.18 Y TYPE STRAINERS

- A. Type (1) - Screwed end, iron body, 250 psi steam at 425°F., 400 psi water at 100°F., with blowoff outlet, stainless steel screen or Monel. Screen shall have 1/32" holes for water service. Muessco #11.

- B. Type (2) - Flanged, 125 lb. ASA flanges, iron body, 125 psi steam, 175 psi WOG with blowoff outlet, reinforced brass screen with 1/4" perforations for water. Muessco #751.
- C. Type (3) - Pressed fit end, bronze body, Class125, 250°F max operating temperature., 200 psi WP., with plugged cap, 20 mesh stainless steel screen. Nibco PF221 or equal.

2.19 BASKET STRAINERS

- A. Type (2) - Flanged, 125 lb. ASA flanges, iron body, iron clamp and Buna N O-ring basket seal, 155 psi WOG with plugged drain outlet, stainless steel perforated basket with 5/32" perforations for water. Muessco # 155M.

2.20 DUPLEX BASKET STRAINERS

- A. Flanged, 125 lb. ASA flanges thru 5", 150 lb. ASA flanges 6" thru 16", iron body, iron clamp and Buna N O-ring basket seal, 150 psi WOG with plugged drain outlet, stainless steel perforated basket with 5/32" perforations for water. Muessco # 691.

2.21 AIR VENTS

- A. Type (1) - Manual air vents shall be equal to Dole, screw driver type.
- B. Type (2) - Manual air vents at pumps shall be 1/4" or 3/8" ball valves equal to Nibco T-569-BR-Y-20 one pc., bronze ball valve, teflon seats and seals, bronze ball and stem, threaded ends, comply with MSS-SP-110, 600 psi WOG.
- C. Type (3) - Automatic Air Vent: designed to vent automatically with float principle; bronze body and nonferrous internal parts; 150 psig working pressure, 240 deg F operating temperature; and having 1/4 inch discharge connection and 1/2 inch inlet connection. Bell & Gossett Model 87 or equal.

2.22 BALANCE VALVES

- A. Type (1)
 - 1. Valves shall be calibrated bronze balance valves with provisions for connecting a portable differential pressure meter as shown on the plans.
 - 2. Meter connections to have built-in check valves. An integral pointer shall register degree of valve opening. Each balance valve shall be constructed with internal seals to prevent leakage around rotating element, suitable for 100% shut-off.
 - 3. Each balance valve shall be constructed for 150 pounds working pressure @ 250°F. and supplied with preformed polyurethane insulation.
 - 4. Valves shall be as manufactured by Bell and Gossett, TACO, Nibco, Illinois or Armstrong.
 - 5. Contractor shall furnish to Balancing Contractor a differential pressure meter equal to Bell & Gossett Model No. RO-4 for balancing of balance valves. Balancing Contractor shall give the meter to the Owner upon completion of water balancing.

2.23 AUTO FLOW CONTROL VALVES

- A. Valves shall be brass and stainless steel with threaded connections and shall have the following features:

1. Performance certified by an independent laboratory.
2. Permanently marked to show direction of flow, flow rate and pressure range.
3. Pre-set to control the flow rate within 5% of the tagged rating.
4. Replaceable flow cartridges that allow field-exchange of internal components without removing the valve body from the pipeline.
5. Maximum of 5 feet of pressure drop.
6. Inline check valve and strainer.

- B. Valve shall be sized to handle 110% of flow scheduled on drawings.

2.24 TRIPLE DUTY VALVES

- A. Straight or angle pattern, flanged cast-iron valve body with bolt-on bonnet for 175 psig operating pressure, non-slam check valve with spring-loaded bronze disc and seat, stainless steel stem, and calibrated adjustment permitting flow regulation. Size valve to for 3 to 6 feet pressure differential with valve 100% open; reduce from line size if required.

2.25 FLEXIBLE PIPE CONNECTORS

- A. Type (1)

1. Metraflex metal braided, bellows type, screwed or flanged, 150 psi working pressure at the maximum service temperature (up to 250°F). Length shall allow for 3/8" misalignment.
 - a. Model BBS, bronze hose and braid up through 2"
 - b. Model SLP, stainless steel hose and braid over 2"

- B. Type (2)

1. Resistoflex Model R6904 with bellows molded from DuPont T.F.E. teflon. Connectors shall be equipped with monel reinforcing rings, ductile iron flanges and integral limit bolts. Each unit shall be supplied with disposable spacer blocks to facilitate correct installation. All units shall permit pipe movement of 1/4" from pipe axis with flanges parallel and axial compression of 1/4" from the installed length. Published working pressure at operating temperature (up to 250F.) shall be based on 4 to 1 safety factor and shall be no less than the sum of the system relief valve set pressure and the circulating pump specified operating head.
2. Alternatively, in lieu of flexible connector, Contractor may utilize groove joint mechanical couplings at the pump connectors in accordance with coupling manufacturer's installation instructions for this application. Provide a minimum of three (3) couplings at each pump connection. Mechanical couplings shall be as indicated below.

2.26 PUMP SUCTION DIFFUSERS

- A. Cast-iron body, with threaded connections for 2 inch and smaller, flanged or grooved mechanical joint connections for 2-1/2 inch and larger; 175 psig working pressure, 300 deg F maximum operating temperature; and complete with the following features:

1. Inlet vanes with length 2-1/2 times pump suction diameter or greater.
2. Cylinder strainer with 3/16 inch diameter openings with total free area equal to or greater than 5 times cross-sectional area of pump suction, designed to withstand pressure differential equal to pump shutoff head.
3. Disposable fine mesh strainer to fit over cylinder strainer.
4. Permanent magnet, located in flow stream, removable for cleaning.
5. Adjustable foot support, designed to carry weight of suction piping.
6. Blowdown tapping in bottom; gauge tapping in side.

2.27 THERMOMETERS

- A. Weiss #A9VU35 adjustable angle. Blue liquid filled-magnifying lens “Blue Reading” Tube, Industrial Thermometers cast of extruded brass or aluminum closed cases, stainless steel or brass tapered bulbs with bulbs in direct contact with metal, individually calibrated tubes and engraved scales. Each 9" thermometer shall have adjustable angle and shall be installed in a matching brass separable socket with a 3/4" NPT. Stem length of socket shall be 3-1/2" except on lines where the insulation thickness exceeds 3" the stem length shall be 6" with an extension neck socket.
- B. Thermal wells in liquid lines shall be brass construction of same manufacturer as thermometers with 3/4" NPT, cap and chain, and shall have Government Standard tapered walls. Socket length shall be 3-1/2" under hex, except on lines where the insulation thickness exceeds 3" the length shall be 6" including 2-1/2" extension neck.
- C. All thermometers and thermal wells shall be by one manufacturer and shall be interchangeable.
- D. Graduation of thermometers shall be as follows:

	RANGE (°F)	DIVISIONS	FIG. INTERVAL
Chilled	0 to 120	1°F	10°
Condenser Water	0 to 120	1°F	10°

- E. Submit shop drawings on thermometers and thermal wells.

2.28 PRESSURE GAUGES

- A. Gauges shall be equal to Weiss #PG-1
- B. Gauges shall include:
 1. 4-1/2" diameter, no flange
 2. Closed type ring with clear glass
 3. Bronze tube, Bourdon Type
 4. Silver brazed connecting joints
 5. Bushed, brass rotary movement
 6. 1/4" NPT bottom connections with brass tee handle cock
 7. Pressure "snubbers" at locations where gauge needle pulsation might occur
- C. Submit shop drawings on gauges.

- D. Graduation of pressure gauges shall be:

	RANGE	DIVISIONS	FIG. INTERVAL
Chilled Water	0 – 100 psi	1.0 psi	10 psi
Condenser Water	0 – 100 psi	1.0 psi	10 psi

- E. Gauge cocks shall be brass, equal to Weiss No. TC-14 or LC-14.
- F. Pressure gauges at pumps, chillers and other locations shown on the drawings shall be Flow Conditioning Corp. Hydronic Indicator Systems or equal. These gauges shall include a manifold valve and a gauge with pressure indications accurate to 1/2 of 1%. Gauges shall be as specified above with a quick set dial for pressure comparison. Manifold valve shall be spring return push-button manifold with ports for connection to system at indicated points. System shall be a four port system at pumps, and multiple ports at other locations as shown. Gauges shall be connected to sensing ports with 1/4" copper tubing.

2.29 TEST PLUGS

- A. Test plugs, 1/4" NPT, shall be arranged to allow attachment of either a thermometer or a pressure gauge. Test plugs shall have a valve core of neoprene or other material suitable for use with hot water, chilled water and condenser water. Valve core material shall also be suitable for propylene glycol and water solutions. Test plugs shall be brass, with color coded and marked cap to cover opening when not in use.
- B. Contractor shall furnish the Owner with two (2) pressure and temperature testing kits equal to series 1500 (Peterson Equipment Co.), each consisting of a 0-100 psi, 0-230 ft. water pressure gage with No. 500 gage adaptor attached, a 25-125°F pocket testing thermometer, a 0-220°F pocket testing thermometer, a No. 500 gage adaptor and a protective carrying case.
- C. Test plugs shall be equal to Model No. 110 (Pete's Plug) as manufactured by the Peterson Equipment Company, Incorporated of Richardson, Texas.

2.30 EXPANSION JOINTS

- A. Expansion Loops
1. Expansion Loops shall comply with the following:
 - a. U bend design expansion loop equal to Metraloop as manufactured by the MetraFlex Company. Loops shall be designed to impart no thrust loads on the anchors and shall consist of two flexible sections of hose and braid, two 90 degree elbows and a 180 degree return bend.
 - b. For copper pipe applications, pipe fittings shall be type L copper wrought copper or bronze metal with a bronze hose and braid with fittings for solder connections, 150 psi working pressure at up to 250°F.

2.31 PIPE ALIGNMENT GUIDES

- A. Alignment guides shall be factory fabricated with split steel guiding cylinder with anchor case and split steel spider. Guiding cylinders shall be split on 45° and shall be designed to

accommodate specified insulation thickness. Allow 1/8" minimum clearance between I.D. of guiding cylinder and O.D. of insulation. For chilled or cold services, guides shall include a thermal barrier between the pipe and spider.

- B. Guides shall be equal to ADSCO Model E for steel piping and Model FRC for copper. For cold services, guides shall include ITB feature.

2.32 GROOVED PIPE JOINING METHODS

- A. Contractor may use grooved pipe joining methods for the following services:

- 1. Chilled Water
- 2. Condenser Water

- B. Contractor may, at his option, if approved by the local building code, use grooved pipe, couplings, fittings, butterfly valves, and mechanical tee stub-ins in lieu of welded, flanged or threaded methods of pipe joining. If used, joining methods and components shall be approved for services up to and including 230°F. Joining methods and components shall be Victaulic, Gustin Bacon or approved equal. All methods, procedures and components shall be in compliance with the manufacturer's recommendations. System shall be suitable for 150 psi normal working pressure.

- C. Coupling Housings

- 1. Coupling segments shall be cast of malleable iron conforming to ASTM A-47 or ductile iron conforming to ASTM A-536.
- 2. The coupling shall be of the grooved, mechanical type which engages grooved or shouldered pipe ends, encasing an elastomeric gasket which bridges the pipe ends to create the seal. The coupling shall be cast in two or more parts secured together during assembly by nuts and bolts as specified. The coupling shall permit a degree of angular pipe deflection, contraction and expansion.

- D. Gaskets

- 1. Elastomers shall have properties as designated by ASTM D-2000.
- 2. Gasket shall be of the mechanical grooved coupling design, pressure responsive so that internal pressure serves to increase the seal's tightness.
- 3. Gasket supplied shall be EPDM Grade "E", with green color code identification, conforming to ASTM D-2000 for water services up to 230°F.

- E. Bolts and Nuts

- 1. Bolts and nuts shall be heat treated carbon steel conforming to ASTM A183, minimum tensile 110,000 psi.
- 2. The coupling segments shall be assembled with two or more oval neck track bolts. The nuts shall be tightened to assure firm metal-to-metal contact of the coupling bolt pads.

- F. Branch stub-in connections may be made with Victaulic Mechanical-T in lieu of welded fittings. If used, tees shall comply with the following:

1. Mechanical-T shall be cast of malleable iron conforming to ASTM A-47 or ductile from conforming to ASTM A-536.
 2. Mechanical-T shall consist of an upper housing with full locating collar for rigid positioning which engages a machine-cut hole in the pipe, encasing an elastomeric gasket which conforms to the pipe outside diameter around the hole and a lower housing with positioning lugs, secured together during assembly by nuts and bolts as specified, pre-torqued to 50 lb. ft.
 3. Gasket shall be the same as paragraph above.
 4. Bolts and nuts shall be the same as paragraph above.
- G. Fittings shall be of grooved or shouldered end design to accept grooved mechanical couplings without field preparation.
1. Malleable Iron - ASTM A-47.
 2. Ductile Iron - ASTM A-536.
 3. Fabricated Steel - ASTM A-53, 3/4" - 1-1/2", Type F, 2-20", Type E or S, Grade B.
 4. Steel - ASTM A-234, (A-106, Gr. B) (14-24", 45°F and 90°F elbows).
- H. Flanges for connecting flanged components into the grooved system shall be Victaulic Vic-Flanges. Flanges shall conform to 125# cast-iron and 150# steel bolt hole alignment.
1. Steel Pipe - Vic-Flange for steel pipe shall be Style 741 in sizes 2-12" and Style 742 in sizes 14" and 16".
 2. Materials
 - a. Malleable Iron - ASTM A-47.
 - b. Ductile Iron - ASTM A-536.
- I. Valves. Valves may be of grooved end design in sizes 1" through 12". All valves shall have iron body, bronze disc, extended neck, 150 psig pressure rating, and stainless steel stem and disc screws. All butterfly valves 6" and smaller shall be Victaulic Series 700 butterfly valves with standard handle, Grade "E" or Grade "H" linings and standard trim. All butterfly valves 8" through 12" shall be Victaulic Series 701 butterfly valves with manual gear operator, Grade "E" linings and standard trim. Valves shall be suitable for up to 230°F service.
- J. Pipe shall be supplied grooved in accordance with coupling manufacturer's specifications. For grooving on-site, pipe shall be prepared in accordance with the same specifications using specially designed tools.
- K. All standard steel pipe shall be black or hot-dipped galvanized, as indicated, conforming to ASTM Specification A-53, 3/4" - 1-1/2" Type F and 2" - 24" Type E or S, Grade B, and of standard weight wall thickness, manufacturer's standard square cut grooving specifications.
- L. The joints shall be assembled in compliance with the coupling manufacturer's recommendations.
- M. The requirements of MSS-SP-69, "Pipe Hangers and Supports-Selection and Application" shall in general, govern the installation of hangers and supports, in accordance with the following recommendations.

1. Horizontal Piping. No pipe shall be left unsupported between any two couplings nor shall any pipe be left unsupported whenever a change in direction of line flow takes place. Supports shall meet the requirements stated above but in no case shall the distance between supports exceed the following:

Pipe Size	Between Hangers
3/4 - 1"	8'
1-1/4 - 2"	10'
2-1/2 - 4"	12'
5 - 8"	14'
10 - 12"	16'

2. Vertical Piping. Vertical piping shall be supported at every other floor or every other pipe length, whichever is most frequent. The base of the riser or base fitting shall be set on a pedestal or foundation.

2.33 DESIGN PRESSURE/TEMPERATURE SCHEDULES:

SERVICE	VALVES PSIG/°F	PIPING PSIG/°F
Chilled Water	125/150	100/150
Makeup Water	150/150	100/150
Drains	125/150	50/150
Cooling Tower Water	125/150	100/150

PART 3 - EXECUTION

- 3.1 See Section 230100 for piping installation.

3.2 HYDRONIC SPECIALTIES INSTALLATION:

- A. Install manual air vents at high points in the system, at heat transfer coils, and elsewhere as required for system air venting.
- B. Install inline air separators in pump suction lines. Install automatic air vent on top of separator and pipe discharge to floor drain unless otherwise indicated. Install drain valve on units 2 inch and larger.
- C. Install strainer blowdown piping with ball valve; extend to nearest drain.
- D. Install pump suction diffusers on pump suction inlet where indicated, adjust foot support to carry weight of suction piping. Install nipple and ball valve in blowdown connection.
- E. Install pump discharge valves in horizontal or vertical position with stem in upward position. Allow clearance above stem for check mechanism removal.
- F. Install flexible pipe connectors on pipes connected to equipment where indicated.
 1. Rigidly anchor pipe to building structure where necessary.

2. Install flexible pipe connectors in accordance with manufacturer's instructions. Align joints to avoid end loading and torsional stress.
- G. Install ASME pressure relief valves on all portions of the piping systems which during normal usage could be isolated from the expansion system by manual or automatic valves. Valves shall be set to relieve at 125 PSI, unless otherwise indicated.
- H. Install expansion joints and compensators where indicated and where required to control expansion and contraction of piping, loops, pipe offsets, and swing joints. Install corrugated bellows type expansion joints where required. Rigidly anchor pipe to building structure where necessary in accordance with manufacturer's guidelines. Provide pipe guides so that movement takes place along axis of pipe only.
- I. Install a P/T plug at each water sensor which is an input point to the control system.
- J. Install balance valves in accordance with manufacturer's written installation instructions. Provide a minimum of 2 diameters of straight pipe downstream of the balance valve, a minimum of 5 diameters of straight pipe upstream of the balance valve to any pipe fitting, valve, control valve or thermal well, and a minimum of 10 diameters upstream of the balance valve to any pump discharge.

END OF SECTION 230110

SECTION 230200 – MECHANICAL INSULATION

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Furnish all labor, services, material and related items necessary to complete the thermal insulation work indicated on the drawings and/or specified herein.
 - 1. Mechanical Piping.
 - 2. Mechanical Equipment.

1.2 WORK EXCLUDED

- A. Work not included in this Section that is specified in other Sections of these specifications:

1.3 RELATED DOCUMENTS

- A. All drawings and applicable provisions of Division 0 Bidding Requirements and Division 1 General Requirements apply to work of this Section.
- B. Section 230000 - Mechanical General Conditions.
- C. Section 230100 - Installation of Mechanical Piping.
- D. Section 220400 - Plumbing Systems (plumbing piping insulation).
- E. Section 230900 - Air Distribution.

1.4 QUALITY ASSURANCE

- A. Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 (NFPA 255) method.

1.5 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, k-value, thickness, and furnished accessories for each mechanical system requiring insulation.
- B. Submit product data under provisions of Section 230000. Indicate application for each product.
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail attachment and covering of heat tracing inside insulation.
 - 3. Detail insulation application at pipe expansion joints for each type of insulation.
 - 4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 5. Detail removable insulation at piping specialties, equipment connections, and access panels.
 - 6. Detail application of field-applied jackets.
 - 7. Detail application at linkages of control devices.

8. Detail field application for each equipment type.

1.6 DELIVERY, STORAGE, AND, HANDLING

- A. Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with manufacturer's stamp or label, affixed showing fire hazard indexes of products.
- B. Store insulation in a clean, dry place and protect against dirt, water, and chemical and mechanical damage. Do not install damaged or wet insulation; remove from project site.

1.7 REFERENCES

- A. ASTM E 84 Standard Test Method for Surface Burning Characteristics of Building Materials.

PART 2 - PRODUCTS

- 2.1 The piping insulation material for each Type is specified to establish the desired quality and performance. Equal products, complying with the requirements of these specifications, by the following manufacturers are acceptable:

- A. Owens-Corning
- B. Certain-Teed
- C. Armstrong
- D. Manson formerly Manville
- E. Knauf
- F. Rubbatex
- G. Imcoa
- H. Foamglas

- 2.2 Type (1) - Owens-Corning Fiberglass, Fiberglass 25 with ASJ all service jacket, seal down lap joints, vapor barrier in jacket. Thermal conductivity of 0.26 BTU/HR/SF°F/IN @ 100°F mean temperature, 0.3 @ 200°F, 0.35 @ 300°F. PVC jacket over fittings. Aluminum jacket over straight sections of piping located outdoors.

- 2.3 Type (2) - Armatuff Plus II (Flame/Smoke Rating less than 25/50 thru 1" thickness per ASTM E-84) Armaflex foamed plastic flexible sheeting laminated with a white thermoplastic rubber membrane (TPR). TPR membrane shall be UV resistant with a 25 year warranty. Thermal conductivity of 0.28 BTU/HR/SF°F /IN @ 90°F mean temperature.

- 2.4 Type (3) - Armacell AP/Unslit (Flame/Smoke Rating less than 25/50 thru 1" thickness per ASTM E-84) Armaflex foamed plastic flexible tubing insulation Unslit. Thermal conductivity of 0.28 BTU/HR/SF°F /IN @ 90°F mean temperature. See Execution for allowable locations of Lap Seal.

- A. Provide Armafix insulated pipe hangers at all pipe hangers.

- 2.5 Type (11) - Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Preformed Pipe Insulation with Factory-Applied ASJ-SSL: Comply with ASTM C 552, Type II, Class 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

- A. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.
 - 1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
 - 3. Acceptable manufacturers:
 - a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 81-84.
 - B. Cellular-Glass Joint Sealants:
 - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 2. Permanently flexible, elastomeric sealant.
 - 3. Service Temperature Range: Minus 100 to plus 300 deg F.
 - 4. Color: White or gray.
 - a. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - b. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
 - 5. Acceptable Manufacturers:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
 - b. Eagle Bridges - Marathon Industries; 405.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
 - d. Mon-Eco Industries, Inc.; 44-05.
 - e. Pittsburgh Corning Corporation; Pittseal 444.
- 2.6 Type (12) - Armaflex AP White Unslit (Flame/Smoke Rating 25/50 thru 1" thickness) Armaflex white foamed plastic flexible tubing insulation, Unslit. UV resistant thermal conductivity of 0.28 BTU/HR/SF°F /IN @ 90°F mean temperature. Available ½" thick thru 2-5/8" ID and 3/4" or 1" thick thru 4-1/8" ID. See Execution for allowable locations of Lap Seal.
- A. Provide Armafix insulated pipe hangers at all pipe hangers.
- 2.7 JACKETS
- A. Vapor Barrier Jackets: Kraft reinforced foil vapor barrier with self-sealing adhesive joints.
 - B. PVC Jackets: One piece, premolded type.

- C. Aluminum Jackets: ASTM B209; 0.032 inch thick; Stucco Embossed corrugated finish; 2-1/2" deep corrugations. Childers jacketing system, ITW Insulation system, or equal.
 - 1. Finish and thickness are indicated in field-applied jacket schedules.
 - 2. Moisture Barrier for Indoor Applications: 1-mil thick, heat-bonded polyethylene and kraft paper or 2.5-mil thick polysurlyn.
 - 3. Moisture Barrier for Outdoor Applications: 2.5-mil thick polysurlyn.
- D. Vapor barrier mastic coatings:
 - 1. for outdoor service: Foster Division - 30-15
 - 2. for indoor service: Foster Division - 30-80 or 30-90 (water based)
 - 3. Or equal products by the following manufacturers:
 - a. Exxon Chemical Company USA
 - b. Insul - Coustic IC
 - c. Epolux-Cadalar
- E. Reinforced Polyvinyl-Chloride (PVC) Flashing Sheet: ASTM D 4434, Type III, fabric reinforced and fabric scrim-backed; felt backed; capable of being heat-welded. Sheet Thickness: 60 mils, nominal. (For use on ductwork exterior location where indicated on the plans.)
- F. Thermoplastic Polyolefin (TPO) Flashing Sheet: ASTM D 6878, internally fabric or scrim reinforced, uniform, flexible TPO sheet; free of surface defects and embossing or marking which affect membrane thickness or performance; capable of being heat-welded. Thickness: 60 mils, nominal. (For use on ductwork exterior location where indicated on the plans.)
- G. Removable/Reusable Valve Covers - select one of the following:
 - 1. Cover shall be factory fabricated of 1" close cell elastomeric insulation (Flame/Smoke rating less than 25/50 per ASTM E-84) with Velcro closures. Thermal conductivity of 0.28 BTU/HR/SF°F /IN @ 90°F mean temperature. Cover shall overlap adjoining sections of pipe insulation and shall totally enclose all portions of the valve being covered. Installation shall not require the use of any special hand tools. As manufactured by Corick, Baton Rouge, Louisiana, or approved equal.
 - 2. Cover shall be factory fabricated of 1-½" fiberglass blanket insulation. Thermal conductivity of 0.26 BTU/HR/SF°F/IN @ 100°F mean. Flame/Smoke rating less than 25/50 per ASTM E-84. Outer jacket shall be made of material equal to DuPont Tychem® QC, overlapping and completely covering the insulation with seams joined with Velcro closures. Butt ends shall have sewn-in-place elastic. Outer jacket shall overlap adjoining sections of pipe insulation and shall totally enclose all portions of the valve being covered. Installation shall not require the use of any special hand tools. As manufactured by "No Sweat" Valve Wraps, Inc., Fit Tight Covers, or approved equal.
 - 3. Cover shall be factory fabricated with molded polyisocyanurate insulation or molded cellular glass insulation. Polyisocyanurate shall comply with ASTM C591, nominal 2 lb/ft³ density, K factor of 0.19 Btu/hr/ft²F at 75°F mean temperature. Cellular glass shall comply with ASTM C 552, Type III and shall be inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Covers shall comply with

Flame/Smoke Rating less than 25/50 per ASTM E-84. Covers shall have close fitting PVC or aluminum jackets. Units shall have plugs that allow valve to be operated without removing the cover. Outer jacket shall have seams joined with Velcro closures, shall overlap adjoining sections of pipe insulation, and shall totally enclose all portions of the valve being covered. Installation shall not require the use of any special hand tools. As manufactured by Extol of Ohio, or approved equal.

- H. Underground Direct-Buried Jacket: 125-mil- thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.

1. Acceptable Products and Manufacturers:

- a. Pittsburgh Corning Corporation; Pittwrap.
- b. Polyguard; Insulrap No Torch 125.

I. PVC Insulation Fitting Covers:

1. Factory fabricated, pre-molded, fitting covers manufactured from 20-mil- thick, high-impact, ultraviolet-resistant PVC.
2. Factory fabricated, pre-molded, fiberglass fitting inserts, 1-1/2 pound per cubic foot density, semi-rigid insulation formed to fit the pipe fitting, valve, etc. that it is designed to cover.
3. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, reducers, end caps, traps, and mechanical joints.
4. Acceptable manufacturers:
 - a. Ceel-Co, "Ceel-tite #320" (indoors), #330 (outdoors 0°F to 150°F)
 - b. Certain Teed, "Snap Form"
 - c. Foster Div., H.B. Fuller Co., "Speedline Smoke-Safe"
 - d. Knauf, "Proto Lo SMOKE"
 - e. Manville, "Zeston 2000"
5. Adhesive: Compatible with fitting cover material. Do not use regular PVC cement.
 - a. Acceptable manufacturers:
 - 1) Ceel-Co, "Ceel-tite #300" Solvent Welding Adhesive
 - 2) Knauf, "Proto Solvent Adhesive"
 - 3) Manville, "Perma-Weld Adhesive"
 - 4) Aluminum fitting covers by GASCO are equally acceptable.

2.8 ACCESSORIES

- A. Insulation Bands: ¾ inch wide; 0.015 inch thick galvanized steel.
- B. Metal Jacket Bands: ¾ inch wide; 0.015 inch thick aluminum.
- C. Insulating Cement: ANSI/ASTM C195; hydraulic setting mineral wool.
- D. Finishing Cement: ASTM C449.
- E. Fibrous Glass Cloth: Untreated; 9 oz/sq yd weight.
- F. Adhesives/Tapes: Compatible with insulation.

- G. Flexible elastomeric foam finish-Armstrong FR/Armaflex finish.

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPING INSULATION

- A. Install insulation, vapor retarder and jacketing per manufacturer's recommendations. Particular attention should be paid to recommendations for joint staggering, adhesive application, external hanger design, expansion/contraction joint design and spacing and vapor retarder integrity.
- B. Insulate all pipe, valves, and specialties except where insulation is specifically indicated to be omitted.
- C. All insulation shall be continuous through wall, floor, and ceiling openings and sleeves.
- D. Install insulation with all joints tightly butted (except expansion joints in hot applications).
- E. Piping insulation and jacketing shall be applied in accordance with MICA (Midwest Insulation Contractors Association) Plate #3 (b) requirements. Insulation at hangers shall be applied in accordance with MICA Plate #6A. Insulation for fittings, valves, flanges, and couplings shall be installed in accordance with MICA Plates 10-18.
- F. The open end of all insulation shall be neatly beveled either by beveling the insulation or by using finish cement.
- G. Prior to application of insulation, heat tracing, or painting; piping and equipment shall have been tested and accepted.
- H. All surfaces to be insulated shall be clean and dry. Special solvents are not required for use in cleaning, but any oil, grease, dirt or foreign material shall be wiped or scraped from the pipe or equipment surface. Insulation shall not be applied on damp or frosty surfaces.
- I. All pipe lines with hangers, saddles, etc., shall be set in their permanent location before insulation is applied. Should it be necessary to block or shore up pipe to install insulation, or should it be necessary to displace or remove hangers, the pipe and hangers shall be restored to their original location and alignment when the insulation is complete. Where pipe hangers are installed in a manner that prevents the specified insulation thickness to be installed, the pipe hangers shall be adjusted or moved and rehung to allow the specified insulation thickness to be applied.
- J. Where insulated piping is supported by hangers clamped directly to the pipe, the insulation shall be carefully fitted around hanger clamp and sealed at openings in jacket.
- K. For all cold service piping:
 - 1. Seal the beginning and end of each run of insulation to the pipe being insulated with vapor barrier mastic to prevent air from entering the space between the pipe and the insulation. This especially applies at connections to air handling units and similar equipment. See details on plans.

2. Install a vapor stop on each side of all valves that are not fully encapsulated by the insulation including all valves where the stem or handle protrudes outside the insulation. The vapor stop shall consist a vapor barrier and mastic to prevent moisture from traveling longitudinally along the insulation in the space between the pipe and the insulation. See details on plans.
 3. Vapor retarder/seal shall be installed in a continuous manner. No staples, rivets, screws or any other attachment device capable of penetrating the vapor retarder/seal shall be used to attach the vapor retarder/seal or jacketing. No wire ties capable of penetrating the vapor retarder/seal shall be used to hold the insulation in place. Banding shall be used to attach PVC or metal jacketing.
 4. Where cold service piping attaches to coils in air handling equipment, vapor seal the end of the insulation and seal insulation to air handling unit casing. Seal in accordance with air handling unit manufacturer's installation instructions or as directed by the Engineer.
 5. At pipe riser supports, where the support is clamped directly to the pipe, insulation shall be installed over the outside of the riser support clamp and shall totally enclose the riser clamp.
- L. Insulate heating and cooling coil headers located outside of units or ductwork or not located above a condensate pan as specified for piping.
- M. Unions, flanges and valves:
1. All unions, flanges, valves and other similar fittings shall be insulated unless otherwise indicated.
 2. Extended Stems: Where insulation is indicated or specified, coordinate with contractor furnishing valves to furnish extended stems arranged to receive insulation. Cold service valves that are insulated with removable covers do not require extended stems.
 3. For all cold service piping:
 - a. Insulate all balance (flow control) valves, flow measuring devices, and stop valves (except valves located in mechanical rooms and valves exterior to the building) with molded, pre-shaped fiberglass insulation inserts and cover with a two piece PVC Fitting Cover. Insulation and fitting cover shall be removable. Secure the two piece PVC fitting cover by taping the ends to the adjacent pipe covering. All seams of cover shall be sealed with vapor barrier pressure sensitive color matched tape.
 - b. Insulate all balance (flow control) valves, flow measuring devices, and stop valves (except valves located in mechanical rooms and valves exterior to the building) with factory fabricated removable/reusable valve covers. Install in accordance with the manufacturers instructions to prevent the condensation. All removable valve covers shall be the same manufacture.
 - c. Insulate all fittings, control valves, manual valves (in mechanical rooms and valves exterior to the building), check valves, unions, instruments, hanger rods and clamps, and flanges with molded, pre-shaped insulation inserts of the same material as the straight pipe insulation, or wrap the fitting, valve, etc. with 1.5-pound density flexible fiberglass insulation to a thickness equal to the adjacent piping insulation, and cover with a one piece PVC Fitting Cover per MICA Plate

17A or 18. Tuck the ends of the insulation snugly into the throat of the fitting and the edge adjacent to the pipe fitting. Secure the one piece PVC fitting cover by taping the ends to the adjacent pipe covering. All seam edges of cover shall be sealed with vapor barrier pressure sensitive color matched tape. The tape shall extend over the adjacent pipe insulation and have an overlap on itself at least 2 inches. Use of polyurethane spray-foam to fill PVC elbow jacket is prohibited on cold applications.

- N. At pipe hangers, furnish and install a sheet metal protection shield and wooden inserts the same thickness as the insulation. Shields and blocks are intended to prevent the crushing of the insulation. Blocks shall be sealed to provide continuity of the vapor barrier.
1. In lieu of the wooden blocks at pipe hangers, this Contractor may, at his option, provide rigid insulation saddle, equal to Fee and Mason Fig. 71, consisting of rigid urethane foam insulation with vapor barrier jacket. Thermal conductivity of 0.13 BTU/HR/FT²/°F/IN @ 75°F. Insulation lengths shall be three (3) times the pipe diameter plus 8" with a minimum length of 20". Insulation thickness shall be the same as the pipe insulation.

3.2 INSTALLATION OF CELLULAR-GLASS INSULATION

A. Insulation Installation on Straight Pipes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
5. Only where Unslit Insulation cannot be installed and longitudinal slit is needed, provide Lap Seal insulation. The longitudinal slit should only be used when insulating existing piping.

B. Insulation Installation on Pipe Flanges:

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

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange cellular glass insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.3 INSTALLATION OF EQUIPMENT INSULATION

- A. Install equipment insulation products in accordance with manufacturer's written instructions, and in compliance with recognized industry practices to ensure that insulation serves intended purpose.
- B. Install insulation materials with smooth and even surfaces and on clean and dry surfaces. Redo poorly fitted joints. Do not use mastic or joint sealer as filler for gapping joints and excessive voids resulting from poor workmanship.
- C. Maintain integrity of vapor-barrier on equipment insulation and protect it to prevent puncture and other damage.
- D. Do not apply insulation to equipment while the equipment surface temperature is above or below ambient air temperature.
- E. Apply insulation using staggered joint method for both single and double layer construction, where feasible. Apply each layer of insulation separately.
- F. Coat insulated surfaces with layer of insulating cement, troweled in workmanlike manner, leaving smooth continuous surface. Fill in scored block, seams, chipped edges and depressions, and cover over wire netting and joints with cement of sufficient thickness to remove surface irregularities.
- G. Cover insulated surfaces with all-service jacketing neatly fitted and firmly secured. Lap seams at least 2". Apply over vapor barrier where applicable.
- H. Provide removable insulation sections to cover parts of equipment which must be opened periodically for maintenance; include metal vessel covers, fasteners, flanges, frames and accessories.
- I. Attachments beyond the insulation line on equipment such as stiffening rings shall be considered an integral part of the equipment and shall be insulated and finished in the same manner as the equipment proper. Thickness of insulation on such attachments and projections shall be the same as the adjoining insulation.
- J. Equipment exposed to Weather: Protect outdoor insulation from weather by installation of mastic or weather-barrier protective finish, or jacketing, as recommended by manufacturer.

3.4 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. Equipment Jacketing: Apply jacketing to the following types of equipment:
 - 1. Condensate Receiver Tanks/ Surge Tanks
 - 2. Steam Coil Casing and Header
 - 3. Expansion Joints
- C. Piping, Exposed or Concealed:
 - 1. None.
 - 2. PVC 30 mils thick.
 - 3. Aluminum, Smooth: 0.024 inch thick.
 - 4. Stainless Steel, Type 304, Smooth 2B Finish 0.016 inch thick.
- D. If more than one material is listed, selection from materials listed is Contractor's option.
- E. Equipment, Exposed, up to 48 inches Diameter or with Flat Surfaces up to 72 inches:
 - 1. None.
 - 2. Aluminum: Corrugated: 0.032 inch thick.
 - 3. Stainless Steel, Type 304, Smooth 2B Finish 0.016 inch thick.
- F. Equipment, Exposed, Larger Than 48 in Diameter or with Flat Surfaces Larger Than 72 Inches:
 - 1. None.
 - 2. Aluminum: Corrugated: 0.040 inch thick.
 - 3. Stainless Steel, Type 304, Smooth 2B Finish: 0.024 inch thick.

3.5 PROTECTION AND REPLACEMENT

- A. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.
- B. Protection: Insulation Installer shall advise Contractor of required protection for insulation work during remainder of construction period, to avoid damage and deterioration.

3.6 INSULATION THICKNESS

- A. The following equipment requires field applied insulation:
 - 1. The following equipment requires field applied insulation:

System	Insulation Type	Thickness
Chilled Water Pumps	2	3/4"
	11	2"
Chiller Heads (unless factory insulated)	2	3/4"

2. The following piping requires field applied insulation:

System		Insulation Type	Thickness
Condensate Drain Lines (Inside Building)		3	1/2"
Chilled Water Piping - (Interior Locations)	1/2" to 3"	1	1-1/2"
	3-1/2" to 16"	1	2"
	1/2" to 16	11	1-1/2"
Chilled Water Piping (Riser Supports - See details on plans)	1/2" to 16	3	1"
		11	2"
Cooling Tower Make Up Piping – (Interior Only)		1	1"

END OF SECTION 230200

SECTION 230700 - HVAC WATER PUMPS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. All drawings and applicable provisions of Division 0 Bidding Requirements and Division 1 General Requirements apply to work of this Section.
- B. Furnish all labor, services, material and related items necessary to complete the pump installation indicated on the drawings and/or specified herein.

1.2 RELATED DOCUMENTS:

- A. Section 230000 - Mechanical General Conditions
- B. Section 230010 - Basic Mechanical Materials and Method
- C. Section 230020 - Vibration Isolation and Seismic Restraints
- D. Section 230050 - Motors
- E. Section 230110 - Hydronic Piping
- F. Section 230930 - Testing and Balancing

1.3 SUBMITTALS:

- A. General: Submit in accordance with Section 230000.
- B. Submit product data including certified performance curves of selected models indicating selected pump's operating point, weights (shipping, installed, and operating), furnished specialties, and accessories. For pumps selected for parallel operation, submit pump curves showing both parallel and single operation.
- C. Submit shop drawings showing layout and connections for HVAC pumps. Include setting drawings with templates, and directions for installation of foundation bolts and other anchorages.
- D. Submit wiring diagrams detailing wiring for power, signal, and control systems, differentiating between manufacturer-installed wiring and field-installed wiring.
- E. Data for inclusion in Operating and Maintenance Manual specified in Section 230000.

1.4 QUALITY ASSURANCE:

- A. Hydraulic Institute Compliance: Design, manufacture, and install HVAC pumps in accordance with "Hydraulic Institute Standards."
- B. National Electrical Code Compliance: Provide components complying with NFPA 70 "National Electrical Code."
- C. UL Compliance: Provide HVAC pumps which are listed and labeled by UL, and comply with UL Standard 778 "Motor Operated Water Pumps."
- D. Single Source Responsibility: Obtain HVAC pumps from a single manufacturer.

- E. Design Criteria: The Drawings indicate sizes, profiles, connections, and dimensional requirements of HVAC pumps, and are based on the specific manufacturer types and models indicated. Pumps having equal performance characteristics by other manufacturers may be considered provided deviations in dimensions and profiles and efficiencies do not change the design concept or intended performance as judged by the Engineer.
- F. Motor Selection: Select motors which cannot overload over the full operating range of the pump.

1.5 DELIVERY, STORAGE, AND HANDLING:

- A. Deliver products to job site.
- B. Store pumps in a dry location.
- C. Retain shipping flange protective covers and protective coatings during storage.
- D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.
- E. Comply with manufacturer's rigging instructions for handling.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL PUMP MANUFACTURERS

- A. Centrifugal pump selections have been based on the manufacturer scheduled. Equivalent products complying with these specifications by the following manufacturers are acceptable:
 - 1. Bell & Gossett
 - 2. Peerless
 - 3. Taco
 - 4. Armstrong
 - 5. Weinman
- B. Variable speed pumping system selections have been based on the manufacturer scheduled. Equivalent products complying with these specifications by the following manufacturers are acceptable:
 - 1. Bell & Gossett
 - 2. SysteCon

2.2 PUMPS, GENERAL:

- A. Pumps: Factory-assembled and factory-tested. Fabricate casings to allow removal and replacement of impellers without necessity of disconnecting piping. Type, sizes, and capacities shall be as indicated. Pumps and motors shall be maximum 1750 RPM unless otherwise indicated.
- B. Preparation for Shipping: After assembly and testing, clean flanges and exposed machined metal surfaces and treat with an anticorrosion compound. Protect flanges, pipe openings, and nozzles.
- C. Motors: Provide motors in accordance with Section 230050 with open drip proof enclosures unless otherwise indicated. Single, multiple, or variable speed type as indicated. Provide

motors with permanently lubricated ball bearings. Select motors that are non-overloading within the full range of the pump performance curve.

- D. Efficiency: Provide pumps that meet or exceed the hydraulic efficiency indicated or that meet or exceed the efficiency of the pump indicated. Pumps selected for parallel pumping applications shall meet the efficiencies indicated for both single or parallel operating points or if not indicated, meet or exceed the efficiencies of the indicated pump.
- E. Apply factory finish paint to assembled, tested units prior to shipping.
- F. Pumps selected for parallel pumping applications shall operate at published operating points on the pump curve for both parallel and single pump operation. Pumps that operate past the end of the published operating curve for single pumps operation are not acceptable.

2.3 BASE-MOUNTED END SUCTION PUMPS:

- A. Type: Horizontal shaft, single stage, direct connected, vertical split casing end suction for 175 psig maximum working pressure.
- B. Casing: Cast iron, with suction and discharge gage ports, renewable bronze casing wear rings, seal flush connection, drain plug, flanged suction and discharge.
- C. Impeller: Bronze, fully enclosed, keyed to shaft.
- D. Bearings: Permanently sealed, grease- lubricated ball bearings.
- E. Shaft: Alloy steel with bronze, or stainless steel shaft sleeve in wetted area.
- F. Seal: Carbon rotating against a stationary ceramic seat, viton fitted for condenser water pumps and buna-N or ethylene propylene filled for chilled water pumps, 225°F maximum continuous operating temperature.
- G. Drive: Flexible coupling with coupling guard.
- H. Baseplate: Cast iron or fabricated steel, fully enclosed base plate with integral drain rim and having adequately sized grout holes.

PART 3 - EXECUTION

3.1 EXAMINATION:

- A. Examine areas, equipment foundations, inertia bases, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of HVAC pumps.
- B. Examine rough-in for piping systems to verify actual locations of piping connections prior to installation.
- C. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION:

- A. General: Comply with the manufacturer's written installation and alignment instructions.
- B. Install pumps in locations and arranged to provide access for periodic maintenance, including removal of motors, impellers, couplings, and accessories. Provide access space around pumps for service. Provide no less than minimum clearance recommended by manufacturer.
- C. Support pumps and piping separately so that the weight of the piping system does not rest on the pump.
- D. Set base-mounted pumps on housekeeping pad. See Section 230010. See Section 230020 for vibration isolation and seismic restraint requirements. Disconnect coupling halves before setting pumps. Do not reconnect couplings until the alignment operations have been completed.
 - 1. Support pump base plate on rectangular metal blocks and shims, or on metal wedges having a small taper, at points near the foundation bolts to provide a gap of $\frac{3}{4}$ to $1\frac{1}{2}$ inches between the pump base and the foundation for grouting.
 - 2. Adjust the metal supports or wedges until the shafts of the pump and driver are level. Check the coupling faces and suction and discharge flanges of the pump to verify that they are level and plumb.
- E. Support in-line pumps on adjustable foot or as indicated.

3.3 ALIGNMENT:

- A. Align pump and motor shafts and piping connections of base mounted pumps after setting on foundations, after grout has been set and foundations bolts have been tightened, and after piping connections have been made.
 - 1. Adjust alignment of pump and motor shafts for angular and parallel alignment by one of the two methods specified in the Hydraulic Institute "Centrifugal Pumps - Instructions for Installation, Operation and Maintenance."
- B. After alignment is correct, tighten the foundation bolts evenly, but not too firmly. Fill the base plate completely with non-shrink, nonmetallic grout, with metal blocks and shims or wedges in place. After grout has cured, fully tighten foundation bolts.
 - 1. Alignment tolerances shall meet manufacturer's recommendations.

3.4 CONNECTIONS:

- A. General: Install valves that are same size as the piping connecting the pump.
- B. Install suction and discharge pipe sizes equal to or greater than the diameter of the pump nozzles. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. For close coupled or base mounted pumps, provide supports under elbows on pump suction and discharge line sizes 4 inches and over.

- C. Install a triple-duty valve or non-slam check valve plus a butterfly valve on the discharge side of pumps. Size triple duty valve so pump flow can be verified by measuring pressure drop across valve.
- D. Install a pump suction diffuser or strainer and ball or butterfly valve on the suction side of pump except where otherwise indicated.
- E. Install flexible connectors on the suction and discharge side of each base-mounted pump where indicated on the drawings. Install flexible connectors between the pump casing and the discharge valves, upstream from the pump suction diffuser, or downstream of the strainer.
- F. Pipe to a single pressure gage from the suction and discharge of each pump at the integral pressure gauge tapings provided.
- G. Electrical wiring and connections are specified in Division 26 sections.
- H. Control wiring and connections are specified in Section 230960.
- I. Check suction lines connections for tightness to avoid drawing air into the pump.

3.5 COMMISSIONING:

- A. Perform the following operations and checks before start-up:
 - 1. Lubricate in accordance with the manufacturer's recommendations.
 - 2. Check motor for proper rotation.
 - 3. Check that pump is free to rotate by hand. If the pump is bound or even drags slightly, do not operate the pump until the cause of the trouble is determined and corrected.
 - 4. Install fine mesh start-up screen ahead of pump; remove after 3 hours operation.
- B. Starting procedure for pumps with shutoff power not exceeding the safe motor power:
 - 1. Prime the pump, opening the suction valve, closing the drains.
 - 2. Open the recirculating line valve if the pump should not be operated against dead shutoff.
 - 3. Start the motor.
 - 4. Open the discharge valve slowly.
 - 5. Check the general mechanical operation of the pump and motor.
 - 6. Close the recirculating line valve once there is sufficient flow through the pump to prevent overheating.
 - 7. If the pump is to be started against a closed check valve with the discharge stop valve open, the steps are the same, except that the discharge stop valve is opened some time before the motor is started.
- C. Refer to Section 230930 "Testing, Adjusting and Balancing" for detailed requirements for testing, adjusting, and balancing hydronic systems.

END OF SECTION 230700

SECTION 230707 – CENTRIFUGAL CHILLERS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Provide completely factory assembled and tested water cooled centrifugal chillers as specified herein.
- B. Each chiller shall be furnished complete with compressor, evaporator, condenser, refrigerant flow control devices, starter, variable frequency drive, and control panels.
- C. Each chiller shall be shipped with a full charge of refrigerant 134A and oil.
- D. Types of chillers specified in this section include the following:
 - 1. Water-cooled centrifugal chillers with VFD's.
- E. Performance
 - 1. The unit selected shall operate at conditions specified in the schedule. The full load operation of the unit shall not exceed the demands indicated on the schedule. Evaporator and condenser shall be rated for cooling a solution of water and/or glycol as indicated with the scale fouling factors indicated.
 - 2. Full load capacity shall meet or exceed the capacity indicated on the attached Schedule.
 - 3. Both full load kw/ton and NPLV criteria shall be met.
 - 4. Select chiller components to allow unloading with stable operation down to 15% of full load capacity with tower water relief down to 65°F.
 - 5. Select chiller components to allow unloading with stable operation down to 20% of full load capacity with constant tower water temperature of 85°F.

1.2 RELATED DOCUMENTS

- A. All applicable provisions of Division 0 Bidding Requirements and Division 1 General Requirements apply to work of this Section.
- B. Section 230000 - Mechanical General Conditions.
- C. Section 230010 - Mechanical Basic Materials and Methods
- D. Section 230020 - Vibration Isolation and Seismic Restraints.
- E. Section 230050 - Motors.
- F. Section 230076 - Variable Frequency Drives for New Chillers
- G. Section 230110 - HVAC Water Systems Piping.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements:

1. ARI Compliance: Test and rate reciprocating chiller in accordance with latest version of ARI Std 550/590, "Standard for Centrifugal or Rotary Water-Chilling Packages."
2. ASHRAE Compliance: Construct and install chiller in accordance with latest version of ASHRAE Std 15, "Safety Code for Mechanical Refrigeration."
3. ASHRAE 90.1-2004 Compliance: Applicable requirements in ASHRAE 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."
4. NEC Compliance: Comply with applicable National Electrical Code (NEC) requirements pertaining to electrical power and control wiring for construction and installation of reciprocating chiller.
5. ANSI Compliance: Comply with ANSI B9.1 safety code requirements pertaining to unit construction of reciprocating chiller.
6. ASME Compliance: Construct and test reciprocating chiller in accordance with ASME Boiler and Pressure Vessel Code, Section 8.
7. Stamp cooler with ASME mark when cooler has been successfully tested in accordance with ASME Code. Pressure test cooler for refrigerant working side pressure of not less than 350 PSIG, and water side pressure of not less than 150 PSIG. Leak test condenser tubes at 150 PSIG and pressure test shell at 450 PSIG.
8. NEMA Compliance: Provide high-efficiency hermetic motors for reciprocating chiller which comply with NEMA Stds Pub/No.'s MG 1, 2, 3, 10, and 11.
9. UL Compliance: Comply with applicable requirements of UL 465, "Central Cooling Air Conditioners," pertaining to construction and installation of reciprocating chiller. Provide reciprocating chiller which are UL-listed and labeled.

B. Performance Requirements:

1. Seismic Performance: Scroll water chillers shall withstand the effects of earthquake motions determined according to SEI/ASCE 7. 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."

1.4 SUBMITTALS

- A. Provide submittals in accordance with Section 230000 - Mechanical General Conditions.
- B. Product Data: Submit manufacturer's technical product data, including rated capacities for chiller indicated, full load kw/ton, Non-Standard Part Load Value (NPLV), weights (shipping, installed, and operating), furnished specialties and accessories; and rigging, installation, and start-up instructions.
- C. Submit octave band sound power level data.
- D. Submit the installed operating weight of each unit and the weight of subassemblies of units that are specified to be shipped in pieces.
- E. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances, methods of assembly of components, and location and size of each field-connection.
- F. Provide templates for anchor bolt placement in concrete pad.

- G. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
- H. Include calibration certification documentation of factory installed temperature control sensors.
- I. Operation and Maintenance: Submit manufacturer's operation and maintenance data under provisions of Section 230000 - Mechanical General Conditions.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver chiller to the job site.
- B. Hoist to the locations indicated on the plans where they shall be installed.
- C. Handle chiller and components properly to prevent damage, breaking, denting and scoring. Do not install damaged chiller or components; replace with new. Comply with manufacturer's rigging and installation instructions for unloading chiller, and transporting them to final location.
- D. Store chiller and components in clean dry space. Protect from weather, dirt, fumes, water, construction debris, and physical damage. Storage temperatures for unit controls are not to exceed 105°F.

1.6 WARRANTY

- A. Provide warranty under provision of Section 230000 - Mechanical General Conditions.
- B. Warranty Includes:
 - 1. Complete chiller including refrigerant and oil charge.
 - 2. Complete compressor and drive assembly including refrigerant and oil charge.
 - 3. Refrigerant and oil charge.
 - 4. Parts and labor.
 - 5. Loss of refrigerant charge for any reason.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL CHILLERS – GENERAL

- A. Acceptable Manufacturers:
 - 1. Subject to compliance with requirements, provide water-cooled reciprocating chiller of one of the following:
 - a. York International
- B. Provide water-chilling hermetic or open type centrifugal chiller of size, rating, capacity, and characteristics scheduled, consisting of centrifugal compressors, compressor motor, evaporator, condenser, controls and panels including gages and indicating lights, auxiliary

components and accessories, and as required for complete chiller installation. Except as otherwise indicated, provide chiller manufacturer's standard chiller materials and components specified by published product information, designed and constructed as recommended by manufacturer. Provide chiller units with indicated functional and construction features.

1. Compressor's internal components shall be accessible without having to remove compressor-drive assembly from chiller.
 2. Design units to permit normal servicing with only minor compressor disassembly and no disassembly of main refrigerant piping.
 3. Provide lifting lugs or eye bolts attached to casing.
- C. Factory Finish: Chiller manufacturer's standard factory finish including metal surface cleaning before coating.
1. Provide alkyd enamel metal finish paint coating on factory fabricated chiller work, including exposed ferrous metal surfaces and factory installed insulation (if any).

2.2 COMPRESSOR ASSEMBLY

- A. Compressor Casing: Construct of fine grain cast iron. Seal casing joints against leakage with gaskets.
- B. Compressor Guide Vanes: Design variable guide vanes to provide stable operation without surge, cavitation, or vibration from full-load to 10% of full-load capacity, without hot-gas bypass.
- C. Shaft and Impeller Assembly: Construct of carbon or forged steel shaft with cast high-strength aluminum alloy impellers, designed and assembled for no critical speeds within operating range, and balanced statically and dynamically. The shaft seal shall be a spring-loaded carbon ring with precision lapped collar cooled by oil during operation. A gravity-fed oil reservoir shall be built into the top of the compressor to provide lubrication during coast down in the event of a power failure.
- D. Compressor Journal and Thrust Bearings: Manufacturer's standard material and design except as otherwise indicated. Provide inspection openings on compressor to facilitate bearing inspection and replacement.
- E. Drive Assembly: One of the following arrangements:
1. Direct Drive: Compressor connected directly to motor shaft, to operate at motor speed and designed for balanced thrust.
 2. Gear Transmission: Integral with compressor and lubricated through compressor lubrication system.
 - a. Gear Assembly: A pair of symmetrical helical gears, of opposite hand; supported by spherically seated, positive lubricated, babbitted, split-sleeve, self-aligning bearings.
 - b. Arrange gears and bearings for visual inspection, through inspection openings, without disassembly or removal of compressor casing or impellers.
 - c. Gear Assembly: Helical gear set supported by aluminum alloy bearings.

- F. Compressor Lubrication System: Forced-circulation type, with positive displacement submerged pump and replaceable oil filter. Automatic oil heater designed to separate refrigerant from oil. Oil heater shall be powered from the unit starter; provide a transformer, contactor, and controls as required for a complete installation. Refrigerant cooled oil cooler if required for proper performance. Positive visual indication of oil level.
 - 1. Performance: Provide positive pressure lubrication of journals, bearings and seals (if any), during start-up, operating and coast-down of chiller, including power interruptions.
- G. Compressor Motor: 2-pole, continuous duty, single-speed, squirrel-cage, induction type.
 - 1. Cool motor by manufacturer's standard system of either water-cooled, air-cooled or refrigerant-cooled design except as otherwise indicated.
 - 2. Factory mounted, aligned, and balanced as part of compressor assembly before shipping.
 - 3. Motor shall be of sufficient capacity to drive compressor throughout entire operating range without overload and with sufficient capacity to start and accelerate compressor without damage.

2.3 HEAT EXCHANGERS

- A. Evaporator: Shell-and-tube type, designed to comply with ASHRAE 15. Design and fabricate in accordance with ASME Boiler and Pressure Vessel Code, Section VIII. Limit tube velocities to range recommended by manufacturer in published literature.
 - 1. Pressure Limiting and Pressure Relief Devices: Manufacturer's standard complying with ASHRAE 15.
 - 2. Design evaporator for circulation of scheduled fluid quantities; for scheduled pressure drops from inlet to outlet including water heads as indicated; to have means of distributing liquid refrigerant uniformly through length of vessel; to have sufficient eliminator area or other means to prevent liquid refrigerant carry-over into compressor; to have minimum tube wall temperature of 32°F (0°C); and to meet fouling factors as indicated. Evaporator shall be sized for percent of glycol in water as indicated.
 - 3. Equip evaporator with suitable refrigerant charging and transfer connections, pressure relief device to prevent excessive pressure in refrigerant side, and means to sense refrigerant pressure or temperature.
 - 4. Tube Sheets: Fabricate of steel, to be self-supporting, of sufficient strength to withstand working pressures, and welded to vessel shells. Include intermediate tube support sheets as required to prevent tube vibration.
 - 5. Heat-Transfer Tubes: Design tubes to be individually removable without affecting strength and durability of tube sheets and without causing leakage at adjacent tubes. Expand ends of tubes in tube sheets and intermediate tube support sheets for tight fit to prevent vibration of tubes. Tube wall thickness shall be minimum 0.028 inches (measured from the root of fins for enhanced tubes.)
 - 6. Water Heads: Manufacturer's standard fabricated steel water heads with integral water connections, designed and fabricated in accordance with ASME Boiler and Pressure Vessel Code, Section VIII.

- a. Attachment: Bolt to tube sheets or vessel assembly.
 - b. Equip water heads with water piping stubouts suitable for welding or with grooved victaulic connections.
7. Insulation: Insulate evaporators and other cold surfaces (except evaporator heads and piping connections shall be insulated in the field by the Contractor) as required to prevent sweating, with ambient humidity of 75% and dry-bulb temperature range of 50°F to 90°F, no air movement. Provide the following type:
 - a. Insulation: Closed cell rubber with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E-84 (NFPA 255) method.
- B. Water-Cooled Condenser: Shell-and-tube type, designed to comply with ASHRAE 15. Design and fabricate in accordance with ASME Boiler and Pressure Vessel Code, Section VIII. Limit tube velocities to range recommended by manufacturer in published literature.
 1. Pressure Limiting and Pressure Relief Devices: Manufacturer's standard complying with ASHRAE 15.
 2. Design condenser for circulation of scheduled fluid quantities, for scheduled pressure drops from inlet to outlet including water heads, as indicated; and to meet fouling factors indicated.
 3. Equip condenser with suitable baffles or distributing plates to evenly distribute refrigerant discharge gas on heat-transfer tubes.
 4. Tube Sheets: Fabricate of steel, to be self-supporting, of sufficient strength to withstand working pressures, and welded to vessel shells. Include intermediate tube support sheets as required to prevent tube vibration.
 5. Heat-Transfer Tubes: Design tubes to be individually removable without affecting strength and durability of tube sheets and without causing leakage at adjacent tubes. Expand ends of tubes in tube sheets and intermediate tube support sheets for tight fit to prevent vibration of tubes. Tube wall thickness shall be minimum 0.028 inches (measured from the root of fins for enhanced tubes.)
 6. Water Heads: Manufacturer's standard fabricated steel water heads, with integral water connections, designed and fabricated in accordance with ASME Boiler and Pressure Vessel Code, Section VIII.
 - a. Attachment: Bolt to tube sheets or vessel assembly.
 - b. Equip water heads with water piping stubouts suitable for welding or with grooved victaulic connections.
- C. Water Boxes:
 1. Cast-iron or carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
 2. Standard type for water box with piping connections. Standard type for water box without piping connections.
 3. Provide water boxes with lifting lugs or eyebolts.
 4. Hinged or davited water boxes.
 5. Hinged or davited marine water-box covers.
 6. Thermistor or RTD temperature sensor factory installed in each nozzle.

7. Fit each water box with 1-inch drain connection at low point and 3/4" vent connection at high point, each with threaded plug.
- D. Refrigerant Flow Control Devices: Provide between evaporator and condensers (and elsewhere as required) to regulate refrigerant flow at volume and pressure required to maintain evaporator liquid refrigerant at level sufficient to keep evaporator heat transfer tubes adequately wetted through full range of chiller operation.
 1. Design to permit chiller operation at scheduled conditions, and to allow condenser-water-entering-temperature to decrease to minimum permissible temperature of 1.0°F (0.5°C) above return chilled water temperature.

2.4 REFRIGERANT

- A. Refrigerant: Provide full operating charge of refrigerant and oil. Unit shall produce specified capacity and efficiency using refrigerant indicated above.
- B. Units shipped fully assembled shall have full refrigerant charge installed at the factory. Units shipped unassembled shall have the refrigerant charge installed in the field under the manufacturer's supervision.
- C. Flow Switches: Provide differential pressure type NEMA 1 flow switches for the chilled water line or include integrally with the unit.
- D. Refrigeration Transfer: Provide service valves and other factory-installed accessories required to facilitate transfer of refrigerant from chiller to a remote refrigerant storage and recycling system. Comply with requirements in ASHRAE 15 and ASHRAE 147.
- E. Refrigerant Isolation for Chillers Using R-134a: Factory install positive shutoff, manual isolation valves in the compressor discharge line to the condenser and the refrigerant liquid line leaving the condenser to allow for isolation and storage of full refrigerant charge in the chiller condenser shell. In addition, provide isolation valve on suction side of compressor from evaporator to allow for isolation and storage of full refrigerant charge in the chiller evaporator shell.

2.5 PURGE SYSTEM

- A. Purge or Pump Out System: Comply with ASHRAE 15. Provide manufacturer's high efficiency design required for refrigerant used in chiller for any chillers with a refrigerant that operates below atmospheric pressure.
 1. The high efficiency purge system shall have automatic controls to allow unattended operation. The controls shall provide options for:
 - a. Continuous operation.
 - b. Operation only when the chiller compressor is running.
 - c. Purge lockout.
- B. The purge system shall automatically lockout and alarm if excessive purging is detected. An operator override of the lockout shall be provided.

- C. The system shall have a low temperature refrigeration system that generates temperatures lower than 10°F at the separation coil. The purge refrigeration system shall have an integral air cooled condensing system and shall not require cooling water. The high efficiency purge system shall be able to operate while the chiller compressor is off.
- D. The system shall have a gravity system for returning liquefied refrigerant to the chiller. Return systems requiring float valves are unacceptable. The purge system shall have a serviceable refrigerant dryer to separate water and acid from the returning liquid. Air shall be extracted from the separation tank using an exhaust compressor and a solenoid isolation valve.
- E. The system shall release to the atmosphere no more than 0.02 pounds of refrigerant per pound of air when operating at standard room conditions and at 100°F chiller condensing temperature and rated according to ARI 580.
- F. The high efficiency purge system shall have a purge duration timer which gives an accurate indication of the amount of air being purged from the chiller and shall have a refrigerant moisture indicator.
- G. Factory wire purge to chiller's main power supply and system complete with controls, piping, and refrigerant valves to isolate the purge system from the chiller.
- H. Construct components of corrosion resistant materials.
- I. Controls shall interface with chiller control panel to indicate modes of operation, set points, data reports, diagnostics, and alarms.

2.6 CONTROLS

- A. Capacity Control: Design to regulate evaporator leaving water temperature by control of compressor guide vanes. Design for capacity modulation, from full-load to scheduled minimum load capacity under normal operating conditions, without overshooting and without hunting at scheduled throttling range.
 - 1. Demand Limit Devices: Provide adjustable control device to decrease compressor-motor power when power demand reaches selected percentage of full-load power demand; adjustable from 40% to 100% continuously or in increments no greater than 20%. Design mechanism to control operation by monitoring motor-amperage and modulating inlet vanes.
 - 2. Chillers with variable frequency controllers shall modulate compressor speed with variable-inlet, guide-vane control to achieve optimum energy efficiency.
- B. Safety Controls: Design cut-outs to operate independently and factory-wire to control panel. Design controls to stop compressor motor in event of low refrigerant pressure or temperature in evaporator, high condenser pressure, high motor-winding temperature, low differential oil pressure, high refrigerant pressure, low water temperature, compressor motor current-draw greater than rated full-load amperes (motor-overload) or power-interruption.
 - 1. Design each cutout to require manual re-starting of compressor.
 - 2. Include anti-recycle timer, factory-wired to control panel, limiting compressor-motor restarts at scheduled time intervals.

- C. Operational Controls: Manufacturer's standard, except as otherwise indicated.
 - 1. Motor Protection: Provide controls to ensure that compressor will start only under unloaded condition.
 - 2. Sequencing: Provide sequencing controls to ensure lubrication of compressor motor bearings and seals (if any). Sequence as follows: 1) Run lubrication system oil so that compressor motor bearing is lubricated before start-up; 2) Start compressor motor; 3) Provide lubrication during coast-down after compressor motor shut-down.
 - 3. Provide electronic, microprocessor based controls with 30 day battery back-up.
 - 4. Reset: Design controls to automatically restart compressor after power-failure interruptions, provided minimum time between starts has been complied with.
- D. Control Panel: Manufacturer's standard design, except as otherwise indicated, complying with the National Electrical Code (NEC).
 - 1. Design panel for electrical operation in accordance with chiller manufacturer's written instructions.
 - 2. Control Wiring:
 - a. For units with unit mounted starters and unit mounted VFD's, provide all control wiring from the control transformer in compressor motor starter to all components (except field installed interlocks with condenser and chilled water pumps and flow switches).
 - b. For units with field installed starters, provide all control wiring from transformer mounted in the starter to all components in the starter and from all components located in the control panel mounted at the unit to components mounted within the panel or on the unit. Provide clearly labeled terminal strips in the control panel and the starter for all field installed connections.
 - c. Control power transformer with sufficient power for all controlled devices shall be provided with starter or VFD.
 - d. Provide switches and pushbuttons designed to permit indicated operations including the following:
 - 1) Manual and automatic operation of oil pump.
 - 2) Manual and automatic operation of oil separator heater.
 - 3. User Interface: Provide control panel with keypad input and minimum 40 character alphanumeric display. Display shall indicate the following operating parameters and be able to indicate the following safety cutouts:
 - a. Operating Parameters
 - 1) Date and time.
 - 2) Operating or alarm status.
 - 3) Fault history with not less than last 10 faults displayed.
 - 4) Set points of controllable parameters.
 - 5) Trend data.
 - 6) Operating hours.
 - 7) Number of chiller starts.

- 8) Outdoor-air temperature or space temperature if required for chilled-water reset.
 - 9) Entering- and leaving-fluid temperatures of evaporator and condenser.
 - 10) Difference in fluid temperatures of evaporator and condenser.
 - 11) Fluid flow of evaporator and condenser.
 - 12) Fluid pressure drop of evaporator and condenser.
 - 13) Refrigerant pressures in evaporator and condenser.
 - 14) Refrigerant saturation temperature in evaporator and condenser shell.
 - 15) Compressor refrigerant suction and discharge temperature.
 - 16) Compressor bearing temperature.
 - 17) Motor bearing temperature.
 - 18) Motor winding temperature.
 - 19) Oil temperature.
 - 20) Oil discharge pressure.
 - 21) Phase current.
 - 22) Percent of motor rated load amperage.
 - 23) Phase voltage.
 - 24) Demand power (kilowatts).
 - 25) Energy use (kilowatt-hours).
 - 26) Power factor.
 - 27) Purge suction temperature if purge system is provided.
 - 28) Purge elapsed time if purge system is provided.
 - 29) For chillers equipped with variable frequency controllers, include the following (See additional requirements in Section 230076, Variable Frequency Drives for New Chillers, for units with VFD's.):
 - a) Output voltage and frequency.
 - b) Voltage total harmonic distortion for each phase.
 - c) Supply current total demand distortion for each phase.
 - d) Inlet vane position.
 - e) Controller internal ambient temperature.
 - f) Heatsink temperature.
- b. Control Functions:
- 1) Manual or automatic startup and shutdown time schedule.
 - 2) Entering and leaving chilled-water temperatures, control set points, and motor load limits.
 - 3) Current limit and demand limit.
 - 4) Condenser fluid temperature.
 - 5) External chiller emergency stop.
 - 6) Variable evaporator flow.
- c. Manually Reset Safety Controls: The following conditions shall shut down chiller and require manual reset:
- 1) Low evaporator pressure or temperature; high condenser pressure.
 - 2) Low evaporator fluid temperature.
 - 3) Low oil differential pressure.

- 4) High or low oil pressure.
 - 5) High oil temperature.
 - 6) High compressor-discharge temperature.
 - 7) Loss of condenser-fluid flow.
 - 8) Loss of evaporator fluid flow.
 - 9) Motor over current.
 - 10) Motor over voltage.
 - 11) Motor under voltage.
 - 12) Motor phase reversal.
 - 13) Motor phase failure.
 - 14) Sensor- or detection-circuit fault.
 - 15) Processor communication loss.
 - 16) Motor controller fault.
 - 17) Extended compressor surge.
 - 18) Excessive air-leakage detection for chillers using R-123 refrigerant.
- d. Trending: Capability to trend analog data of up to five parameters simultaneously over an adjustable period and frequency of polling.
 - e. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: view only; view and operate; and view, operate, and service.
 - f. Control Authority: At least four conditions: Off, local manual control at chiller, local automatic control at chiller, and automatic control through a remote source.
 - g. Communication Port: RS-232 port, USB 2.0 port, or equivalent connection capable of connecting a printer and/or a notebook computer.
4. Building Automation System Interface: Factory-installed hardware and software to enable building automation system to monitor, control, and display water chiller status and alarms.
 - a. Hardwired Points:
 - 1) Monitoring: On/off status, common trouble alarm electrical power demand (kilowatts) electrical power consumption (kilowatt hours).
 - 2) Control: On/off operation, chilled-water discharge temperature set-point adjustment] [electrical power demand limit.
 - b. A MSTP BACnet communication interface with building automation system shall enable building automation system operator to remotely control and monitor the water chiller from an operator workstation. Control features and monitoring points displayed locally at water chiller control panel shall be available through building automation system.
 - c. The communications protocol provided by the MSTP BACnet card shall conform to the standards defined by ASHRAE/ANSI SPC 135. At a minimum the MSTP BACnet card shall support Read/Write services of Analog and Binary objects of the BACnet standard. Physical transfer of data shall be via RS-232 communications as defined in the open standard, BACnet. Describe in proposal the points of information that will be available for monitoring and control on the chiller.

2.7 ELECTRICAL

- A. Factory installed and wired, and functionally tested at factory before shipment.
- B. Single-point, field-power connection to the motor starter or VFD.
 - 1. Branch power circuit to each motor, electric heater, dedicated electrical load, and controls with disconnect switch or circuit breaker.
 - a. NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.
 - b. NEMA AB 1, circuit breaker with field-adjustable, short-circuit-trip set point.
 - 2. NEMA ICS 2-rated motor controller for auxiliary motors, hand-off-auto switch, and over current protection for each motor. Provide variable frequency controller for each variable-speed motor furnished.
 - 3. Control-circuit transformer with primary and secondary side fuses.
 - 4. Minimum withstand rating shall be as required by electrical power distribution system, but not less than 42,000.
- C. Terminal blocks with numbered and color-coded wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.

2.8 VARIABLE FREQUENCY DRIVES

- A. Variable Frequency Drives shall be in accordance with Section 230076, Variable Frequency Drives for New Chillers.

2.9 ACCESSORIES

- A. Flow Switches:
 - 1. Chiller manufacturer shall furnish a switch for each evaporator and condenser and verify field-mounting location before installation.
 - 2. Paddle Flow Switches:
 - a. Vane operated to actuate a double-pole, double-throw switch with one pole field wired to the chiller control panel [and the other pole field wired to the BAS].
 - b. Contacts: Platinum alloy, silver alloy, or gold-plated switch contacts with a rating of 10 A at 120-V ac.
 - c. Pressure rating equal to pressure rating of heat exchanger.
 - d. Construct body and wetted parts of Type 316 stainless steel.
 - e. House switch in a NEMA 250, Type 4 enclosure constructed of die-cast aluminum.
 - f. Vane length to suit installation.
 - 3. Pressure Differential Switches:
 - a. Construction: Wetted parts of body and trim constructed of Type 316 stainless steel.

- b. Performance: Switch shall withstand, without damage, the full-pressure rating of the heat exchanger applied to either port and exhibit zero set-point shift due to variation in working pressure.
- c. Set Point: Screw type, field adjustable.
- d. Electrical Connections: Internally mounted screw-type terminal blocks.
- e. Switch Enclosure: NEMA 250, Type 4.
- f. Switch Action: Double-pole, double-throw switch with one pole field wired to the chiller control panel and the other pole field wired to the BAS.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Contractor shall examine the area and conditions under which chillers are to be installed and shall notify Engineer, General Contractor, and Owner in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been.
- B. Carefully inspect the positioning of the chillers to orient them as shown on the drawings; final positioning of the chillers is the responsibility of this contractor. If discrepancies exist between the drawings and the equipment delivered to the job site, report these discrepancies immediately to the Engineer and General Contractor. Also report any visual damage. Do not install such items prior to resolving said discrepancies with the Engineer.

3.2 INSTALLATION OF CHILLERS

- A. Install chillers in accordance with manufacturer's written instructions. Install units plumb and level, firmly anchored in locations indicated; maintain manufacturer's recommended clearances. Position units as indicated on the plans.
- B. Install chiller on concrete bases using isolators indicated on Schedule. Comply with requirements for concrete bases specified in Section 230010, Basic Mechanical Materials and Methods or Division 03 "Cast-in-Place Concrete." Comply with requirements for vibration isolation devices specified in Section 230020 "Vibration and Seismic Controls for HVAC Piping and Equipment."
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
- C. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements. Do not proceed with equipment start-up until wiring installation is acceptable to manufacturer and equipment installer.

- D. Install flow switches provided by manufacturer in accordance with manufacturer's recommendations.
- E. Furnish field-installed automatic temperature control requirements to Temperature Control Contractor. Field-installed automatic temperature controls are to be installed by the Temperature Control Contractor.
- F. Paint damaged and abraded factory finish with touch up paint matching factory finish.
- G. Start-up chillers, in accordance with manufacturer's start-up instructions, and in presence of manufacturer's technical representative. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment and retest.
 - 1. Do not place chillers in sustained operation prior to initial balancing of mechanical systems interfacing with the chillers.
 - 2. Furnish sufficient refrigerant and dry nitrogen for pressure testing under manufacturer's supervision. Provide any refrigerant needed to replace losses during installation.

3.3 CENTRIFUGAL CHILLER INSTALLATION, TESTING, AND START-UP

- A. Manufacturer's Supervision: Chiller manufacturer shall supervise field assembly (if any) and installation of chiller work, with factory-trained technical service representative. Prepare manufacturer's written report of installation, signed by representative.
 - 1. Include leak testing, evacuation, dehydration, vacuum pumping, and charging in scope of supervision by manufacturer's representative.
 - 2. Include lubrication, filling of reservoirs, and confirming that lubricant is of quantity and type recommended by manufacturer in scope of supervision by manufacturer's representative.
- B. Include start-up service for VFD's for chillers supplied with a VFD. Service shall include inspection, final adjustment, operational checks, and a final report for record purpose.
- C. Manufacturer's representative shall start-up centrifugal chiller in accordance with manufacturer's start-up instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
 - 1. Do not place chillers in sustained operation prior to initial balancing of mechanical systems that interface with centrifugal chillers.
- D. Training of Owner's Personnel: Provide service of manufacturer's representative for one 8 hour day to instruct Owner's personnel in operation and maintenance of the chiller.
- E. Additional requirements apply for Supervision, Start-up and Training for units with VFD's. See Section 230076, Variable Frequency Drives for New Chillers.

3.4 OPERATION OF HVAC EQUIPMENT WATER TREATMENT SYSTEMS

- A. HVAC equipment shall not be operated for any extended period of time prior to the water treatment systems for this equipment being fully operational. Chillers and cooling towers shall

not be operated with manual chemical feeds for the condenser water without written approval from the Engineer.

- B. Contractor shall be liable for any damage to HVAC equipment caused by operation prior to the water treatment systems being fully operational.

END OF SECTION 230707

SECTION 230715 – COOLING TOWER AND SUMP

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Furnish and install Induced or Forced Draft Cooling Tower as herein specified.
- B. Types of cooling towers specified in this section include the following:
 - 1. Induced or forced draft counter flow cooling towers.

1.2 SUBMITTALS

- A. Submit under provisions of Section 230000, Mechanical General Conditions.
- B. Submit shop drawings indicating suggested structural steel supports including dimensions, sizes, and locations for mounting bolt holes.
- C. Submit product data indicating rated capacities, dimensions, weights and point loadings, accessories, required clearances, electrical requirements and wiring diagrams, and location and size of field connections. Submit schematic indicating capacity controls.
- D. Certify performance, based on CTI STD-201 and submit performance curve plotting leaving water temperature against wet bulb temperature, for installation configuration indicated.
- E. Submit manufacturer's installation instructions.
- F. Submit sound ratings based on sound pressure levels in D.B. (RE 0.0002 microar) for a free and unobstructed environment, when measured five feet from the sound source, octave bands 63 through 2000 at cased face, louvered face and fan discharge.
- G. Submit flame spread and fuel contributed values in accordance with ASTM E136 for all combustible materials used in the construction of these specified cooling towers.

1.3 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Section 230000, Mechanical General Conditions.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver cooling tower to the job site, F.O.B. factory with freight allowed.
- B. Handle units carefully to prevent damage.
- C. Factory assemble entire unit. For shipping, disassemble into as large as practical sub-assemblies so that minimum amount of field work is required for re-assembly. Indicate, with submittals, number of sub-assemblies to be shipped.

1.5 WARRANTY

- A. Provide one year warranty under provisions of "General Conditions."

1.6 RELATED DOCUMENTS

- A. All drawings and applicable provisions of Division 0 Bidding Requirements and Division 1 General Requirements apply to work of this Section.
- B. Section 230000 - Mechanical General Conditions.
- C. Section 230010 - Mechanical Basic Materials and Methods.
- D. Section 230020 - Vibration Isolation and Seismic Restraints.
- E. Section 230050 - Motors.
- F. Section 230110 - HVAC Water Systems Piping.
- G. Section 230920 - Chemical Treatment.
- H. Section 230930 - Balancing.
- I. Section 230960 - Temperature Controls.

1.7 REFERENCES

- A. ANSI/AFBMA 9 - Load Rating and Fatigue Life for Ball Bearings.
- B. ANSI/AFBMA 11 - Load Rating and Fatigue Life for Roller Bearings.
- C. ASME PTC-23 - Atmospheric Water-Cooling Equipment.
- D. Cooling Tower Institute (CTI) ATC-105 - Acceptance Test Code for Water Cooling Towers.
- E. Cooling Tower Institute (CTI) - Certification Standard STD-201.
- F. ASTM - E-84 - Test Method for Surface Burning Characteristics of Building Materials.
- G. NFPA - 255 Standard Method Test of Surface Burning Characteristics of Building Materials.
- H. NEMA - 250 Enclosures for Electrical Equipment (1000 Volts Maximum).
- I. ASTM E136 - Standard Method of Test for Non-Combustibility of Elementary Materials.

1.8 REGULATORY REQUIREMENTS

- A. NFPA-214 Water Cooling Tower Standards.
- B. O.S.H.A.
- C. National Electrical Code.
- D. Underwriters Laboratory or Engineering Testing Laboratory Listing.
- E. Owners Insurance Co., I.R.I.

PART 2 - PRODUCTS

- 2.1 Manufacturers: Subject to compliance with requirements, provide induced or forced draft cooling tower of one of the following:
- A. Baltimore Air Coil
 - B. Evapco
 - C. Marley Cooling Tower Company
- 2.2 MANUFACTURED UNITS
- A. Provide units, factory assembled, counter- flow, vertical discharge, forced draft type, with integral sump, surface sections, drift eliminators, and motor.
 - B. Provide piping connections as indicated on the drawings.
- 2.3 COMPONENTS
- A. Framework and Casing: Stainless steel or pultruded fiberglass/polyester resin framework with casing of stainless steel or glass reinforced polyester with vertical corrugations and lapped joints and corner rolls. Polyester resin shall be protected with ultraviolet radiation inhibitors.
 - B. Louvers: Corrugated glass reinforced polyester or polyvinyl chloride (PVC), sight tight spaced to minimize air resistance and prevent splash out.
 - C. Fan: Multi blade, cast aluminum fixed pitch, axial type with geared, right angle drive and drive shaft equipped with non- lubricated flexible couplings or one piece, multi-grooved neoprene/ polyester belt drive with corrosion resistant sheaves, bearings with ANSI/AFBMA 9 or ANSI/AFBMA 11 L- 10 life expectancy of 40,000 hours, with grease fittings extended to the exterior of the casing.
 - D. Motor:
 - 1. Variable speed.
 - 2. If located in air stream: totally enclosed air over (TEAO) type or totally enclosed fan cooled (TEFC) with special moisture protection.
 - 3. If not located in air stream: totally enclosed fan cooled (TEFC) type, mounted on welded steel frame.
 - 4. Motors shall be PREMIUM EFFICIENCY motors as specified in Section 230050. Electrical characteristics shall be as indicated on the schedule on the plans.
 - E. Drive shall be one of the following:
 - 1. Belt Drive: Belt drive system designed for minimum 150 percent motor nameplate horsepower.
 - 2. Gear Drive: Right angle, industrial duty, oil lubricated, geared speed reducer, equipped with oil level sight glass.
 - 3. Direct Drive: Fan blade mounted directly on motor shaft.
 - F. Fan Cylinder: One piece, welded steel, galvanized or pultruded fiberglass/polyester resin fan assembly.

- G. Fan Guard: One piece, removable, welded steel rod and wire guard, galvanized after fabrication.
- H. Access Doors: Large hinged access door at end of tower for access to eliminators and air plenum. Doors shall be operable from both exterior and interior.
- I. Maintenance Access:
 - 1. General: Maintenance platforms, ladders and supports shall be galvanized steel. Platforms shall be structural grating, rated for minimum 300# live load, and be removable where required for maintenance of other components of the tower. OSHA approved safety railings shall surround open perimeter of platform. Provide ladder from platform to adjacent roof. Ladders shall be 18" wide and minimum 1/4" x 2" bar rails with 5/8" diameter rod rungs welded to side rails with separate hand rails and safety cages in accordance with OSHA requirements.
 - 2. Counter Flow Towers: Provide maintenance platform along entire width of tower to provide access to all access doors to fans and external fan motors (both sides of tower where required).
- J. Hot Water Distribution System:
 - 1. Counter Flow Towers: Provide PVC distribution piping and replaceable PVC spray nozzles with non-clog orifices.
- K. Hot Water Piping: Contractor's option shall be to provide for a single point, side inlet hot water piping connection with an internal balance chamber with internal strainer and PVC distribution piping to hot wells or external piping to multiple hot water connections with cast iron flow control balance valves with stainless steel stems and locking handles.
- L. Fill: Vertical sheets of polyvinyl chloride plastic (minimum 15 mils thick) hung from galvanized steel supports. Fill shall be suitable for 125F entering water.
- M. Drift Eliminators: Two or three pass polyvinyl chloride plastic to limit drift loss to 0.005 percent of total water circulated.
- N. Collection Basin: Minimum 16 gauge stainless steel or glass reinforced polyester (GRP) with depressed center section, designed to support tower, with cleanout and drain fitting. Minimum 8 gauge steel or minimum 1/4" GRP side outlet sump with ¼ inch mesh stainless steel strainer, and minimum 3" overflow. For multiple cell towers; provide flume between adjacent cell basins to equalize basin operating water level and to provide a flow passage from cells without an outlet connection.
- O. Float Valves: Brass or bronze make-up valve with plastic or copper float.
- P. Hardware: Nuts, bolts, and washers shall be galvanized steel.
- Q. Finish:
 - 1. Steel components shall be stainless steel.
 - 2. All plastic components shall have ultra-violet protection.
 - 3. All components of the tower shall have a flame spread of 5 or less.

- R. Outlet Piping: Provide single outlet connection. Connections 2" NPS and less shall have threaded connections; connections over 2" NPS shall be suitable for welding or have mechanical groove for victaulic piping connection.
- S. Overflow and Drain: Provide removable standpipe for overflow/drain with bottom connection or separate side outlet connections for overflow and drain.
- T. Vibration Cut-Out Switch: Provide switch to de-energize fan motors upon excessive vibration.
- U. Overall Height: The maximum overall height of the cooling tower shall not exceed 6' 7".

2.4 INDOOR SUMP

- A. Provide indoor sump as scheduled on the drawings. Indoor sump shall comply with the following:
 - 1. Galvanized steel tank with corrosion protection system equivalent to BAC Baltibond.
 - 2. Tank shall be fully enclosed including a top.
 - 3. High and low float level controls and make-up water assembly.
 - 4. Strainer and anti-vortexing baffle.
 - 5. Drain and overflow connections.
 - 6. Sized to hold all cooling tower water.
 - 7. Supports.

2.5 ACCESSORIES

- A. Electric Immersion Heaters: In collection basin; suitable to maintain temperature of water in basin of at least 42°F when outside temperature is 0°F and wind velocity is 15 mph; immersion thermostat to operate heaters and low water cut out to prevent heater operation when basin is drained. Capacity shall be minimum as indicated on the plans. Components shall be in a weatherproof enclosure.

PART 3 - EXECUTION

- 3.1 Examine areas and conditions under which cooling towers are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.
- 3.2 Install cooling towers where indicated, in accordance with equipment manufacturer's written instructions and with recognized industry practices, to ensure that cooling towers comply with requirements and serve intended purposes.
- 3.3 Provide access and service space around and over cooling towers as indicated on drawings, but in no case less than that recommended by manufacturer.
- 3.4 Install roof-mounted units on structural steel mechanical equipment stand. Anchor cooling tower to stand with bolts or other removable fasteners. Construct mechanical equipment stand as indicated, and in accordance with NRCA Handbook and Accepted Roofing Knowledge, Detail "N".

- 3.5 Mount unit on vibration isolators in accordance with Section 230020. Level units to tolerance of 1/8 inch in 10 feet - 0 inch, in both directions.
- 3.6 Install gaskets or sealants between cooling tower cells.
- 3.7 Condenser Water Piping: Refer to Section 230110. Provide flanged, union or victaulic connections to cooling tower, with flexible pipe connections for towers mounted on vibration isolators. Pitch lines so water will drain into sump. Connect inlets to cooling tower with shutoff valve, and balancing valves (if 2 or more inlets). Connect outlets with shutoff valves.
- 3.8 Provide flanged, union or victaulic connections to sump tank. Connect to automatic fill valve with 3-valve bypass, and backflow preventer. (Backflow preventer shall be provided under Plumbing Section).
- 3.9 Connect drain, overflow, and bleed lines to cooling tower and sump tank as indicated, full size of connection on cooling tower.
- 3.10 Permanently remove the plug in the "balance clean chamber" in the internal tower piping provided by the manufacturer and install a reducer to a 4" long 3/8" pipe to allow all the piping to drain when the tower is off. This will allow a continuous flow of less than 4 gpm which has been accounted for in the design.
- 3.11 Install electrical devices furnished by manufacturer, but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Temperature Controls Contractor.
- 3.12 Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 16 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.
- 3.13 Clean inside of cooling tower thoroughly before filling for start-up. Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.
- 3.14 Comply with manufacturer's instructions for filling and start-up of operation, but not less than the following:
 - A. Verify lubrication of rotating parts; lubricate as needed.
 - B. Verify fan rotation direction.
 - C. Verify that motor amperage is in accordance with manufacturer's data.
 - D. Balance condenser water flow to tower and to each inlet for multiple inlet towers.
 - E. Adjust water level control for proper operating level.
 - F. Adjust bleed valve for indicated percentage of circulated water volume.
 - G. Adjust temperature controls and verify operation.
 - H. Coordinate with manufacturer to insure steps are taken to avoid operating at or near the fan's "critical speed".

3.15 SUMP TANK INSTALLATION SHALL COMPLY WITH THE FOLLOWING:

- A. Install high and low float level controls and make-up water assembly.
- B. Install strainer.
- C. Install drain and overflow connections.
- D. Connect condenser water piping.

3.16 OPERATION OF HVAC EQUIPMENT WATER TREATMENT SYSTEMS

- A. HVAC equipment shall not be operated for any extended period of time prior to the water treatment systems for this equipment being fully operational. Chillers and cooling towers shall not be operated with manual chemical feeds for the condenser water without written approval from the Engineer.
- B. Contractor shall be liable for any damage to HVAC equipment caused by operation prior to the water treatment systems being fully operational.

END OF SECTION 230715

SECTION 230910 – START-UP, CLEANING AND TESTING

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Furnish all labor, services, materials and related items necessary to complete the start-up, cleaning and testing work indicated on the drawings and/or specified herein. Work to be performed shall include, but not be limited to, the following items:
 - 1. Chilled Water System
 - 2. Condenser Water System
 - 3. Refrigerant Relief Piping
 - 4. Condensate Drains
 - 5. Make-up Water

1.2 RELATED DOCUMENTS

- A. All drawings and applicable provisions of Division 0 Bidding Requirements and Division 1 General Requirements apply to work of this Section.
- B. Section 230000 - General Mechanical Conditions.

PART 2 - PRODUCTS

2.1 PIPE CLEANING CHEMICALS

- A. Vulcan Precleaner or approved equal by Nalco or Calgon.

PART 3 - EXECUTION

3.1 START-UP OF SYSTEMS AND EQUIPMENT

- A. Before any systems, or parts of systems are placed into unattended operation, they shall be completely installed, pressure tested, cleaned, flushed and balanced with all operating and safety controllers installed, calibrated and operational.
- B. When started, all motors shall be checked for proper rotation, speed, and amperage. If overloading is indicated, immediate corrective measures shall be taken to prevent damage to the motor.
- C. Before systems are operated, all bearings shall be lubricated and all other liquid levels and pressures checked and if necessary corrected.
- D. Contractor shall start-up all systems and equipment and place all systems into operation. Any equipment, pieces of equipment, controls, etc., damaged or not operating properly shall be replaced at this contractor's expense.
- E. Contractor shall verify proper and safe operation of all equipment, components, controls and control circuits before any system is left unattended.

- F. Whenever air systems are operated, air filters shall be in place. Air systems shall not be operated at any time without filters.

3.2 PIPE SYSTEMS TESTING

- A. Except for those pipes hereinafter listed, all piping installed by this Contractor shall be pressure tested. (See Plumbing Section for testing of plumbing piping.)
- B. Perform the following tests on hydronic piping:
1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
 2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
 3. Isolate expansion tanks and determine that hydronic system is full of water.
 4. Subject piping system to hydrostatic test pressure as indicated below and that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
 5. Prepare written report of testing.
- C. Any item which might be damaged by the pressure test shall be removed from the system during the test, or isolated from the test.
- D. Gauges used for testing shall be tested for accuracy, and then installed as close as possible to the low point of the system to be checked.
- E. For hydronic piping, test pressure shall be maintained for 24 hours. Initial and final test pressures and ambient temperatures shall be recorded. Test pressure and ambient temperature shall also be recorded on 2 hour intervals during the daytime work shift. All tests shall be witnessed and signed by the Owner's Representative. When test is complete, recorded data shall be submitted to this Engineer. Any tests which are not witnessed shall be considered void and pipes shall be retested.
- F. No leakage is permitted. Leaks shall be repaired and the lines retested.
- G. Any lines changed after testing shall be retested.
- H. Test data shall be recorded on a standard form.
- I. While piping is under test, care shall be taken that excessive pressure does not occur due to increase of ambient temperature.
- J. Test Pressure and Medium:

LINE SERVICE	MEDIUM	TEST PRESSURE PSIG
Chilled Water	Water	125
Condenser Water	Water	125

Refrigerant Relief Piping Dry Nitrogen 200

3.3 CLEANING

- A. Adequate precautions shall be taken during storage and installation to keep the inside of all pipes, valves and fittings free from foreign materials.
- B. The inside of all pipes, valves, and fittings shall be smooth, clean, free from blister, loose mill scale, sand, dirt and other foreign material.
- C. This Contractor shall clean all piping installed by him.
- D. Closed, recirculating water systems (chilled water, heating hot water, etc.) shall be filled with clean water and flushed. The systems shall then be refilled with clean water to which 5 lbs. of Vulcan pre-cleaner, or approved equal, per 100 gallons of water has been added. System shall be allowed to recirculate for 8 hours and then drained and flushed with clean water. Any components which might be damaged by the cleaner shall be isolated or removed from the system. Vulcan Laboratories, or other approved cleaner manufacturer, shall supervise the cleaning and shall submit to the Owner a certificate of completion of cleaning. After cleaning, all strainers shall be cleaned. Systems which connect to existing systems shall have temporary bypasses or temporary pumping installed, whichever is applicable to allow cleaning of the system as described above before it is connected to the existing system.

3.4 TURN OVER TO OWNER

- A. Perform the following before operating the system:
 - 1. Open manual valves fully.
 - 2. Inspect pumps for proper rotation.
 - 3. Set makeup pressure-reducing valves for required system pressure.
 - 4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
 - 5. Set temperature controls so all coils are calling for full flow.
 - 6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
- B. When the system is turned over to the Owner, all systems shall have been started, tested, balanced and checked and proven to be fully operational in every respect.
- C. When the system is turned over to the Owner, all bearings shall have been recently lubricated, oil levels checked and oil added if necessary, liquid levels and pressures checked and corrected, flow rates checked and corrected, R.P.M.'s verified, belts tightened and aligned, and all controls and control sequences checked, verified operational and if necessary, corrected.
- D. When the system is turned over to the Owner, all air filters shall be replaced with clean filters.

END OF SECTION 230910

SECTION 230920 – WATER TREATMENT SYSTEMS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Contractor shall provide water treatment chemicals and chemical feed equipment for the following systems:
 - 1. Treatment for closed, recirculating systems including:
 - a. Chilled Water
 - 2. Treatment for open systems including:
 - a. Cooling Tower Water
- B. This specification provides for a preassembled condenser water treatment system with remotely mounted feed pumps. Contractor shall have the option to provide field installed components, but shall include any additional costs including control wiring in the bid.
- C. Treatment systems shall be as shown on the drawings and as described below.
- D. Mechanical Contractor shall engage a Water Treatment Subcontractor to provide a complete program to prevent scale, corrosion, and organic growth. The water treatment subcontractor shall have a laboratory equipped to analyze samples in accordance with the American Public Health Association and the American Society for Testing Material requirements.
- E. All chemicals used shall be in compliance with all applicable codes and regulations.

1.2 SUBMITTALS

- A. Submit shop drawings in accordance with Section 230000.
- B. Submit shop drawings indicating system schematics, equipment locations, and controls schematics.
- C. Submit product data indicating chemical treatment materials, chemicals, materials safety data sheets, equipment, and make up water conditions from the local water purveyor.
- D. Submit reports indicating start-up of treatment systems is completed and operating properly.
- E. Submit reports indicating analysis of system water after cleaning and after treatment.
- F. Submit product data on water meter.
- G. Submit operation and maintenance data. Include data on chemical feed pumps, agitators, and other equipment including spare parts lists, procedures, and treatment programs.
- H. Submit step by step instructions on test procedures including target concentrations.

- 1.3 QUALIFICATIONS: Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum three years documented experience. Company shall have local representatives with water analysis laboratories and full time service personnel.
- 1.4 REGULATORY REQUIREMENTS: Conform to applicable code for addition of non-potable chemicals to building mechanical systems, and for delivery to public sewage systems.
- 1.5 MAINTENANCE SERVICE
 - A. Furnish service and maintenance of treatment systems for one year from Date of Substantial Completion.
 - B. Provide laboratory and technical assistance services for warranty period.
 - C. Include two hour training course for operating personnel, instructing them on installation, care, maintenance, testing, and operation of water treatment systems. Arrange course at start-up of system.
 - D. Provide on-site inspections of equipment during scheduled or emergency shutdown to properly evaluate success of water treatment program, and make recommendations in writing based upon these inspections.
- 1.6 MAINTENANCE MATERIALS: Provide sufficient chemicals for treatment and testing during warranty period.
- 1.7 RELATED DOCUMENTS:
 - A. All drawings and applicable provisions of Division 0 Bidding Requirements and Division 1 General Requirements apply to work of this Section.
 - B. Section 230000 - General Mechanical Conditions.
 - C. Section 230110 - HVAC Water Systems Piping.

PART 2 - PRODUCTS

- 2.1 MANUFACTURERS
 - A. Subject to compliance with requirements, provide water treatment systems of one of the following:
 - 1. Nalco
 - 2. American Water Conditioning
 - 3. Calgon Corp
 - 4. Chem Aqua
 - 5. Culligan Intl.
 - 6. Dearborn
 - 7. Diversey
 - 8. Drew Chemical Corp.
 - 9. San Jaquin Chemical
- 2.2 SYSTEM CLEANER

- A. Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products; sodium tripoly phosphate and sodium molybdate.
- B. Algaecide; chlorine release agents such as sodium hypochlorite or calcium hypochlorite, or microbiocides such as quarternary ammonia compounds, tributyl tin oxide, methylene bis (thiocyanate), or isothiazolones.

2.3 CHEMICAL FEEDING AND CONTROL EQUIPMENT - OPEN WATER SYSTEMS

- A. Contractor shall provide the following apparatus (including all external piping):
- B. One (1) Nalco Towerpac model or approved equal for controlling conductivity and chemical treatment in cooling water systems. All components shall be powered with 115 VAC. Component sizes and capacities shall be as shown on the drawings and as indicated herein. The system shall have the following features and capabilities:
 - 1. Conductivity Monitor: Shall provide linear, temperature compensated measurements directly in microhms over full scale. Provide two ranges of measurement, 50-1,000 microhms and 500-10,000 microhms, which shall be field selectable. Conductivity measurement shall be displayed on a 2 inch indicating meter with 0-10 scale. Power switch, set point adjustment, test button, calibration screw, indicating lights and indicating meter shall all be front panel mounted for easy access. Provide an adjustable alarm to indicate trouble.
 - 2. The controller shall be insensitive to phase angle shifts and be capable of operating with input line voltage of 95 to 130 volts AC, without affecting accuracy.
 - 3. Conductivity Probe: Provide a single probe with dual carbon elements, potted in a PVC holder and mounted in a 1-1/4" ball valve with safety chain and probe fitting. Unit shall be designed to be mounted directly into the circulating line and not require any additional piping. The conductivity probe shall be easily removed.
 - 4. Water meter shall be a 1", split case all bronze water meter with a maximum working pressure of 125 psig. Meter register shall be calibrated in GPM, and shall be electrically connected to the control panel in the basement (by this subcontractor). Water meter shall be installed in the make-up line by this Contractor.
 - 5. Inhibitor Feed: Inhibitor chemical shall be fed proportional to makeup water. A water meter with electric contactor shall pulse a reset counter with an adjustable range of 0-99 counts. Completion of the counter cycle shall initiate a solid state reset timer to activate the inhibitor pump with adjustable range of 0-10 minutes.
 - a. Meter shall be all bronze construction with a maximum working pressure of 125 psig.
 - b. Water meter shall be calibrated in GPM and shall be complete with electric contacting register sized to meter twice the volume of the maximum makeup rate of the system.
 - c. Meter shall be a minimum of 1" NPT and shall be able to flow 15 gpm at 14 psig pressure drop (max.).
 - 6. Biocide Feed: Biocide chemical feed shall be controlled by a 14 day (minimum), 24 hour timer which shall actuate a chemical pump whenever required.

- C. The conductivity monitor and sample stream piping assembly shall be mounted on a wall supported frame, painted with polyurethane enamel paint. All components of the system on the wall frame shall be pre-piped and pre-wired to form a ready to install system. System shall consist of the following:
 - 1. One (1) sample stream piping assembly with:
 - a. Two (2) 1" inlet/outlet shutoff valves rated for 125 PSI Service.
 - b. One (1) flow switch rated for 125 PSI service.
 - c. Two (2) ¾" PVC chemical injection tees.
 - d. One (1) conductivity probe of PVC construction with a temperature compensating element mounted in a quick-disconnect fitting.
 - D. One (1) Pre-piped bleed-off piping assembly consisting of inlet shut off valve, wye strainer, flush valve, throttling valve and 0-PSI differential brass solenoid valve rated at 125 PSIG with Buna-N or ethylene propylene seats. All other internal parts in contact with fluid shall be stainless steel. Bleed-off piping assembly shall be sized to bleed twice the maximum design bleed-off rate of the system.
 - 1. The strainer body shall be cast iron and the strainer shall be stainless steel.
 - E. One (1) Pre-piped Sch. 80 PVC coupon rack with six coupon holders with quick disconnect, o-ring sealed coupon holders that do not require tools for installation or maintenance and inlet and outlet isolation ball valves. The coupon racks shall be mounted on a corrosion-resistant, PVC panel. Safety cable shall prevent lost coupons; nylon sample-holding screws shall not alter coupon corrosion rates.
 - F. Two (2) Chemical feed pumps, PVC or glass filled polypropylene, positive displacement type with PVC or polypropylene ball type check valves, shall be provided to feed the corrosion inhibitor and biocide. Feed rate shall be adjustable while pump is running from 0.2 to 9.0 gallons per day. Necessary polyethylene discharge tubing shall be included. Pumps shall be rated for minimum 100 psig discharge pressure and minimum eight (8) feet suction lift. Motors shall be 115 VAC.
 - G. Two (2) corporate stops and injection assemblies with PVC diffuser tube and back check valve for injecting chemicals into the recirculating line.
- 2.4 DRUM SPILL CONTAINMENT PALLET
- A. Provide a polypropylene pallet to support two 55 gallon drums of chemicals (inhibitor and biocide). Pallet shall be approximately 54" long x 30" wide x 17" high and shall be able to contain a spill of 60 gallons (min.) and shall be able to support a 2,000 pound static load. Deck shall have removable polypropylene grating.
- 2.5 WATER TREATMENT CHEMICALS - OPEN WATER SYSTEMS
- A. Provide one year's supply of organophosphonate or amolybdate based formulas for control of scale and corrosion in the open recirculating system. Provide two separate formulas for prevention of microbiological growth in the same system. Biocide products recommended shall be properly registered with the Environmental Protection Agency and EPA registration

numbers shall be clearly shown on all product literature and drum labels. Sulfuric acid and heavy metals shall not be used. All chemical products shall be provided in liquid form for direct feed from shipping container to the cooling system.

2.6 TESTING EQUIPMENT

- A. Furnish basic water test equipment, including carrying case and spare reagents for maintaining control of program standards in the condenser, and chilled water water systems. Test kits shall include the following:
 - 1. Reagents and apparatus for determination of corrosion inhibitor level in the water systems.
 - 2. Apparatus for determination of Total Dissolved Solids/Conductivity, 0-10,000 range.
 - 3. Apparatus for determination of microbiological colony population and biocide effectiveness.
- B. Corrosion Test-Coupon Assembly: Constructed of corrosive-resistant material, complete with piping, valves, and mild steel and copper coupons. Locate copper coupon downstream from mild steel coupon in the test-coupon assembly.
 - 1. Four-station rack for open systems.

2.7 WATER TREATMENT SERVICE PROGRAM

- A. Provide all consulting services for start-up of the water treatment systems which shall include:
 - 1. Installation and system start-up procedures recommendations.
 - 2. Pre-operation system cleanout procedure supervision.
 - 3. Initial water analysis and recommendations.
 - 4. Training of operating personnel on proper feeding and control techniques.
 - 5. Any necessary log sheets and record forms.
 - 6. Any required laboratory and technical assistance.
- B. All services shall be provided by a qualified representative.

PART 3 - EXECUTION

- 3.1 INSPECTION: Examine areas and conditions under which water treatment systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.
- 3.2 INSTALLATION OF WATER TREATMENT SYSTEMS
 - A. General: Install water treatment systems in accordance with manufacturer's written instructions.
 - B. Coordination with other work (plumbing, electrical, and piping) as necessary to interface components of water treatment system properly with other components.

- C. Install conductivity monitor, bleed-off piping assembly, water meter, and sample stream piping assembly at locations indicated on the plans. All components shall be mounted at an easily accessible and clearly visible height.
- D. Electrical
 - 1. Provide electrical devices required by manufacturer's wiring diagram.
 - 2. Provide all control wiring required for proper operation including wiring between the control panel, conductivity probe, chemical feed pumps, blow-down valve, and water meter. Wiring shall be installed by a licensed electrical contractor.
 - 3. All electrical wiring installation shall be in accordance with manufacturer's submittal. Do not proceed with equipment start-up until wiring installation is acceptable to equipment manufacturer's representative.
 - 4. All electrical wiring shall be in accordance with the requirements of Division 26 and shall be in EMT inside the building and in rigid conduit outside the building.
- E. Install pressure gauges, valves and controls furnished by manufacturer, in accordance with manufacturer's instructions.
- F. Install inhibitor and biocide feed pumps on wall above drum pallet where indicated. Provide $\frac{3}{8}$ " discharge tubing from pumps to tie-in point(s) in piping.
- G. Install test-coupon assembly in bypass circuit around circulating pumps, unless otherwise indicated on Drawings.

END OF SECTION 230920

SECTION 230930 – TESTING AND BALANCING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Furnish all labor, services, materials and related items necessary to complete the testing and balancing (TAB) work indicated on the drawings and/or specified herein. The scope of work shall include:

- 1. Balancing of hydronic systems.

1.2 RELATED DOCUMENTS

- A. All drawings and applicable provisions of Division 0 Bidding Requirements and Division 1 General Requirements apply to work of this Section.
- B. Section 230000 - Mechanical General Conditions.
- C. Section 230010 - Mechanical Basic Materials and Methods.
- D. Section 230020 - Vibration Isolation and Seismic Restraints.

- 1.3 All instruments used by this agency shall be accurately calibrated and maintained in good working order.

- 1.4 The balance work shall be performed by an AABC (Associated Air Balance Council) or a NEBB (National Environmental Balance Bureau) certified firm. All work shall be done in compliance with the standards of the certification. All balance work shall be done under direct supervision of a qualified heating and ventilating engineer employed by them. All work shall also comply with the ASHRAE Standard 111 recommendations pertaining to measurements, instruments, testing, adjusting and balancing.

- 1.5 The balance firm shall have a minimum of 5 year's experience balancing similar systems.

- 1.6 If requested, the tests shall be conducted in the presence of the Engineer or their representative.

1.7 REFERENCES

- A. AABC - National Standards for Field Measurement and Instrumentation, Total System Balance.
- B. ASHRAE - 1984 Systems Handbook: Chapter 37, Testing, Adjusting and Balancing.
- C. NEBB - Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.

1.8 SUBMITTAL

- A. Provide submittals under provisions of Section 230000.
- B. Within 30 days of award of the contract, submit:
 - 1. Name and qualifications of testing, adjusting and balancing agency for approval by the Engineer.
 - 2. Submit sample balance report forms and detailed procedures for approval by the Engineer.

3. Forms shall be representative for all the tests. Formulas and data to be used for determining heat exchange capacities, where required, shall be included.
- C. Submit 3 bound copies of draft report for review prior to final acceptance of Project.
- D. Submit 5 bound copies of final reports to the Engineer for inclusion in operating and maintenance manuals.
- E. Provide reports in soft cover, letter size, multi-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.
- F. Reports shall include the following information:
 1. TAB Company name, address, and telephone number.
 2. Project name, location, Project COR, Project Engineer, and Project Contractor.
 3. Project altitude.
 4. Instrument List:
 - a. Instrument.
 - b. Manufacturer.
 - c. Model.
 - d. Serial number.
 - e. Range.
 - f. Calibration date.

1.9 QUALITY ASSURANCE

- A. Agency shall be company specializing in the adjusting and balancing of systems specified in this Section with minimum three years documented experience. Perform work under supervision of AABC Certified Test and Balance Engineer.
- B. Total system balance shall be performed in accordance with AABC National Standards for Field Measurement and Instrumentation, Total System Balance.

1.10 SCHEDULE

- A. Sequence work to commence after completion of systems. Schedule completion of TAB work before Substantial Completion of Project.

1.11 PREPARATION FOR TESTING AND BALANCING

- A. The Mechanical Contractor shall bring the work to a state of readiness for testing and balancing all equipment and systems by doing the following:
 1. Verify lubrication of all equipment.
 2. Permanent instrumentation to be operational.
 3. Check rotation and alignment of rotating equipment and tension of belt drives.
 4. "Start-up" HVAC equipment and continue operating the equipment during the testing and balancing.
 5. Set control points of automatic controls and check calibrations and adjustments.

6. Repair or replace at this contractor's expense components of system which do not function properly.

B. Mechanical Contractor shall assist the balance firm as follows:

1. Provide TAB firm with copy of the HVAC plans, specifications and approved equipment submittals.
2. Change, at the Mechanical Contractor's expense, pulleys, belts, drive, etc., required to obtain correct air balance.
3. Add, at the Mechanical Contractor's expense, dampers and/or valves as required by the TAB firm to correctly balance the HVAC systems.
4. Put all HVAC equipment and systems into operation and continue the operation during each working day of TAB, as required.
5. Provide temperature and pressure taps according to the Construction Documents for TAB testing.

1.12 DEMONSTRATION

A. Demonstrate as follows:

1. The TAB Firm shall be prepared to demonstrate to the Engineer and the Owner that actual conditions match the balancing report. At the Engineer's discretion:
 - a. Retest no more than 30% fan/pump, etc., systems to demonstrate that they are operating at conditions indicated in the balancing report.
 - b. Retest no more than 30% of controls relative to the mechanical equipment to demonstrate that they are operating properly.
 - c. Retesting shall be done in cooperation with the Engineer and the Owner's personnel and in their presence if requested.

PART 2 - PRODUCTS

2.1 MEASUREMENTS AND INSTRUMENTATION

- A. Provide all required instrumentation to obtain proper measurements, calibrated to the tolerances specified in the referenced standards. Instruments shall be properly maintained and protected against damage.
- B. Provide instruments meeting the specifications of the referenced standards.
- C. Use only those instruments which have the maximum field measuring accuracy and are best suited to the function being measured.
- D. Apply instrument as recommended by the manufacturer.
- E. Use instruments with minimum scale and maximum subdivisions and with scale ranges proper for the value being measured.
- F. When averaging values, take a sufficient quantity of readings which will result in a repeatability error of less than 5 percent. When measuring a single point, repeat readings until 2 consecutive identical values are obtained.

- G. Take all reading with the eye at the level of the indicated value to prevent parallax.
- H. Use pulsation dampeners where necessary to eliminate error involved in estimating average of rapidly fluctuation readings.
- I. Take measurements in the system where best suited to the task.
- J. Prepare and submit a profile of the air flow across all coils in all air handling units.

PART 3 - EXECUTION

3.1 The TAB firm shall perform the following tests, balance the system in accordance with the following requirements, and report the following data.

- A. General
 - 1. Report manufacturer, model, type, size and location of all equipment and devices.
 - 2. All equipment except AHU and RTU supply fans (see below for AHUs and RTUs) shall be balanced to within 10% of design flow.
- B. Air Handling Units
 - 1. Cooling coil entering and leaving air DB and WB temperatures and entering and leaving chilled water temperatures.
 - 2. Report simultaneous heat exchange capacity of cooling coil at full load (BTU/HR); both airside and waterside.
 - 3. Report water pressure drop across cooling coil and GPM through coils. Balance GPM to that shown on drawings. Where units have multiple coils without calibrated balance valves on each coil, balance flows to obtain uniform leaving air temperature across all coil sections. Adjust data for glycol in water when appropriate.
- C. Hydronic Heating Coils
 - 1. Air pressure drop across coil.
 - 2. Water pressure drop across coil GPM through coil. Balance GPM to that shown on drawings.
 - 3. Measure temperature rise across coil with boiler at maximum water temperature. Report entering and leaving water temperature.
 - 4. Measure the concentration of the glycol in the system(s).
- D. Chillers
 - 1. Inlet and outlet temperatures on chilled water and cooling tower water.
 - 2. Pressure drops across and water flow through each chiller. Adjust data for glycol in water.
 - 3. Full load amperage of each chiller.
 - 4. Balance chilled and cooling water flows through chiller tube bundle. Adjust data for glycol in water.
 - 5. Percent glycol in chilled water.

6. Calculate and report heat exchange capacity of evaporator and condenser at full load. This shall be done at the same time that the heat exchange capacity of the air handlers is measured.

E. Pumps

1. Motor rpm.
2. Full load amperage draw.
3. Test for correct rotation.
4. Pump pressure differential.
5. Test and balance water flow to design flow rate. (Adjust data for glycol for chilled water pumps.)
6. Measure the concentration of the glycol in the system(s).

F. Cooling Towers

1. Inlet and outlet temperature on cooling tower water.
2. Full load amperage of all fans at all speeds.
3. Measure heat exchange capacity of tower at full load. Report ambient temperature and wet bulb temperature at time of test. Test shall be performed at the same time the chiller and air handling unit test data is recorded.
4. Balance water flow through each cell.

G. Measurements of Existing Systems

1. Hydronic Systems
 - a. Where indicated on the plans, a water flow measurement shall be made to verify existing flows in the system. If a flow measuring device is not installed at these locations, measure inlet and outlet pressures at the indicated coils or pumps to verify the pressure drop at these devices.

END OF SECTION 230930

SECTION 230960 - DIRECT DIGITAL TEMPERATURE CONTROL SYSTEM

PART 1 - GENERAL

- 1.1 This Contractor shall furnish and install a complete system of native BACnet temperature controls. This system shall include all DDC controllers, thermostats, control devices, wiring, etc., required to accomplish the sequence indicated in Part 4.
- 1.2 All power wiring shall be in conduit and shall meet the latest edition of NEC.
- 1.3 WORK INCLUDED
 - A. Extent of control systems work required by this section is indicated on drawings and schedules, and by requirements of this section.
 - B. Refer to other Division-23 sections for installation of instrument wells, valve bodies, and dampers in mechanical systems; not work of this section.
 - C. Provide the following electrical work as work of this section, complying with requirements of Division-26 sections:
 1. Control wiring between field-installed controls, indicating devices, and unit control panels.
 2. Interlock wiring between electrically-operated equipment units; and between equipment and field-installed control devices unless otherwise indicated on the electrical drawings.
 3. Power supply wiring to power controls and/or unit controls unless otherwise indicated. Obtain power from nearest available electrical panel (if not shown on the plans) and coordinate with electrician for circuit availability.
- 1.4 HVAC SYSTEM DESCRIPTION
 - A. The systems in this project include the following:
 1. Cooling towers
 2. Chillers, associated pumps
 3. Control valves
 4. DDC system shall include communications between all DDC controllers (building control panel(s), unit controllers).
- 1.5 BACnet DIRECT DIGITAL CONTROL SYSTEM DESCRIPTION
 - A. Merge with existing BACnet DDC systems including associated equipment and accessories. All new devices are accessible using a Web browser interface and communicate using ASHRAE 135 BACnet communications, without the use of gateways, unless gateways are shown on the design drawings and specifically requested by the Engineer. Where gateways are allowed, they must support ASHRAE 135, including all object properties and read-write services shown on Engineer approved interoperability schedules. Manufacturer's products, including design, materials, fabrication, assembly, inspection, and testing shall be in accordance with ASHRAE 135, ASME B31.1, and NFPA 70, except where indicated otherwise.

- B. The existing DDC system is manufactured by DCI. If installing a system made by the same manufacturer, upgrade or replace the existing server, operator workstation, and laptop computer software with the manufacturer's latest software version for all used applications.

1.6 DESIGN REQUIREMENTS

A. Control System Drawings Title Sheet

- 1. Provide a title sheet for the control system drawing set. Include the project title, project location, contract number, the controls contractor preparing the drawings, an index of the control drawings in the set, and a legend of the symbols and abbreviations used throughout the control system drawings.

B. List of I/O Points

- 1. Also known as a Point Schedule, provide for each input and output point physically connected to a digital controller: point name, point description, point type (Analog Output (AO), Analog Input (AI), Binary Output (BO), Binary Input (BI)), point sensor range, point actuator range, point address, BACnet object, associated BIBBS (where applicable), and point connection terminal number. Typical schedules for multiple identical equipment are allowed unless otherwise requested in design or contract criteria.

C. Control System Components List

- 1. Provide a complete list of control system components installed on this project. Include for each controller and device: control system schematic name, control system schematic designation, device description, manufacturer, and manufacturer part number. For sensors, include point name, sensor range, and operating limits. For valves, include body style, Cv, design flow rate, pressure drop, valve characteristic (linear or equal percentage), and pipe connection size. For actuators, include point name, spring or non-spring return, modulating or two-position action, normal (power fail) position, nominal control signal operating range (0-10 volts DC or 4-20 milliamps), and operating limits.

D. Control System Schematics

- 1. Provide control system schematics. Typical schematics for multiple identical equipment are allowed unless otherwise requested in design or contract criteria. Include the following:
 - a. Location of each input and output device
 - b. Flow diagram for each piece of HVAC equipment
 - c. Name or symbol for each control system component, such as V-1 for a valve
 - d. Setpoints, with differential or proportional band values
 - e. Written sequence of operation for the HVAC equipment
 - f. Valve and Damper Schedules, with normal (power fail) position
- 2. HVAC Equipment Electrical Ladder Diagrams

- a. Provide HVAC equipment electrical ladder diagrams. Indicate required electrical interlocks.
- 3. Component Wiring Diagrams
 - a. Provide a wiring diagram for each type of input device and output device. Indicate how each device is wired and powered; showing typical connections at the digital controller and power supply. Show for all field connected devices such as control relays, motor starters, actuators, sensors, and transmitters.
- 4. Terminal Strip Diagrams
 - a. Provide a diagram of each terminal strip. Indicate the terminal strip location, termination numbers, and associated point names.
- 5. BACnet Communication Architecture Schematic
 - a. Provide a schematic showing the project's entire BACnet communication network, including addressing used for LANs, LAN devices including routers and bridges, gateways, controllers, workstations, and field interface devices. If applicable, show connection to existing networks.

1.7 QUALITY ASSURANCE

- A. Provide material and equipment that are standard manufacturer's products currently in production and supported by a local service organization.
- B. Handle, store, and protect equipment and materials to prevent damage before and during installation according to manufacturer's recommendations, and as approved by the Owner. Replace damaged or defective items.
- C. Protect components from humidity and temperature variation, dust, and contaminants. If components are stored before installation, keep them within the manufacturer's limits.
- D. New equipment finishing shall be factory provided. Manufacturer's standard factory finishing shall be proven to withstand 125 hours in a salt-spray fog test. Equipment located outdoors shall be proven to withstand 500 hours in a salt-spray fog test. Salt-spray fog test shall be according to ASTM B 117, with acceptance criteria as follows: immediately after completion of the test, the finish shall show no signs of degradation or loss of adhesion beyond 0.125 inch on either side of the scratch mark.
- E. The contractor shall verify all dimensions in the field, and advise the Engineer of any discrepancy before performing work.
- F. Contractor's Qualifications. Submit documentation certifying the controls Contractor performing the work has completed at least three DDC systems installations of a similar design to this project, and programmed similar sequences of operation for at least two years.

1.8 Project Sequence - The control system work for this project shall proceed in the following order:

- A. Provide material and equipment that are standard manufacturer's products currently in production and supported by a local service organization.
- B. Handle, store, and protect equipment and materials to prevent damage before and during installation according to manufacturer's recommendations, and as approved by the Owner. Replace damaged or defective items.
- C. Protect components from humidity and temperature variation, dust, and contaminants. If components are stored before installation, keep them within the manufacturer's limits.
- D. New equipment finishing shall be factory provided. Manufacturer's standard factory finishing shall be proven to withstand 125 hours in a salt-spray fog test. Equipment located outdoors shall be proven to withstand 500 hours in a salt-spray fog test. Salt-spray fog test shall be according to ASTM B 117, with acceptance criteria as follows: immediately after completion of the test, the finish shall show no signs of degradation or loss of adhesion beyond 0.125 inch on either side of the scratch mark.
- E. The contractor shall verify all dimensions in the field, and advise the Engineer of any discrepancy before performing work.
- F. Contractor's Qualifications. Submit documentation certifying the controls Contractor performing the work has completed at least three DDC systems installations of a similar design to this project, and programmed similar sequences of operation for at least two years.
- G. Project Sequence - The control system work for this project shall proceed in the following order:
 - 1. Submit and receive approval on the Shop Drawings, Product Data, and Certificates specified under the paragraph entitled "SUBMITTALS."
 - 2. Perform the control system installation work, including all field check-outs and tuning.
 - 3. Provide support to TAB personnel as specified under the paragraph "Test and Balance Support."
 - 4. Submit and receive approval of the Controls System Operators Manual specified under the paragraph "Controls System Operators Manuals."
 - 5. Submit and receive approval of the Performance Verification Testing Plan and the Pre-PVT Checklist specified under the paragraph "Performance Verification Testing."
 - 6. Perform the Performance Verification Testing.
 - 7. Submit and receive approval on the PVT Report.
 - 8. Submit and receive approval on the Training Documentation specified under the paragraph "Instruction to Owner Personnel". Submit at least 30 days before training.
 - 9. Deliver the final Controls System Operators Manuals.
 - 10. Conduct the Phase I Training.
 - 11. Conduct the Phase II Training.
 - 12. Submit and receive approval of Closeout Submittals.

1.9 WARRANTY

- A. Building control system shall be guaranteed and warrantied for two years as required in Section 230000 and General Conditions. All DDC controllers, control valves, control valve actuators, and damper actuators shall have a five year parts warranty.

1.10 DEFINITIONS

A. List

1. ANSI/ASHRAE Standard 135: BACnet - A Data Communication Protocol for Building Automation and Control Networks, referred to as "BACnet". ASHRAE developed BACnet to provide a method for diverse building automation devices to communicate and share data over a network.
2. ARCNET: ATA 878.1 - Attached Resource Computer Network. ARCNET is a deterministic LAN technology; meaning it's possible to determine the maximum delay before a device is able to transmit a message.
3. BACnet: Building Automation and Control Network; the common name for the communication standard ASHRAE 135. The standard defines methods and protocol for cooperating building automation devices to communicate over a variety of LAN technologies.
4. BACnet/IP: An extension of BACnet, Annex J, defines this mechanism using a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP subnetworks that share the same BACnet network number. See also "BACnet Broadcast Management Device".
5. BACnet Internetwork: Two or more BACnet networks, possibly using different LAN technologies, connected with routers. In a BACnet internetwork, there exists only one message path between devices.
6. BACnet Network: One or more BACnet segments that have the same network address and are interconnected by bridges at the physical and data link layers.
7. BACnet Segment: One or more physical segments of BACnet devices on a BACnet network, connected at the physical layer by repeaters.
8. BBMD: BACnet Broadcast Management Device (BBMD). A communications device, typically combined with a BACnet router. A BBMD forwards BACnet broadcast messages to BACnet/IP devices and other BBMDs connected to the same BACnet/IP network. Every IP subnetwork that is part of a BACnet/IP network must have only one BBMD. See also "BACnet/IP".
9. BAS: Building Automation Systems, including DDC (Direct Digital Controls) used for facility automation and energy management.
10. BAS Owner: The local user responsible for managing all aspects of the BAS operation, including: network connections, workstation management, submittal review, technical support, control parameters, and daily operation.
11. BIBBs: BACnet Interoperability Building Blocks. A collection of BACnet services used to describe supported tasks. BIBBs are often described in terms of "A" (client) and "B" (server) devices. The "A" device uses data provided by the "B" device, or requests an action from the "B" device.
12. BI: BACnet International, formerly two organizations: the BACnet Manufacturers Association (BMA) and the BACnet Interest Group - North America (BIG-NA).
13. BI/BTL: BACnet International/BACnet Testing Laboratories (Formerly BMA/BTL). The organization responsible for testing products for compliance with the BACnet standard, operated under the direction of BACnet International.
14. Bridge: Network hardware that connects two or more network (or BACnet internetwork) segments at the physical and data link layers. A bridge may also filter messages.
15. Broadcast: A message sent to all devices on a network segment.

16. Device: Any control system component, usually a digital controller that contains a BACnet Device Object and uses BACnet to communicate with other devices. See also "Digital Controller".
17. Device Object: Every BACnet device requires one Device Object, whose properties represent the network visible properties of that device. Every Device Object requires a unique Object Identifier number on the BACnet internetwork. This number is often referred to as the device instance.
18. Device Profile: A collection of BIBBs determining minimum BACnet capabilities of a device, defined in ASHRAE Standard 135-2004, Annex L. Standard device profiles include BACnet Operator Workstations (B-OWS), BACnet Building Controllers (B-BC), BACnet Advanced Application Controllers (B-AAC), BACnet Application Specific Controllers (B-ASC), BACnet Smart Actuator (B-SA), and BACnet Smart Sensor (B-SS). Each device used in new construction is required to have a PICS statement listing BIBBs supported.
19. Digital Controller: An electronic controller, usually with internal programming logic and digital and analog input/output capability, which performs control functions. In most cases, synonymous with a BACnet device described in this specification. See also "Device".
20. Direct Digital Control (DDC): Digital controllers performing control logic. Usually the controller directly senses physical values, makes control decisions with internal programs, and outputs control signals to directly operate switches, valves, dampers, and motor controllers.
21. DDC System: A network of digital controllers, communication architecture, and user interfaces. A DDC system may include programming, sensors, actuators, switches, relays, factory controls, operator workstations, and various other devices, components, and attributes.
22. Ethernet: A family of local-area-network technologies providing high-speed networking features over various media.
23. Firmware: Software programmed into read only memory (ROM), flash memory, electrically erasable programmable read only memory (EEPROM), or erasable programmable read only memory (EPROM) chips.
24. Gateway: Communication hardware connecting two or more different protocols, similar to human language translators. The Gateway translates one protocol into equivalent concepts for the other protocol. In BACnet applications, a gateway has BACnet on one side and non-BACnet (usually proprietary) protocols on the other side.
25. Half Router: A device that participates as one partner in a BACnet point-to-point (PTP) connection. Two half-routers in an active PTP connection combine to form a single router.
26. Hub: A common connection point for devices on a network.
27. Internet Protocol (IP, TCP/IP, UDP/IP): A communication method, the most common use is the World Wide Web. At the lowest level, it is based on Internet Protocol (IP), a method for conveying and routing packets of information over various LAN media. Two common protocols using IP are User Datagram Protocol (UDP) and Transmission Control Protocol (TCP). UDP conveys information to well-known "sockets" without confirmation of receipt. TCP establishes "sessions", which have end-to-end confirmation and guaranteed sequence of delivery.
28. Input/Output (I/O): Physical inputs and outputs to and from a device, although the term sometimes describes software, or "virtual" I/O. See also "Points".

29. I/O Expansion Unit: An I/O expansion unit provides additional point capacity to a digital controller.
30. IP subnet: Internet protocol (IP) identifies individual devices with a 32-bit number divided into four groups from 0 to 255. Devices are often grouped and share some portion of this number. For example, one device has IP address 209.185.47.68 and another device has IP address 209.185.47.82. These two devices share Class C subnet 209.185.47.00
31. Local-Area Network (LAN): A communication network that spans a limited geographic area and uses the same basic communication technology throughout.
32. LonTalk: ANSI/EIA 709. A communication protocol developed by Echelon Corp. LonTalk is an optional physical and data link layer for BACnet.
33. MAC Address: Media Access Control address. The physical node address that identifies a device on a Local Area Network.
34. Master-Slave/Token-Passing (MS/TP): ISO/IEC 8802-3. One of the LAN options for BACnet. MSTP uses twisted-pair wiring for relatively low speed and low cost communication (up to 4,000 ft at 76.8K bps).
35. Native BACnet Device: A device that uses BACnet as its primary, if not only, method of communication with other BACnet devices without intermediary gateways. A system that uses native BACnet devices at all levels is a native BACnet system.
36. Network: Communication technology for data communications. BACnet approved network types are BACnet over Internet Protocol (IP), Point to Point (PTP) Ethernet, ARCNET, MS/TP, and LonTalk®.
37. Network Number: A site-specific number assigned to each network segment to identify for routing. This network number must be unique throughout the BACnet internetwork.
38. Object: The concept of organizing BACnet information into standard components with various associated properties. Examples include analog input objects and binary output objects.
39. Object Identifier: An object property used to identify the object, including object type and instance. Object Identifiers must be unique within a device.
40. Object Properties: Attributes of an object. Examples include present value and high limit properties of an analog input object. Properties are defined in ASHRAE 135; some are optional and some are required. Objects are controlled by reading from and writing to object properties.
41. Peer-to-Peer: Peer-to-peer refers to devices where any device can initiate and respond to communication with other devices.
42. Performance Verification Test (PVT): The procedure for determining if the installed BAS meets design criteria prior to final acceptance. The PVT is performed after installation, testing, and balancing of mechanical systems. Typically the PVT is performed by the Contractor in the presence of the Owner and/or Engineer.
43. PID: Proportional, integral, and derivative control; three parameters used to control modulating equipment to maintain a setpoint. Derivative control is often not required for HVAC systems (leaving "PI" control).
44. PICS: Protocol Implementation Conformance Statement (PICS), describing the BACnet capabilities of a device. See BACnet, Annex A for the standard format and content of a PICS statement.
45. Points: Physical and virtual inputs and outputs. See also "Input/Output".

- 46. PTP: Point-to-Point protocol connects individual BACnet devices or networks using serial connections like modem-to-modem links.
- 47. Repeater: A network component that connects two or more physical segments at the physical layer.
- 48. Router: A BACnet router is a component that joins together two or more networks using different LAN technologies. Examples include joining a BACnet Ethernet LAN to a BACnet MS/TP LAN.
- 49. Stand-Alone Control: Refers to devices performing equipment-specific and small system control without communication to other devices or computers for physical I/O, excluding outside air and other common shared conditions. Devices are located near controlled equipment, with physical input and output points limited to 64 or less per device, except for complex individual equipment or systems. Failure of any single device will not cause other network devices to fail. BACnet "Smart" actuators (B-SA profile) and sensors (B-SS profile) communicating on a network with a parent device are exempt from stand-alone requirements.

1.11 SUBMITTALS

- A. Submit detailed and annotated manufacturer's data, drawings, and specification sheets for each item listed, that clearly show compliance with the project specifications. Submit shop drawings and product data under provisions of Section 230000.
 - 1. Shop Drawings. Include the following in the project's control system drawing set:
 - a. Control system drawings title sheet
 - b. List of I/O Points
 - c. Control System Components List
 - d. Control system schematics
 - e. HVAC Equipment Electrical Ladder diagrams
 - f. Component wiring diagrams
 - g. Terminal strip diagrams
 - h. BACnet communication architecture schematic
 - 2. Product Data
 - a. Direct Digital Controllers
 - b. Include BACnet PICS for each controller/device type, including smart sensors (B-SS) and smart actuators (B-SA).
 - c. BACnet Gateways Include BACnet and workstation display information; bi-directional communication ability; compliance with interoperability schedule expansion capacity; handling of alarms, events, scheduling and trend data; and single device capability (not depending on multiple devices for exchanging information from either side of the gateway).
 - d. Sensors and Input Hardware
 - e. Output Hardware
 - f. Indicators
 - 3. Design Data

- a. Performance Verification Testing Plan
 - b. Pre-Performance Verification Testing Checklist
- 4. Test Reports
 - a. Performance Verification Testing Report
- 5. Certificates
 - a. Contractor's Qualifications
- B. Manufacturer's Field Reports
 - 1. Pre-PVT Checklist
- C. Closeout Submittals
 - 1. Operation and Maintenance Data: For DDC system to include in emergency, operation and maintenance manuals.
 - a. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - 1) Project Record Drawings of as-built versions of submittal Shop Drawings provided in electronic PDF format.
 - 2) Testing and commissioning reports and checklists of completed final versions of reports, checklists, and trend logs.
 - 3) As-built versions of submittal Product Data.
 - 4) Names, addresses, e-mail addresses and 24-hour telephone numbers of Installer and service representatives for DDC system and products.
 - 5) Operator's manual with procedures for operating control systems including logging on and off, handling alarms, producing point reports, trending data, overriding computer control and changing set points and variables.
 - 6) Programming manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
 - 7) Engineering, installation, and maintenance manuals that explain how to:
 - a) Design and install new points, panels, and other hardware.
 - b) Perform preventive maintenance and calibration.
 - c) Debug hardware problems.
 - d) Repair or replace hardware.
 - 8) Documentation of all programs created using custom programming language including set points, tuning parameters, and object database.
 - 9) Backup copy of graphic files, programs, and database on electronic media such as DVDs.
 - 10) List of recommended spare parts with part numbers and suppliers.

- 11) Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
- 12) Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
- 13) Licenses, guarantees, and warranty documents.
- 14) Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
- 15) Owner training materials.

1.12 This Contractor shall review the electrical drawings to obtain location of electrical panels, motor starters, and all other coordination items.

1.13 RELATED DOCUMENTS

- A. All drawings and applicable provisions of Division 0 Bidding Requirements and Division 1 General Requirements apply to work of this Section.
- B. Section 230000 - Mechanical General Conditions.
- C. Section 230010 - Basic Materials and Methods.
- D. Section 230020 - Vibration Isolation and Seismic Restraints.
- E. Section 230930 - Testing and Balancing.

1.14 REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.
 1. AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL (AMCA)
 - a. AMCA 500-D (1998) Laboratory Methods of Testing Dampers for Rating
 2. AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)
 - a. ASHRAE 135 (2008; Addenda q Errata 2009, Addenda l, o, r, s, v 2009; Addenda j Errata 2010; Addenda h, k, n, t, u, w, x, y 2010; Errata 2010) BACnet—A Data Communication Protocol for Building Automation and Control Networks
 3. ARCNET TRADE ASSOCIATION (ATA)
 - a. ATA 878.1 (1999) Local Area Network: Token Bus
 4. ASTM INTERNATIONAL (ASTM)
 - a. ASTM B 117 (2009) Standard Practice for Operating Salt Spray (Fog) Apparatus
 - b. ASTM D 1238 (2010) Melt Flow Rates of Thermoplastics by Extrusion Plastometer
 - c. ASTM D 1693 (2008) Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics

- d. ASTM D 635 (2010) Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position
 - e. ASTM D 638 (2010) Standard Test Method for Tensile Properties of Plastics
 - f. ASTM D 792 (2008) Density and Specific Gravity (Relative Density) of Plastics by Displacement
5. INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)
- a. IEEE C57.13 (2008) Standard Requirements for Instrument Transformers
 - b. IEEE C62.41.1 (2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
 - c. IEEE C62.41.2 (2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits
 - d. IEEE C62.45 (2002; R 2008) Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000v and less) AC Power Circuits
6. INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)
- a. ISO/IEC 8802-3 (2000) Information Technology - Telecommunications and Information Exchange Between Systems - Local and Metropolitan Area Networks - Specific Requirements - Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications
 - b. NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)
 - c. NEMA/ANSI C12.10 (2004) Physical Aspects of Watthour Meters - Safety Standards
7. NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)
- a. NFPA 70 (2011) National Electrical Code
 - b. NFPA 72 (2010; TIA 10-1; TIA 10-2; TIA 10-3; TIA 10-4) National Fire Alarm and Signaling Code
 - c. NFPA 90A (2009; Errata 09-1) Standard for the Installation of Air Conditioning and Ventilating Systems
8. SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)
- a. SMACNA 1966 (2005) HVAC Duct Construction Standards Metal and Flexible, 3rd Edition
9. UNDERWRITERS LABORATORIES (UL)
- a. UL 1449 (2006; R 2009 - R 2010) Surge Protective Devices
 - b. UL 506 (2008; R 2010) Specialty Transformers
 - c. UL 508A (2001; R thru 2010) Industrial Control Panels
 - d. UL 916 (2007; R 2009; R 2010) Standard for Energy Management Equipment

PART 2 - PRODUCTS

2.1 TEMPERATURE CONTROL

- A. Control Manufacturers: This Contractor to provide a complete control system as hereinafter described. The control system shall be furnished and installed by one of the following manufacturers:
1. Johnson Controls
 2. Honeywell
 3. Other manufacturers are not acceptable unless approved by the Engineer prior to bid date.
- B. Component Manufacturers: Subject to compliance with requirements, provide control component products from one of the following:
1. Controllers - from the manufacturers listed above.
 2. Temperature Sensors
 - a. Manufacturers listed above
 - b. ACI
 - c. HY-CAL
 - d. Schaevitz
 - e. Approved equal
 3. Humidity Sensors
 - a. Manufacturers listed above
 - b. Setra
 - c. ACI
 - d. Approved equal
 4. Transducers
 - a. Manufacturers listed above
 - b. Bellofram
 - c. Fairchild
 - d. Veris
 - e. Or approved equal
 5. Relays
 - a. General Electric
 - b. RIB
 - c. Air Products
 - d. Approved equal
 6. Motorized Dampers
 - a. Ruskin
 - b. American Warming
 - c. Nailor
 - d. Delta
 - e. Penn
 - f. Greenheck

7. Motorized Damper Actuators

- a. Belimo
- b. Johnson
- c. Siemens

8. Control Valves

- a. Manufacturers listed above
- b. Delta
- c. Belimo

9. Control Valve Actuators

- a. Belimo
- b. Johnson
- c. Siemens

2.2 DDC SYSTEM

A. Direct Digital Controllers.

- 1. Direct digital controllers shall be UL 916 rated.
- 2. The total number of I/O hardware points used by a single stand-alone digital controller, including I/O expansion units, shall not exceed 64, except for complex individual equipment or systems. Place I/O expansion units in the same cabinet as the digital controller.
- 3. Controllers shall be suitable for, or placed in protective enclosures suitable for the environment (temperature, humidity, dust, and vibration) where they are located.
- 4. Provide stand-alone digital controllers.
- 5. Provide internal clocks for all BACnet Building Controllers (B-BC) and BACnet Advanced Application Controllers (B-AAC) using BACnet time synchronization services. Automatically synchronize system clocks daily from an operator-designated controller. The system shall automatically adjust for daylight saving time.
- 6. Provide sufficient memory for each controller to support the required control, communication, trends, alarms, and messages. Protect programs residing in memory with EEPROM, flash memory, or by an uninterruptible power source (battery or uninterruptible power supply). The backup power source shall have capacity to maintain the memory during a 72-hour continuous power outage. Rechargeable power sources shall be constantly charged while the controller is operating under normal line power. Batteries shall be replaceable without soldering. Trend and alarm history collected during normal operation shall not be lost during power outages less than 72 hours long.
- 7. Controllers shall operate at 90 percent to 110 percent nominal voltage rating.
- 8. The controller power supply transformer shall be fused or current limiting and rated at 125 percent power consumption.
- 9. Use screw terminal wiring terminations for all field-installed controllers. Provide field-removable modular terminal strip or a termination card connected by a ribbon cable for all controllers other than terminal units.
- 10. Provide hard-wired input and output interface for all controllers as follows:

- a. Protection: Shorting an input or output point to itself, to another point, or to ground shall cause no controller damage. Input or output point contact with sources up to 24 volts AC or DC for any duration shall cause no controller damage.
 - b. Binary Inputs: Binary inputs shall have a toggle switch and monitor on and off contacts from a "dry" remote device without external power, and external 5-24 VDC voltage inputs.
 - c. Pulse Accumulation Inputs: Pulse accumulation inputs shall conform to binary input requirements and accumulate pulses at a resolution suitable to the application.
 - d. Analog Inputs: Analog inputs shall monitor low-voltage (0-10 VDC), current (4-20 mA), or resistance (thermistor or RTD) signals.
 - e. Binary Outputs: Binary outputs shall have a toggle switch and send a pulsed 24 VDC low-voltage signal for modulation control, or provide a maintained open-closed position for on-off control. For HVAC equipment and plant controllers, provide for manual overrides, either with three-position (on-off-auto) override switches and status lights, or with an adjacent operator display and interface. Where appropriate, provide a method to select normally open or normally closed operation.
 - f. Analog Outputs: Analog outputs shall send modulating 0-10 VDC or 4-20 mA signals to control output devices.
 - g. Tri-State Outputs: Tri-State outputs shall provide three-point floating control of terminal unit electronic actuators.
11. Digital Controller BACnet Internetwork
- a. Provide a BACnet internetwork with control products, communication media, connectors, repeaters, hubs, and routers. Provide intermediate gateways, only when requested by the Engineer and shown on the contract drawings, to connect existing non-BACnet devices to the BACnet internetwork. Controller and operator interface communication shall conform to ASHRAE 135, BACnet. Use the building's existing Ethernet backbone for network segments marked "existing" on project drawings. Coordinate connections to existing Ethernet backbones with the BAS Owner and LAN administrator. If a controller becomes non-responsive, the remaining controllers shall continue operating and not be affected by the failed controller.
 - 1) Communications Ports
 - a) Direct-Connect Interface Ports: Provide at least one extra communication port at each local BACnet network for direct connecting a notebook computer or BACnet hand-held terminal so all network BACnet objects and properties may be viewed and edited by the operator.

- b) Telecommunications Interface Port: Provide one telecommunication port per building, permitting remote communication via point-to-point (PTP) protocol over telephone lines.
- 2) Modems
 - a) Provide modems where required for communication between the BACnet Operator Workstation (B-OWS) and the DDC system.
- 3) Unitary Controllers (Application Specific Controllers)
 - a) Each Unitary Controller shall operate as a standalone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each Unitary Controller shall be a microprocessor-based, multi-tasking, real-time digital control processor.
 - b) Unitary Controllers shall support, but not be limited to, the following types of systems to address specific applications described in the "Execution" portion of this Specification, and to address future expansion:
 - i. Unit Vents (ASHRAE Cycle, I, II, III, or W).
 - ii. Heat Pumps (Air-to-Air, Water-to-Air).
 - iii. Packaged Rooftops.
 - iv. Fan Coils (Two-Pipe, Four-Pipe).
 - c) Point types – Each Unitary Controller shall support the following types of point inputs and outputs:
 - i. Analog inputs shall monitor the following analog signals:
 - 0-10 VDC Sensors
 - 4-20 MA
 - 10,000ohm thermistors
 - ii. Binary inputs shall monitor dry contact closures. Input shall provide filtering to eliminate false signals resulting from input "bouncing."
 - iii. Counter inputs shall monitor dry contact pulses with an input resolution of one HZ minimum.
 - iv. Analog outputs shall provide the following control outputs:
 - 0-10 VDC
 - 4-20 MA
 - v. Binary outputs shall provide SPDT output contacts rated for 2 amps at 24 VAC. loads (i.e. solenoids) shall be controlled by pilot relays.
 - vi. TriState outputs shall be paired binary outputs for use as Power Close/Power Open control output contacts rated for 2 amps at 24 VAC. Surge and noise suppression shall be provided on all pilot relays.

PART 3 - EXECUTION

- 3.1 INSTALLATION - Perform the installation under the supervision of competent technicians regularly employed in the installation of DDC systems.
- A. Install systems and materials in accordance with manufacturer's instructions and roughing-in drawings, and details on drawings. Install electrical components and use electrical products complying with requirements of applicable Division-26 sections of these specifications. Mount wall mounted controllers where indicate at 48" AFF to 78" AFF. Mount temperature sensors, thermostats and humidistats at the same height as light switches.
 - B. Digital Controller Systems - Each system will be provided with its own dedicated direct digital controller or application specific controller.
 - C. Input Devices - All input devices shall be installed per the manufacturers recommendation. The mechanical contractor shall install all in-line devices such as temperature wells, pressure taps, valves, dampers, etc.
 - D. Output Devices - All output devices shall be installed per the manufacturers recommendations. The mechanical contractor shall install all in-line devices such as control valves, dampers, etc.
 - E. BACnet Naming and Addressing - Coordinate with the BAS Owner and provide unique naming and addressing for BACnet networks and devices.
 - 1. MAC Address - Every BACnet device shall have an assigned and documented MAC Address unique to its network. For Ethernet networks, document the MAC Address assigned at its creation. For ARCNET or MS/TP, assign from 00 to 64.
 - 2. Network Numbering- Assign unique numbers to each new network installed on the BACnet internetwork. Provide ability for changing the network number; either by device switches, network computer, or field operator interface. The BACnet internetwork (all possible connected networks) can contain up to 65,534 possible unique networks.
 - 3. Device Object Identifier Property Number Assign unique Device "Object_Identifier" property numbers or device instances for each device on the BACnet internetwork. Provide for future modification of the device instance number; either by device switches, network computer, or field interface. BACnet allows up to 4,194,302 possible unique devices per internetwork.
 - 4. Device Object Name Property Text - The Device Object Name property field shall support 32 minimum printable characters. Assign unique Device "Object_Name" property names with plain-English descriptive names for each device. For example, the Device Object Name that for the device controlling the chiller plant at Building 3408 would be: Device Object_Name = CW System B3408. A Device Object Name for a VAV box controller might be: Device Object_Name = VAV BOX25
 - 5. Object Name Property Text (Other than Device Objects) - The Object Name property field shall support 32 minimum printable characters. Assign Object Name properties with plain-English names descriptive of the application. Examples include "Zone 1 Temperature" and "Fan Start/Stop".

6. Object Identifier Property Number (Other than Device Objects) - Assign Object Identifier property numbers according to design drawings or tables if provided. If not provided, Object Identifier property numbers may be assigned at the Contractor's discretion but must be approved by the Engineer. In this case they must be documented and unique for like object types within the device.

F. Minimum BACnet Object Requirements

1. Use of Standard BACnet Objects For the following points and parameters, use standard BACnet objects, where all relevant object properties can be read using BACnet's Read Property Service, and all relevant object properties can be modified using BACnet's Write Property Service: all device physical inputs and outputs, all set points, all PID tuning parameters, all calculated pressures, flow rates, and consumption values, all alarm s, all trends, all schedules, and all equipment and lighting circuit operating status.
2. BACnet Object Description Property - The Object Description property shall support 32 minimum printable characters. For each object, complete the description property field using a brief, narrative, plain English description specific to the object and project application. For example: "HW Pump 1 Proof." Document compliance, length restrictions, and whether the description is writeable in the device PICS.
3. Analog Input, Output, and Value Objects - Support and provide Description and/or Device_Type text strings matching signal type and engineering units shown on the points list.
4. Binary Input, Output, and Value Objects - Support and provide Inactive_Text and Active_Text property descriptions matching conditions shown on the points list.
5. Calendar Object - For devices with scheduling capability, provide at least one Calendar Object with ten-entry capacity. All operators may view Calendar Objects; authorized operators may make modifications from a workstation. Enable the writeable Date List property and support all calendar entry data types.
6. Schedule Object - Use Schedule Objects for all building system scheduling. All operators may view schedule entries; authorized operators may modify schedules from a workstation.
7. Loop Object or Equal - Use Loop Objects or equivalent BACnet objects in each applicable field device for PID control. Regardless of program method or object used, allow authorized operators to adjust the Update Interval, Setpoint, Proportional Constant, Integral Constant, and Derivative Constant using BACnet read/write services.

G. Minimum BACnet Service Requirements

1. Command Priorities - Use commandable BACnet objects to control machinery and systems, providing the priority levels listed below. If the sequence of operation requires a different priority, obtain approval from the Engineer.
 - a. Priority Level Application
 - b. 1 Manual-Life Safety

- c. 2 Automatic-Life Safety
- d. 3 (User Defined)
- e. 4 (User Defined)
- f. 5 Critical Equipment Control
- g. 6 Minimum On/Off
- h. 7 (User Defined)
- i. 8 Manual Operator
- j. 9 (User Defined)
- k. 10 (User Defined)
- l. 11 Load Shedding
- m. 12 (User Defined)
- n. 13 (User Defined)
- o. 14 (User Defined)
- p. SECTION 23 09 23.13 20 Page 53
- q. 15 (User Defined)
- r. 16 (User Defined)

2. Alarming

- a. Alarm Priorities - Coordinate alarm and event notification with the BAS Owner.
- b. Notification Class - Enable writeable Priority, Ack required, and Recipient List properties of Notification Class objects.
- c. Event Notification Message Texts - Use condition specific narrative text and numerical references for alarm and event notification.

3. Updating Displayed Property Values - Allow workstations to display property values at discrete polled intervals, or based on receipt of confirmed and unconfirmed Change of Value notifications. The COV increment shall be adjustable by an operator using BACnet services, and polled intervals shall be adjustable at the operator workstation.

H. Local Area Networks - Obtain Owner's approval before connecting new networks with existing networks. Network numbers and device instance numbers shall remain unique when joining networks. Do not change existing network addressing without Owner's approval. See also "BACnet Naming and Addressing".

I. BACnet Routers, Bridges, and Switches - Provide the quantity of BACnet routers, bridges, and switches necessary for communications shown on the BACnet Communication Architecture schematic. Provide BACnet routers with BACnet Broadcast Message Device (BBMD) capability on each BACnet internetwork communicating across an IP network. Configure each BACnet device and bridge, router, or switch to communicate on its network segment.

J. Wiring Criteria

- 1. Provide wire, conduit and miscellaneous materials as required for mounting and connecting electric control devices.
- 2. Install complete wiring system for temperature control systems. All conduit, wiring, accessories and wiring connections required for the installation of the DDC System shall be provided by the Temperature Control Contractor unless specifically shown on the Electrical Drawings.

3. Conceal wiring, except in mechanical rooms and areas where other conduit and piping are exposed. Wiring in the ceiling and within wall cavities may be cable. Wiring to sensors and thermostats or other devices on walls without cavities shall be in wiremold (almond color). Other wiring shall be in conduit. Exposed wiring to rooftop mounted units and other units that are outside the building shall be in conduit.
4. Run circuits operating at more than 100 volts in rigid or flexible conduit, metallic tubing, covered metal raceways, or armored cable.
5. HVAC Control System Wiring
 - a. Use of conduits for control and interlock wiring shall be as follows:
 - 1) Wiring 24 volts or less concealed in walls and above accessible ceilings may be run without conduit.
 - 2) Wiring 24 volts or less above ceilings that are not accessible shall be run in conduit.
 - 3) In mechanical rooms, run cables exposed except below 10 feet above the finished floor, provide mechanical protection below 10 feet AFF by running in EMT; final connection to motorized equipment shall be in flexible conduit.
6. Wiring 24 volts or less not installed in conduit shall be supported every 5' from the building structure utilizing metal hangers designed for this application. Wiring shall be installed parallel to the building structural lines.
7. Low voltage control wiring and 24 VAC wiring can be run in the same conduit. Power wiring over 24 volts (i.e. 115 VAC or greater) must be in a separate conduit.
8. Do not run binary control circuit wiring in the same conduit as power wiring over 100 volts. Where analog signal wiring requires conduit, do not run in the same conduit with AC power circuits or control circuits operating at more than 100 volts.
9. Provide circuit and wiring protection required by NFPA 70.
10. Run all wiring located inside mechanical rooms in conduit.
11. Do not bury aluminum-sheathed cable or aluminum conduit in concrete.
12. Input/output identification: Permanently label each field-installed wire, cable, and pneumatic tube at each end with descriptive text using a commercial wire marking system that fully encircles the wire, cable, or tube. Locate the markers within 2 inches of each termination. Match the names and I/O number to the project's point list. Similarly label all power wiring serving control devices, including the word "power" in the label. Number each pneumatic tube every six feet. Label all terminal blocks with alpha/numeric labels. All wiring and the wiring methods shall be in accordance with UL 508A.
13. For controller power, provide new 120 VAC circuits, with ground. Provide each circuit with a dedicated breaker, and run wiring in its own conduit, separate from any control wiring. Connect the controller's ground wire to the electrical panel ground; conduit grounds are not acceptable.
14. Surge Protection: Install surge protection according to manufacturer's instructions. Multiple controllers fed from a common power supply may be protected by a common surge protector, properly sized for the total connected devices.
15. Grounding: Ground controllers and cabinets to a good earth ground as specified in Section 262000 Interior Distribution System. Conduit grounding is not acceptable; all

- grounding shall have a direct path to the building earth ground. Ground sensor drain wire shields at the controller end.
16. The Contractor shall be responsible for correcting all associated ground loop problems.
 17. Run wiring in panel enclosures in covered wire track.
- K. Unit-Mounted Equipment: Where control devices are indicated to be unit-mounted, ship DDC controllers, electric relays, electric switches, valves, dampers, and damper motors to unit manufacturer for mounting and wiring at factory.
- L. Wiring for Control Valves:
1. Connect 24 volt power to hot water valves in the VAV Boxes (230650) from the control transformer furnished with these units. The control transformers in these units have been oversized to carry this load (see referenced sections).
 2. Provide control transformers and 24 volt power to other hot water heating valves.
- M. Accessibility - Install all equipment so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install digital controllers, data ports, and concealed actuators, valves, dampers, and like equipment in locations freely accessible through access doors.
- N. Digital Controllers
1. Install as stand-alone control devices (see definitions).
 2. Locate control cabinets at the locations shown on the drawings. If not shown on the drawings, install in the most accessible space, close to the controlled equipment.
- O. Hand-Off-Auto Switches - Wire safety controls such as smoke detectors and freeze protection thermostats to protect the equipment during both hand and auto operation.
- P. Temperature Sensors - Install temperature sensors in locations that are accessible and provide a good representation of sensed media. Installations in dead spaces are not acceptable. Calibrate sensors according to manufacturer's instructions. Do not use sensors designed for one application in a different application.
- 3.2 Test and Balance Support - The controls contractor shall coordinate with and provide on-site support to the test and balance (TAB) personnel specified under Section 230930 Testing, Adjusting and Balancing. This support shall include:
- A. On-site operation and manipulation of control systems during the testing and balancing.
 - B. Control setpoint adjustments for balancing all relevant mechanical systems, including VAV boxes.
 - C. Tuning control loops with setpoints and adjustments determined by TAB personnel.
- 3.3 Controls System Operators Manuals - Provide two electronic and printed copies of a Controls System Operators Manual. The manual shall be specific to the project, written to actual project conditions, and provide a complete and concise depiction of the installed work. Provide information in detail to clearly explain all operation requirements for the control system. Provide with each manual: CDs of the project's control system drawings, control programs,

data bases, graphics, and all items listed below. Include gateway back-up data and configuration tools where applicable. Provide CDs in jewel case with printed and dated project-specific labels on both the CD and the case. For text and drawings, use Adobe Acrobat or MS Office file types. When approved by the Engineer, AutoCAD and Visio files are allowed. Give files descriptive English names and organize in folders. Provide printed manuals in sturdy 3-ring binders with a title sheet on the outside of each binder indicating the project title, project location, contract number, and the controls contractor name, address, and telephone number. Each binder shall include a table of contents and tabbed dividers, with all material neatly organized. Manuals shall include the following:

- A. A copy of the as-built control system (shop) drawings set, with all items specified under the paragraph "Submittals." Indicate all field changes and modifications.
- B. A copy of the project's mechanical design drawings, including any official modifications and revisions.
- C. A copy of the project's approved Product Data submittals provided under the paragraph "Submittals."
- D. A copy of the project's approved Performance Verification Testing Plan and Report.
- E. A copy of the project's approved final TAB Report.
- F. Printouts of all control system programs, including controller setup pages if used. Include plain-English narratives of application programs, flowcharts, and source code.
- G. Printouts of all physical input and output object properties, including tuning values, alarm limits, calibration factors, and set points.
- H. A table entitled "AC Power Table" listing the electrical power source for each controller. Include the building electrical panel number, panel location, and circuit breaker number.
- I. The DDC manufacturer's hardware and software manuals in both print and CD format with printed project-specific labels. Include installation and technical manuals for all controller hardware, operator manuals for all controllers, programming manuals for all controllers, operator manuals for all workstation software, installation and technical manuals for the workstation and notebook, and programming manuals for the workstation and notebook software.
- J. A list of qualified control system service organizations for the work provided under this contract. Include their addresses and telephone numbers.
- K. A written statement entitled "Technical Support" stating the control system manufacturer or authorized representative will provide toll-free telephone technical support at no additional cost to the Owner for a minimum of two years from project acceptance, will be furnished by experienced service technicians, and will be available during normal weekday working hours. Include the toll-free technical support telephone number.
- L. A written statement entitled "Software Upgrades" stating software and firmware patches and updates will be provided upon request at no additional cost to the Owner for a minimum of two years from contract acceptance. Include a table of all DDC system software and firmware

provided under this contract, listing the original release dates, version numbers, part numbers, and serial numbers.

- M. Storage Cabinets - In each project mechanical room, provide a wall-mounted metal storage cabinet with hinged doors. In addition to the number of manuals specified above, provide an additional copy of the manuals in each of these mechanical room storage cabinets. Provide cabinets large enough to hold the entire set of Controls System Operators Manuals, and the HVAC operation and maintenance manuals provided under Division 23 Mechanical. Locate cabinets adjacent to DDC control panels where applicable. Have each cabinet's proposed installation site approved in advance by the Engineer and BAS Owner. Prominently label each cabinet with the wording "OPERATION AND MAINTENANCE MANUALS." Prominently label each binder with the wording "MECHANICAL ROOM COPY - DO NOT REMOVE."

3.4 PERFORMANCE VERIFICATION TESTING (PVT)

- A. The PVT shall demonstrate compliance of the control system work with the contract requirements. The PVT shall be performed by the Contractor and witnessed and approved by the Owner and/or Engineer. If the project is phased, provide separate testing for each phase. A Pre-PVT meeting to review the Pre-PVT Checklist is required to coordinate all aspects of the PVT and shall include the Contractor's QA representative, the Contractor's PVT administrator, the Engineer's representative, and the BAS Owner.
- B. Pre-Performance Verification Testing Checklist - Submit the following as a list with items checked off once verified. Provide a detailed explanation for any items that are not completed or verified.
 - 1. Verify all required mechanical installation work is successfully completed, and all HVAC equipment is working correctly (or will be by the time the PVT is conducted).
 - 2. Verify HVAC motors operate below full-load amperage ratings.
 - 3. Verify all required control system components, wiring, and accessories are installed.
 - 4. Verify the installed control system architecture matches approved drawings.
 - 5. Verify all control circuits operate at the proper voltage and are free from grounds or faults.
 - 6. Verify all required surge protection is installed.
 - 7. Verify the A/C Power Table specified in "CONTROLS SYSTEM OPERATORS MANUALS" is accurate.
 - 8. Verify all DDC network communications function properly, including uploading and downloading programming changes.
 - 9. Using the BACnet protocol analyzer (if provided or required in this specification), verify communications are error free.
 - 10. Verify each digital controller's programming is backed up.
 - 11. Verify all wiring, components, and panels are properly labeled.
 - 12. Verify all required points are programmed into devices.
 - 13. Verify all TAB work affecting controls is complete.
 - 14. Verify all valve and actuator zero and span adjustments are set properly.
 - 15. Verify all sensor readings are accurate and calibrated.
 - 16. Verify each control valve and actuator goes to normal position upon loss of power.
 - 17. Verify all control loops are tuned for smooth and stable operation. View trend data where applicable.

18. Verify each controller works properly in stand-alone mode.
19. Verify all safety controls and devices function properly, including freeze protection and interfaces with building fire alarm systems.
20. Verify all electrical interlocks work properly.
21. Verify all workstations, notebooks and maintenance personnel interface tools are delivered, all system and database software is installed, and graphic pages are created for each workstation and notebook.
22. Verify the as-built (shop) control drawings are completed.

C. Conducting Performance Verification Testing

1. PVT testing shall be performed a minimum of 2 weeks prior to substantial completion.
2. Conduct Owner/Engineer-witnessed PVT after approval of the PVT Plan and the completed Pre-PVT Checklist. Notify the Owner and Engineer of the planned PVT at least 15 days prior to testing. Provide an estimated time table required to perform the testing. Furnish personnel, equipment, instrumentation, and supplies necessary to perform all aspects of the PVT. Ensure that testing personnel are regularly employed in the testing and calibration of DDC systems. Using the project's as-built control system (shop) drawings, the project's mechanical design drawings, the approved Pre-PVT Checklist, and the approved PVT Plan, conduct the PVT.
3. During testing, identify any items that do not meet the contract requirements and if time permits, conduct immediate repairs and re-test. Otherwise, deficiencies shall be investigated, corrected, and re-tested later. Document each deficiency and corrective action taken.
4. If re-testing is required, follow the procedures for the initial PVT. The Engineer may require re-testing of any control system components affected by the original failed test.
5. Three (3) paper copies or one (1) electronic copy of completed checklists shall be submitted to Engineer within 3 days following the satisfactory completion of the tests.

D. Controller Capability and Labeling - Test the following for each controller:

1. Memory: Demonstrate that programmed data, parameters, and trend/ alarm history collected during normal operation is not lost during power failure.
2. Direct Connect Interface: Demonstrate the ability to connect directly to each type of digital controller with a portable electronic device like a notebook computer or PDA. Show that maintenance personnel interface tools perform as specified in the manufacturer's technical literature.
3. Stand Alone Ability: Demonstrate controllers provide stable and reliable stand-alone operation using default values or other method for values normally read over the network.
4. Wiring and AC Power: Demonstrate the ability to disconnect any controller safely from its power source using the AC Power Table. Demonstrate the ability to match wiring labels easily with the control drawings. Demonstrate the ability to locate a controller's location using the BACnet Communication Architecture Schematic and floor plans.

5. Nameplates and Tags: Show the nameplates and tags are accurate and permanently attached to control panel doors, devices, sensors, and actuators.
- E. BACnet Communications and Interoperability Areas - Demonstrate proper interoperability of data sharing, alarm and event management, trending, scheduling, and device and network management. If available or required in this specification, use a BACnet protocol analyzer to assist with identifying devices, viewing network traffic, and verifying interoperability. These requirements must be met even if there is only one manufacturer of equipment installed. Testing includes the following:
1. Data Presentation: On each BACnet Operator Workstation, demonstrate graphic display capabilities.
 2. Reading of Any Property: Demonstrate the ability to read and display any used readable object property of any device on the network.
 3. Setpoint and Parameter Modifications: Show the ability to modify all setpoints and tuning parameters in the sequence of control or listed on project schedules. Modifications are made with BACnet messages and write services initiated by an operator using workstation graphics, or by completing a field in a menu with instructional text.
 4. Peer-to-Peer Data Exchange: Show all BACnet devices are installed and configured to perform BACnet read/write services directly (without the need for operator or workstation intervention), to implement the project sequence of operation, and to share global data.
 5. Alarm and Event Management: Show that alarms/events are installed and prioritized according to the BAS Owner. Demonstrate time delays and other logic is set up to avoid nuisance tripping, e.g., no status alarms during unoccupied times or high supply air during cold morning start-up. Show that operators with sufficient privilege can read and write alarm/event parameters for all standard BACnet event types. Show that operators with sufficient privilege can change routing (BACnet notification classes) for each alarm/event including the destination, priority, day of week, time of day, and the type of transition involved (TO-OFF NORMAL, TO-NORMAL, etc.).
 6. Schedule Lists: Show that schedules are configured for start/stop, mode change, occupant overrides, and night setback as defined in the sequence of operations.
 7. Schedule Display and Modification: Show the ability to display any schedule with start and stop times for the calendar year. Show that all calendar entries and schedules are modifiable from any connected workstation by an operator with sufficient privilege.
 8. Archival Storage of Data: Show that data archiving is handled by the operator workstation/server, and local trend archiving and display is accomplished with BACnet Trend Log objects.
 9. Modification of Trend Log Object Parameters: Show that an operator with sufficient privilege can change the logged data points, sampling rate, and trend duration.

10. Device and Network Management: Show the following capabilities:

- a. Display of Device Status Information
 - b. Display of BACnet Object Information
 - c. Silencing Devices that are Transmitting Erroneous Data
 - d. Time Synchronization
 - e. Remote Device Reinitialization
 - f. Backup and Restore Device Programming and Master Database(s)
 - g. Configuration Management of Half-Routers, Routers and BBMDs
- F. Execution of Sequence of Operation - Demonstrate that the HVAC system operates properly through the complete sequence of operation. Use read/write property services to globally read and modify parameters over the internetwork.
- G. Control Loop Stability and Accuracy - For all control loops tested, give the Engineer trend graphs of the control variable over time, demonstrating that the control loop responds to a 20 percent sudden change of the control variable set point without excessive overshoot and undershoot. If the process does not allow a 20 percent set point change, use the largest change possible. Show that once the new set point is reached, it is stable and maintained. Control loop trend data shall be in real-time with the time between data points 30 seconds or less.
- H. Performance Verification Testing Report - Upon successful completion of the PVT, submit a PVT Report to the Engineer and prior to the Owner taking use and possession of the facility. Do not submit the report until all problems are corrected and successfully re-tested. The report shall include the annotated PVT Plan used during the PVT. Where problems were identified, explain each problem and the corrective action taken. Include a written certification that the installation and testing of the control system is complete and meets all of the contract's requirements.

3.5 TRAINING REQUIREMENTS

- A. Provide a qualified instructor (or instructors) with two years minimum field experience with the installation and programming of similar BACnet DDC systems. Orient training to the specific systems installed. Coordinate training times with the Engineer and BAS Owner after receiving approval of the training course documentation. Training shall take place at the job site and/or a nearby Owner-furnished location. A training day shall occur during normal working hours, last no longer than 8 hours and include a one-hour break for lunch and two additional 15-minute breaks. The project's approved Controls System Operators Manual shall be used as the training text. The Contractor shall ensure the manuals are submitted, approved, and available to hand out to the trainees before the start of training.
- B. Training Documentation - Submit training documentation for review 30 days minimum before training. Documentation shall include an agenda for each training day, objectives, a synopsis of each lesson, and the instructor's background and qualifications. The training documentation can be submitted at the same time as the project's Controls System Operators Manual.

- C. Phase I Training - Fundamentals - The Phase I training session shall last [one day] [two consecutive days] and be conducted in a classroom environment with complete audio-visual aids provided by the contractor. Provide each trainee a printed 8.5 by 11 inch hard-copy of all visual aids used. Upon completion of the Phase I Training, each trainee should fully understand the project's DDC system fundamentals. The training session shall include the following:
1. BACnet fundamentals (objects, services, addressing) and how/where they are used on this project
 2. This project's list of control system components
 3. This project's list of points and objects
 4. This project's device and network communication architecture
 5. This project's sequences of control, and:
 6. Alarm capabilities
 7. Trending capabilities
 8. Troubleshooting communication errors
 9. Troubleshooting hardware errors
- D. Phase II Training - Operation - Provide Phase II Training shortly after completing Phase I Training. The Phase II training session shall last one day and be conducted at the DDC system workstation, at a notebook computer connected to the DDC system in the field, and at other site locations as necessary. Upon completion of the Phase II Training, each trainee should fully understand the project's DDC system operation. The training session shall include the following:
1. A walk-through tour of the mechanical system and the installed DDC components (controllers, valves, dampers, surge protection, switches, thermostats, sensors, etc.)
 2. A discussion of the components and functions at each DDC panel
 3. Logging-in and navigating at each operator interface type
 4. Using each operator interface to find, read, and write to specific controllers and objects
 5. Modifying and downloading control program changes
 6. Modifying setpoints
 7. Creating, editing, and viewing trends
 8. Creating, editing, and viewing alarms
 9. Creating, editing, and viewing operating schedules and schedule objects
 10. Backing-up and restoring programming and data bases
 11. Modifying graphic text, backgrounds, dynamic data displays, and links to other graphics
 12. Creating new graphics and adding new dynamic data displays and links
 13. Alarm and Event management
 14. Adding and removing network devices

3.6 IDENTIFICATION STANDARDS

- A. Controller Identification. All controllers shall be identified by a plastic engraved nameplate securely fastened to the outside of the controller enclosure with rivets or screws.
- B. Panel Identification. All local control panels shall be identified by a plastic engraved nameplate securely fastened to the outside of the controller enclosure with rivets or screws.

- C. Field Devices. All field devices shall be identified by a typed (not handwritten) securely attached tag label.
- D. Panel Devices. All panel devices shall be identified by a typed label securely fastened to the backplate of the local control panel.
- E. Raceway Identification. All the covers to junction and pull boxes of the control system raceways shall be painted blue or have identification labels stating "Control System Wiring" affixed to the covers. Labels shall be typed, not hand written.
- F. Number-code or color-code conductors, excluding those used for local individual room controls, appropriately for future identification and servicing of control system. Label all wiring with name and number, as referenced to the associated control diagram, at each end of the conductor or cable. Labels (Stencils) shall be Brady or Westline.

3.7 ADJUSTING AND CLEANING

- A. Start-up, test, and adjust electric control systems in presence of manufacturer's authorized representative. Demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
- B. Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

3.8 CLOSEOUT PROCEDURES

- A. Schedule instruction session with Owner; provide at least 14-day notice to General Contractor, COR and Engineer of training and demonstration dates.

PART 4 - SEQUENCE OF OPERATION

4.1 Provide all wiring and controls for the following sequences except where otherwise indicated:

4.2 DAILY SCHEDULE – See Drawings

4.3 INSPECTION

- A. Examine areas and conditions under which temperature control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

END OF SECTION 230960

SECTION 260000 – BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Applicable provisions of Bidding Requirements and Division 1 General Requirements apply to work of this Section.
- B. Should a conflict arise between this section and other Sections, the General and Supplementary Conditions of Division 1 shall take precedence.
- C. The word "Contractor" as used in these specifications shall be held to mean the person, firm or corporation contracting to do the herein described work.
- D. The submittal of a proposal carries with it the agreement to all items and conditions referred to in the specifications and accompanying drawings.

1.2 RULES AND REGULATIONS

- A. The rules, regulations, ordinances of all applicable governing bodies in force at the time of execution of the Contract shall become a part of these specifications. These shall include the requirements of state, county, city and also the requirements of local utility companies.
- B. All material furnished and work performed shall be in compliance with the latest applicable versions of the following codes, including local ordinances and amendments:

International Building Code	2015
National Fire Protection Association NFPA 70E	2018
National Fire Protection Association NFPA 72	2015
National Electrical Code	2014
OSHA Requirements	
International Energy Conservation Code	2015
Americans with Disabilities Act, Standards for Accessible Design	2010

- C. All electrical material used on this project must be UL listed and labeled.
- D. Where a conflict exists between the applicable codes, the plans and the specifications, the one shall be followed that results in the higher quality, most expensive and most complete installation.
- E. Install electrical equipment, devices and appurtenances in accordance with applicable standards and NECA 1-2010, "Standard Practice of Good Workmanship in Electrical Contracting."

1.3 PERMITS, LICENSES AND INSPECTION FEES

- A. This subcontractor shall obtain and pay the cost of all fees, permits or licenses that may be required for the performance of the work described herein.

1.4 PLANS AND SPECIFICATIONS

- A. The specifications and the accompanying drawings plans (architectural, site, structural, mechanical, electrical, fire protection and plumbing) are mutually explanatory and anything described or shown on one, but not on the other, shall be considered as if shown or described on all. The intention of the drawings and specifications is to provide complete functioning systems in every respect. Furnish all material and equipment and perform all labor to achieve this intent, whether or not such material or equipment is indicated herein. Whenever the term "provide" is used, it shall mean "furnish and install."
- B. Data given herein and on the drawings is as exact as could be secured. Their absolute accuracy is not guaranteed. Obtain and verify exact locations, measurements, levels, space requirements, etc., at the site, and adapt the work to actual conditions at the building as constructed.
- C. The drawings shall be considered schematic and are not intended to indicate all required materials. Conduit, wiring, equipment, etc., shall be installed so all items clear the structure and other building elements and maintain appropriate clearances for access, service and maintenance.
- D. Some of the details on the drawings are schematic or diagrammatic. These details are not intended to show all materials, etc., required to achieve the arrangement shown. Adapt these details to the actual conditions of the job.
- E. Routing of conduit and location of equipment and other devices are shown on plans for general guidance. This Contractor shall coordinate his work with other Contractors and shall provide necessary deviations in routing as far as 10 feet from those shown to provide systems as specified or implied, without interference and pursuant to these requirements at no additional cost to the Owner, COR or Engineer.
- F. Contractor shall not scale the drawings. Refer to architectural and structural drawings for building construction and dimensions and to room finish schedule on architectural drawings for material, finish and construction method of walls, floors and ceilings in order to insure proper rough-in and installation of contractor's work.
- G. Changes, modifications or variations to the plans and specifications will be issued by the Engineer in writing.
- H. Coordinate arrangement, mounting and support of electrical equipment.
 - 1. To allow maximum possible headroom, unless specific mounting heights are indicated.
 - 2. To provide for ease of disconnecting equipment with minimum interference to other installations.
 - 3. To allow right-of-way for piping and conduit installed at slopes.
 - 4. So connecting raceway will be clear of obstructions and of the working and access space of other equipment.
- I. All mechanical, electrical, plumbing, fire protection, and HVAC work shall be coordinated by that contractor and any correction to any of the above work shall be at that contractor's expense.

1.5 DISCREPANCIES OR OMISSIONS

- A. During the bidding period, any discrepancies or omissions in any of the documents or any doubt as to their meaning, should be reported to the Engineer who will, time permitting, issue a written instruction in the form of an addendum to all bidders of record. The Engineer will not be responsible for any oral explanations or interpretations of the documents.
- B. During construction, should a discrepancy or omission be found, it shall be brought to the attention of the Engineer at once for resolution.
- C. No changes in contract price will be allowed for minor changes in layout or location required to avoid interferences, obstructions, etc. Contract price changes will be considered only for changes in the scope of the project requirements. All such scope changes and price revisions must be authorized in writing.
- D. If discrepancies are found within the contract documents, the most demanding requirement shall take precedence unless otherwise agreed by the engineer in writing.

1.6 VISITING THE SITE

- A. Before submitting a bid, visit the site and become acquainted with the conditions under which the work will be performed.
- B. Failure to fully understand the existing site conditions under which the work is to be performed will not be justification for additional compensation after the award of the contract.
- C. Work in electrical rooms imparts labs outside the work area and contractor shall understand all conditions.

1.7 SHOP DRAWINGS

- A. Contractor shall submit shop drawings in compliance with the General and Special Conditions. Contractor shall field verify exact locations, measurements, and space availability at the site, etc. prior to fabricating materials and shall notify the Engineer of discrepancies in writing.
- B. The Contractor shall submit copies of all required Shop Drawings and material and equipment lists.
- C. Submittals shall be transmitted to SSC Engineering as paper documents, electronic documents via email attachments, or electronic documents via FTP file transfers.
 - 1. All submittals shall include a transmittal form identifying the project name, date, contents of submittal package, and names of subcontractor, manufacturer, and supplier.
 - 2. On an attached separate sheet clearly identify deviations from requirements in the Contract Documents, including minor variations and limitations.
 - 3. Paper submittals shall be sent to

SSC Engineering
Attention: Submittals
18207 Edison Ave.
Chesterfield, MO 63005.

4. Emails regarding submittals shall be sent to “submittals@sscengineering.com”.
- D. Documents transmitted in paper format shall be sent to the COR who will forward these to SSC. If approved by the COR prior to submitting documents, these documents may be submitted simultaneously to the COR and SSC. SSC will return all documents to the COR only regardless of how they were transmitted to SSC. Submit four (4) paper copies of all required Shop Drawings and material and equipment lists for the Engineer’s and Owner’s sole use. The Contractor shall submit additional paper copies that will be required for his own use and the Operation and Maintenance Manuals. The additional copies will be reviewed by the Engineer and returned to the Contractor marked accordingly.
- E. Documents transmitted as email attachments shall be sent simultaneously to the COR and SSC. SSC will return one (1) electronic copy of these documents to the COR only.
- F. If SSC is the prime consultant and there is no COR, documents shall be transmitted directly to SSC.
- G. Documents transmitted via FTP file transfers shall be retrieved from the FTP site after SSC has received an email notification that these documents have been posted to the site. SSC will return one (1) electronic copy of these documents to the COR only unless another procedure is agreed to in writing by the COR and the Engineer.
- H. Contractor shall review and correct all shop drawings before they are submitted. Shop drawings shall bear the signed and dated approval stamp of this Contractor.
- I. Shop drawings shall include the plan mark used on the plans.
- J. Equipment shop drawings shall give capacities at conditions specified and shall include manufacturer's catalog numbers and cuts. Shop drawings shall be clearly marked; shall indicate all accessories, items, conditions, etc., which are being furnished; and shall indicate that all conditions of the plans and specifications are being met. Wiring diagrams shall be submitted.
- K. Submittals which do not provide the required information will be returned unchecked.
- L. Contractor shall be responsible for deviations, errors and omissions, quantities, and coordination dimensions in submittals, and this responsibility shall not be relieved by Engineers' review of submittals.
- M. This Contractor shall coordinate each submittal with the contract documents, work of other contractors, and job site conditions.
- N. The Contractor shall not be relieved of responsibility for deviations from requirements of the Contract Documents by the Engineer’s approval of Shop Drawings, Product Data, Samples or similar submittals unless the Contractor has specifically informed the Engineer in writing of such deviation at the time of submittal and (1) the Engineer has given written approval to the specific deviation as a minor change in the Work, or (2) a Change Order or Construction Change Directive has been issued authorizing the deviation. The Contractor shall not be relieved of responsibility for errors or omissions in Shop Drawings, Product Data, Samples or similar submittals by the Engineer’s approval thereof.

- O. This Contractor shall coordinate each submittal with the contract documents, work of other contractors, and job site conditions.
- P. Submit shop drawings on equipment as herein listed:

Motor Control Modifications
Safety switches
Circuit breakers
Motors and motor controls
Fuses
Conduit and boxes
Fire rated wall penetration sealer
Conductors
Wiring devices
Grounding equipment
Seismic restraints

1.8 RELEASE OF CADD FILES

- A. See "Release of Cadd Files Form" at the end of this section.

1.9 MAINTENANCE AND OPERATING INSTRUCTIONS AND MANUALS

- A. Upon completion of the job, the installing contractors and major suppliers shall instruct the Owner's representatives in the proper operation and maintenance of the systems installed. The installing Contractors shall submit documentation indicating the date of instruction; names and organization of persons providing and receiving the instructions; systems the instructions covered; and materials received.
- B. Binders: Heavy-duty, three-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
 - 1. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
 - 2. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents. Indicate volume number for multiple-volume sets.
- C. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.

- D. Contractor shall also submit four (4) complete hard copy sets and one (1) electronic copy of properly bound operating manuals to the Engineer for review. These manuals shall include the following:
1. Include a Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
 2. Complete set of shop drawings.
 3. Copies of all submittals.
 4. Parts lists, wiring diagrams, piping diagrams, etc.
 5. Manufacturers' operating and maintenance instructions.
 6. Written operating and maintenance instructions for the system. This is a written version of Paragraph 1.9A above.
 7. Copies of warranties.
 8. Parts lists for each piece of equipment and name of local supplier.

1.10 TEMPORARY POWER – EXISTING FACILITIES

- A. The Owner's existing electrical distribution system shall be used for temporary power required for temporary lighting, 120 volt GFI receptacles and power to all construction equipment in accordance with NEC Article 527.
- B. Temporary lighting shall consist of protected incandescent, LED, HID or fluorescent fixtures symmetrically spaced to produce a minimum of 5 footcandles throughout the work areas.
- C. Stairs and other enclosed areas shall have adequate lighting.
- D. The service shall be available during all working hours and scheduled overtime hours and otherwise as necessary for security and safety purposes, with security lighting to be provided during all hours of darkness. All such facilities shall conform to all requirements of the National Electrical Code, the local utility, and all other governmental authorities having jurisdiction.
- E. Comply with NECA 200-2010, "Recommended Practice for Installing and Maintaining Temporary Electric Power at Construction Sites."

1.11 AS-BUILT RECORD DRAWINGS

- A. During construction, maintain a separate set of drawings at the jobsite to keep a record of all changes of locations. See additional requirements in General Conditions and Supplementary Conditions.
- B. Locations of conduit and other concealed facilities shall be shown if and when they differ from the drawings. Underground conduit shall be dimensioned on those drawings.
- C. "As built" drawings are to be submitted to COR/Engineer for review prior to the time of request for final payment. Submit as-built record drawings in accordance with the General Conditions.

1.12 GUARANTEE AND WARRANTY

- A. Guarantee and warrant equipment, materials, workmanship, installation, etc., for a period of one year in accordance with the General Conditions.
- B. During the guarantee period, make all required repairs and replacements, and provide necessary service, labor, tools, materials, parts, etc., at no additional cost to the Owner.

PART 2 - PRODUCTS

2.1 MATERIAL SUBSTITUTION

- A. Equipment selection has been based on one manufacturer to establish the desired type, style, quality, performance, etc. When other manufacturers are listed as equally acceptable, the product of those manufacturers will be accepted if their product complies with these specifications and drawings. The listing of a manufacturer does not relieve that manufacturer from complying with the specifications and drawings.
- B. Equipment and materials are subject to the review and approval of the Engineer and COR.
- C. Differences in cost involved in using an equally acceptable manufacturer shall be included in the bid. Contractor shall be responsible for any and all engineering and installation variations due to the substituted equipment. These include structural, electrical, architectural, plumbing, mechanical, fire protection, etc. changes.
- D. Deviations from these specifications are not solicited and are not encouraged. If a deviation between the specifications or drawings and items bid does exist, then that deviation must be clearly itemized and explained on the bid form.

PART 3 - EXECUTION

3.1 RESPONSIBILITY

- A. Provide material, equipment, labor, services, supplies, etc., required to execute to completion work shown on the drawings, described in these specifications, or made necessary by the work shown on the drawings and/or described in these specifications.
- B. Schedule work and furnish the required materials in such a manner that the work may progress from start to finish in an expeditious and efficient manner without undue interruption. Schedule the work to coordinate with the construction.

3.2 COORDINATION OF TRADES

- A. Prior to the installation of any materials, review the drawings indicating work to be performed by each trade. If conflicts occur, they shall be brought to the attention of the Engineer for resolution.
- B. Work installed without coordinating with the other trades, which causes interferences, shall be removed and reworked, at no cost to the Owner.
- C. The Contractor supplying the equipment shall furnish all motors and components which are part of the equipment.

- D. Control wiring is defined as that wiring which conducts electrical energy at a voltage of less than 100 volts. Interlock wiring is defined as that wiring which performs a control function, but at a voltage of 100 volts or greater. All other wiring shall be considered power wiring.
 - E. The Electrical Contractor shall furnish and install all power wiring to, and including connection to the equipment. Unless specifically noted otherwise, all interlock wiring shall be furnished and installed by the Electrical Contractor. Unless noted otherwise, the control wiring shall be furnished and installed by the Contractor furnishing the controlled equipment.
 - F. Unless noted otherwise, the Electrical Contractor shall furnish and install all starters, disconnects, switches, push-button stations, etc., except those which are furnished with the equipment as a part of a factory-assembled package. Heater elements for overload relays on magnetic motor starters (except the starters factory pre-wired with equipment) shall be sized, furnished and installed by the Electrical Contractor. Magnetic motor starters for mechanical equipment (except starters factory pre-wired with equipment such as chillers and packaged air conditioners) shall be furnished by the Electrical Contractor. Magnetic motor starters will be provided with:
 - 1. Auxiliary contacts as required by the interlocks defined on the drawings or in the specifications.
 - 2. Control Power Transformer - 120 volt secondary, minimum 40 Volt Amps.
 - G. Each Contractor furnishing motor-operated equipment shall furnish a list of motor characteristics to the Electrical Contractor so that properly sized heater elements may be provided. The list shall include equipment identification by name and by number, the full load current, locked rotor current, voltage rating, and suggested service factor to compensate for operating duty cycle and ambient temperatures.
 - H. Unless specifically noted otherwise, pilot controllers (aquastats, flow switches, pressure switches, etc.) shall be furnished and mounted by the Contractor furnishing the controlled equipment.
 - I. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls and other structural components as they are constructed.
 - J. Coordinate sleeve selection and application with firestopping specified in Division 7.
- 3.3 PROTECTION OF EQUIPMENT AND WORK
- A. Protect and preserve materials, supplies, equipment, piping, etc., from damage due to weather, corrosion, dirt, vandalism, theft, etc. Provide enclosures or special protection as indicated by circumstances.
 - B. Should any of the materials, equipment, etc., be damaged as a result of their negligence, then this Contractor shall be held responsible for all such damage and costs incurred for repair or replacement.
- 3.4 CONSTRUCTION STAGING
- A. Plan, coordinate and schedule the work to satisfy the project schedule.

- B. Work shall be so arranged that electrical power and other services are available to the building at all times, except for short periods of interruption necessary for the performance of new work. Interruptions shall not be requested until the new services are complete and ready for final connection.
- C. Interruptions shall be scheduled, and services shall not be interrupted without written approval of the Owner's Representative. Notification to the Owner's Representative shall include the exact time and estimated duration of any interruption.

3.5 DEMOLITION OF FACILITIES

A. GENERAL

- 1. The demolition work shall consist of removal of electrical equipment and materials pertaining to the existing electrical systems as indicated on the drawings.
- 2. Demolition drawings provided are representative of existing conditions, prepared from previous design drawings and field surveys, but may not be all inclusive of existing conditions at the present time. Field verify actual existing conditions and remove all items, whether indicated on drawings or not, as required for new work.
- 3. Include in the bid all demolition work as required and as shown on the drawings.
- 4. Where items are removed, utilities and the area from which the items have been removed shall be left in such a manner that they are safe to both people and property.
- 5. Before disconnection of any systems, advance approved arrangements shall be made to prevent interference with utility services to rooms and structures not otherwise affected by work under this contract.
- 6. Equipment to be reused shall be disconnected, marked and protected where necessary.

B. EXISTING CONDITIONS

- 1. Exercise great caution when performing demolition work so as not to damage existing systems or items of work that are to remain. If the Contractor damages, destroys or removes an existing system which is to remain, the Contractor shall be responsible to repair or replace that system to its original condition.
- 2. Unless specifically stated otherwise on the drawings, where access to electrical items is required, provide the required access by removing ceiling, walls and other obstructions, cutting openings, etc., as required. Prior to cutting openings, outline the openings and obtain approval from the General Contractor and cut openings in the manner directed by the Owner's Representative. Demolition work shall also include the removal and replacement of walls as required for installation or removal of equipment.
- 3. Provide repair and replacement of openings. Materials which are removed and are damaged or soiled shall be replaced with new materials. Ceilings, walls, conduits, etc., shall be properly repaired and restored to as close to the original condition as possible. Replacement of surface finish materials such as paint, ceiling tile, flooring materials, etc., shall be provided by the General Contractor.
- 4. Provide repair of floor openings and trenches. Floors shall be repaired to match the level and surface finish of the existing concrete.
- 5. Areas shall be repaired with materials matching those which have been removed.

C. PROTECTION

1. During demolition operations, all persons and property shall be protected. Provide erection of any barriers, fences, guard rails, enclosures, chutes, and shoring to protect all persons and property.
2. The work shall proceed in a manner to minimize any spread of dust, debris and flying particles, and so that any related effects of demolition do not interfere with the surrounding equipment, personnel, or buildings.
3. Protection and barriers shall be provided around electrical equipment to define the Arc Flash Boundary and Limited Approach Boundary (whichever is greater) per NFPA 70E.
4. Where necessary, provide temporary enclosures to be sure that the area is secured, safe and weatherproofed.

D. DISPOSITION OF MATERIAL:

1. Those items of material and equipment to be removed and designated to become the property of the Owner, shall be delivered to an on-site location designated by the Owner. All other materials and equipment removed shall become the property of this Contractor and shall be removed from the job site and legally disposed of.

3.6 MAINTENANCE OF WORK AREAS

- A. This Contractor shall maintain the work area in an organized manner, shall not allow debris to accumulate, and shall store equipment, tools and supplies in a manner which shall not cause interference with the activities of others engaged on the project.
- B. Open ends of conduit, equipment and specialties shall be kept properly closed during construction and installation so as to avoid contamination.

3.7 CLEANING AND CLEANUP

- A. Upon completion of this work, clean all panels, fixtures, and equipment. Leave all work in a finished, clean, and satisfactory working condition.

END OF SECTION 260000

RELEASE OF CADD FILES

The drawings prepared by SSC Engineering have been prepared using AUTOCAD 2018. Files for plan drawings prepared by SSC Engineering will be made available to the successful HVAC, plumbing, electrical and fire protection contractor by email; no other drawings will be released. The files will have background files bound in, borders and title blocks removed, and all notes, details, diagrams, and schedules removed. A release form must be signed. Utilization of these documents for the development of shop drawings and submittals does not relieve the contractor from any of his responsibilities herein.

Release form that must be signed:

As requested, SSC Engineering will provide _____ (name of contractor) with electronic CADD files of the requested (M, E, P, FP) floor or ceiling plans on the terms set forth below. While SSC is not required under its contract to provide or update these electronic files for this purpose, they are being made available as a convenience to the contractor and as a substantial time saver in the preparation of submittals for this project.

The files contain information through the date when the drawings were issued for bidding and may or may not contain information from the addenda. The company using these files shall be responsible for the coordination of the information contained therein with the Plans, Specifications and other Contract Documents. In the event of any ambiguity, discrepancy or conflict between the information within the electronic files and the Contract Documents, the Contract Documents shall be used.

SSC will not be responsible for any error or malfunction in the translation, interpretation or use of this electronic information once it has been provided to the contractor. SSC does not assume any responsibility arising out of the use or adaptation of the information contained in these files or the sufficiency of any drawings prepared based upon the information included within. By accepting these drawing files, the contractor agrees to hold the Engineer harmless with regard to any errors or omissions in the drawing files. Nothing included in this release shall modify any requirements or responsibilities of either party under their respective contracts.

Signing below indicates understanding and acceptance of these terms. Upon receipt of a signed letter or fax, SSC will release the electronic CADD files.

Project Name and Number: _____

Specific Drawings Request: _____

Acknowledged and Agreed:

Company

Version of AutoCAD used

Name (Must be an officer of the Company)

E-mail address

Title

Maximum e-mail attachment size

Date

SECTION 260010 – BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Applicable provisions of the General Conditions, Supplementary General Conditions and Special Conditions shall govern work performed under this section.
- B. Section 260000 - Basic Electrical Requirements.

1.2 SCOPE OF WORK

- A. This section supplements all sections of this Division and shall apply to all phases of work hereinafter specified, shown on the drawings, or required to provide a complete installation of electrical systems.

1.3 QUALITY ASSURANCE

- A. Electrical work including, but not limited to, installation, materials, equipment and wiring methods, shall comply with the applicable National Electrical Code, NFPA 70.
- B. Equipment and materials shall comply with the applicable requirements of the following:
 - 1. National Electrical Manufacturer Association (NEMA).
 - 2. Institute of Electrical and Electronic Engineers (IEEE).
 - 3. American National Standards Institute (ANSI).
 - 4. National Electrical Safety Code (ANSI Standard C2).
 - 5. Underwriters Laboratories (UL).
 - 6. National Electrical Contractors Association (NECA).
- C. Comply with NECA 1-2015, "Standard Practice of Good Workmanship in Electrical Contracting."

PART 2 - PRODUCTS

- 2.1 Provide products, components and materials which are listed and labeled by Underwriters Laboratories (UL).Test

2.2 EQUIPMENT IDENTIFICATION LABELS

- A. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.
- B. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch.
- C. 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.

- D. Established Facility Identification Label Systems shall supersede above methods. Verify with owner.

PART 3 - EXECUTION

- 3.1 Install equipment and materials in a neat and workmanlike manner and align, level, and adjust for satisfactory operation. Install equipment so that all parts are easily accessible for inspection, operation, maintenance and repair.

- 3.2 SUPPORTS

- A. Provide the design, fabrication, and erection of supplementary structural framing required for attachment of hangers or other devices supporting electrical equipment.
- B. Provide members welded to structural members equal to the specification for the main structural member. Provide "simple beam" type framing with end connections welded or bolted for shear loads. Use cantilevers only when detailed or specifically approved by the Engineer. The Engineer's approval is required for location of supplementary framing.
- C. Design framing members for their actual loads, with allowable stresses specified by AISC, without excessive deflection and with consideration for rigidity under vibration, in accordance with standard structural practices.
- D. When supplementary framing is indicated, verify that dimensions are suitable for the equipment furnished. Provide additional strength when equipment furnished is heavier than that specified.

- 3.3 WIRING DEVICE LOCATION

- A. Position of Outlets: Center all outlets with regard to paneling, furring and trim. Symmetrically arrange outlets in the room. Satisfactorily correct outlets improperly located or installed. Repair or replace damaged finishes. Set outlets plumb and extend to the finished surface of the wall, ceiling, or floor without projecting beyond same. Install symmetrically all receptacles, switches, and outlets shown on the trim or casework. Where necessary set the long dimension of the plate horizontal, or ganged in tandem.
- B. Mounting heights, to center of box above finished floor, shall be as follows, unless otherwise indicated. Other mounting heights are indicated on the drawings by detail or by a plus dimension shown adjacent to the symbol:

Motor controllers and disconnect switches 60 inches to top

- 3.4 IDENTIFICATION

- A. General
 - 1. All electrical equipment and devices shall be identified by nameplates or labels.
 - 2. Nameplates - Shall be 4" x 1" x 1/8" thick white core, black face, plastic with engraved letters. Attachment to equipment shall be done by means of screws.

- a. Nameplates shall be used for all major equipment such as switchboards, motor panelboards, motor control centers, transformers, panelboards (lighting, power and auxiliary) on each switch and starter in each panelboard and motor control center, disconnect switches, relays/contactors, loose mounted motor starters, and on control panels serving fire alarm, security and public address system and motor circuits.
 3. Labels (Stencils) - Shall be Brady or Westline and shall be color coded in accordance with ASA-Z34-1-53 "SAFETY COLOR CODE" to include system voltage, abbreviations of service, etc. For example: "480V", "Telephone", "Security", "Intercom", "Emergency", "120/208V", etc.
 - a. In general, all exposed feeders, conduits, raceways, pull boxes, and junction boxes shall be identified.
 - b. For conduit systems installed for future wiring installations, all conduits and pull boxes, both exposed and above ceiling, shall be identified.
 - c. Labels shall be used on all bare or smooth painted surfaces. For rough textured surfaces, such as wrinkle painted surfaces or plastic materials where sticking labels would not be permanent, stencils or screwed on letters shall be used.
 4. Label all low voltage wiring at both ends with Brady tags. Identify data and telephone cables by cable number and document on As-Built documents.
- B. Equipment Identification
1. Disconnect Switches and Motor Starters - Nameplates shall describe the equipment to be controlled and power circuit number.
 2. Pushbutton Stations - Label shall identify the equipment controlled.
 3. Fusible Switches - In addition to the nameplate, there shall be labeled on the inside of switch door, the fuse size required for equipment served.
 4. Junction and Pull Boxes - Identify the function of the box such as "208 volt," "Telephone," "Fire Alarm," etc., with nameplates.
- C. Raceway Identification
1. In general, all exposed feeder conduits, wireways, etc., shall be identified. Branch circuit designations shall be made only after the load balancing of the panelboards has been completed and shall be approved by Owner's representative. In general, designations shall include the area name and lighting type (e.g., Down Lights).
 2. The identification labels shall be located at intervals of 50 feet or less and at every point where a conduit or raceway is entering and leaving a room.
- D. Device Circuit Identification
1. Receptacles connected to emergency power shall be identified by panel name and circuit number, with labels adhered to the device cover plate.

2. Receptacles connected to normal power shall be identified by panel name and circuit number, with labels adhered to the device cover plate.

3.5 TEST

- A. Provide the tests as outlined hereinafter and other tests necessary to establish the adequacy, quality, safety, completed status and suitable operation of each system.
- B. Written test record shall be supplied to the Owner to show compliance with governing codes for grounding continuity.
- C. Final Corrections: Correct promptly any failure or defects revealed by these tests as determined by the Engineer. Reconduct tests on these corrected items as directed by the Engineer.

3.6 ALTERATIONS

- A. The Owner intends to make continued use of existing facilities during the construction period. Utilities and services to existing facilities shall not be interrupted without the Owner's approval. Organize the work as to cause a minimum of interference with the normal routine activities of the facilities. Interruptions shall be scheduled at the convenience of the Owner.
- B. Remove, cap and/or relocate equipment, outlets, conduit, wire, etc., as shown and specified on drawings.
- C. Disconnect switches, junction boxes, etc., which are shown on the demolition plans shall be removed.
- D. Concealed conduit for circuits which are partially or completely abandoned may remain in place. Exposed conduit for abandoned circuits shall be removed unless otherwise noted.
- E. Wiring for existing circuits which must be re-routed, or which are partially abandoned, shall be reconnected to service the remaining outlets on the circuit.
- F. Wiring for a circuit which is to be abandoned shall be removed back to the panel which supplied the circuit.
- G. Refer also to specification 260000 for demolition requirements.

3.7 CUTTING AND PATCHING

- A. Provide openings for conduit, by means of sleeves.
- B. Provide cutting required for conduits if sleeves or openings are not properly provided. Under no circumstances shall any structural members, load bearing walls or footings be cut without first obtaining written permission from the Structural Engineer.
- C. Cutting shall be limited to the size necessary for working conditions. When cutting surfaces are difficult or costly to replace, such as marble, glazed tile, wood paneling, etc., obtain the Owner's approval in advance of the cutting and patching.

- D. Before cutting or drilling holes in floors, verify the location of reinforcing steel bars and embedded electrical conduits to avoid cutting same. X-ray floors where necessary to verify such locations. Contact the Engineer before proceeding with cutting if such obstructions interfere with the locations of planned holes.

3.8 PAINTING

- A. Electrical equipment shall be factory finished standard color as furnished by the manufacturer. Scratches shall be touched up in the field after equipment is installed with paint which matches the original color.

END OF SECTION 260010

SECTION 260070 – ELECTRICAL CONNECTIONS FOR EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. This section covers electrical connections to equipment.

1.2 EQUIPMENT CONNECTIONS

- A. Extent of electrical connections for equipment is indicated by drawings and schedules. Electrical connections are hereby defined to include connections used for providing electrical power to equipment.
- B. Refer to drawings for additional requirements.
- C. Applications of electrical power connections specified in this section include the following:
 - 1. From electrical source to motor starters/VFDs.
 - 2. From motor starters/VFDs to motors.
 - 3. From electrical source to equipment with pre-wired control panels.
- D. Provide electrical connections for equipment, specified in Division 21, 22, & 23 and in other Division 26 sections.
- E. Provide motor starters and controllers, not furnished as part of equipment.
- F. Refer to Division 21, 22, & 23 sections for motor starters and controllers furnished with equipment.
- G. Provide disconnect switches and junction boxes required for connecting motors and other electrical units of equipment.
- H. Variable Frequency Drives (VFD) will be furnished under Division 22 & 23. Install VFDs and provide wiring and connections. Include wiring between VFD and an auxiliary contacts in the local safety switch to shut down VFD when safety switch is turned off and circuit is open. This shut down wiring shall be installed in separate conduit from the power wiring.
- I. Provide electrical identification for wire/cable conductors.
- J. Provide raceways and wires/cables required for connecting motors and other electrical units of equipment.
- K. Temperature control system wiring will be provided under Division 23.
- L. Refer to sections of other divisions for specific individual equipment power requirements requiring electrical connections.

1.3 QUALITY ASSURANCE

- A. ANSI Compliance: Comply with applicable requirements of ANSI/NEMA and ANSI/EIA standards pertaining to products and installation of electrical connections for equipment.

- B. U.L. Compliance: Comply with U.L. Std. 486A, “Wire Connectors and Soldering Lugs for Use with Copper Conductors” including, but not limited to, tightening of electrical connectors to torque values indicated. Provide electrical connection products and materials which are U.L. listed and labeled.
- C. Comply with NFPA 70 “National Electrical Code” for components and installation.

PART 2 - PRODUCTS

- 2.1 Provide products, components and materials which are listed and labeled by UL.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Inspect area and conditions under which electrical connections for equipment are to be installed and notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.2 INSTALLATION OF ELECTRICAL CONNECTIONS

- A. Install electrical connections as indicated, in accordance with equipment manufacturer’s written instructions and with recognized industry practices and complying with applicable requirements of U.L., NEC and NECA’s “Standard of Installation” to ensure that products fulfill requirements.
- B. Coordinate with other work, including wire/cables, raceway and equipment installation, as necessary to properly interface installation of electrical connections for equipment with other work.
- C. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer’s written instructions and wiring diagrams. Mate and match conductors of electrical connections for proper interface between electrical power supplies and installed equipment.
- D. Cover splices with electrical insulating material equivalent to, or of greater insulation resistivity rating than, the electrical insulation rating of those conductors being spliced.
- E. Prepare cables and wires by cutting and stripping covering armor, jacket and insulation properly to ensure uniform and neat appearance where cables and wires are terminated. Exercise care to avoid cutting through tapes which will remain on conductors. Also avoid “ringing” copper conductors while skinning wire.
- F. Trim cables and wires as short as practicable and neatly arrange routing to facilitate inspections, testing and maintenance.
- G. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer’s published torque tightening values for equipment connectors. Accomplish tightening by utilizing proper torqueing tools, including torque screwdriver, beam-type torque wrench and ratchet wrench with adjustable torque settings. Where manufacturer’s torqueing

requirements are not available, tighten connectors and terminals to comply with torquing values contained in U.L's 486A.

- H. Provide flexible conduit for motor connections and other electrical equipment connections, where subject to movement and vibration.
- I. Provide liquid-tight flexible conduit for connection of motors and other electrical equipment where subject to movement and vibration, and also where connections are subjected to one or more of the following conditions:
 - 1. Exterior location
 - 2. Moist or humid atmosphere where condensate can be expected to accumulate
 - 3. Corrosive atmosphere
 - 4. Water spray
 - 5. Dripping oil, grease or water
 - 6. Kitchens or Dishwash areas
- J. Fasten identification markers to each electrical power supply wire/cable conductor which indicates their voltage, phase and feeder number in accordance with Division 26, Sections 260010 and 260120, Part 3.4. Affix markers on each terminal conductor, as close as possible to the point of connection.

3.3 FIELD QUALITY CONTROL

- A. Upon completion of installation of electrical connections, and after circuitry has been energized with rated power source, test connections to demonstrate capability and compliance with requirements. Ensure that direction of rotation of each motor fulfills requirement. Correct malfunctioning units at site, then retest to demonstrate compliance.

END OF SECTION 260070

SECTION 260110 – RACEWAYS, FITTINGS AND BOXES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Applicable provisions of the General Conditions, Supplementary General Conditions and Special Conditions shall govern work performed under this section.

1.2 SUMMARY

- A. This section includes raceways, fittings and outlet boxes.

1.3 QUALITY ASSURANCE

- A. Comply with NFPA 70 “National Electrical Code” for components and installation.
- B. Comply with NECA 101, “Standard for Installing Steel Conduit (Rigid, IMC, EMT).”
- C. Comply with NECA 111, “Standard for Installing Non Metallic Raceways (RNC, ENT and LFNC).”
- D. Comply with NECA 120, “Standard for Installing Armored Cable (Type AC) and Metal Clad Cable (Type MC).”
- E. Comply with NECA 605, “Recommended Practice for Installing Underground Nonmetallic Utility Duct.”

1.4 SUBMITTALS

- A. Submit data sheet for all fire stopping materials.
- B. Submit information on raceways, conduits, boxes and wireways.

PART 2 - PRODUCTS

2.1 RACEWAYS (Raceways shall be new and shall bear the UL label)

- A. Electrical Metallic Tubing: Shall be cold rolled welded steel conduit, galvanized on both the outside and inside. Connectors and couplings shall be steel alloy. Setscrew connectors and couplings are approved for indoor exposed or concealed (but not encased in concrete or masonry) work only. Gland compression connectors and couplings are approved for all locations. Indenter type connectors and couplings are not approved. Connectors up to and including size 1-1/2" shall be with insulated throat. Connectors shall be terminated with a bonding type locknut and for conduit sizes 2" and larger, a plastic insulated bushing. Threaded steel insulated grounding bushings having solderless lugs shall be used where required. Comply with ANSI C80.3. Connectors shall be steel; die-cast is not acceptable.
- B. Intermediate Metal Conduit (IMC): Shall be zinc-coated steel tubing. Comply with ANSI C80.6.
- C. Rigid Steel Conduit: Shall be zinc-coated rigid steel conduit and conduit fittings. Comply with ANSI C80.1 and UL 6. Couplings and fittings shall be of the threaded type. Threadless fittings shall be used only when specific approval is given by the engineer.
- D. Flexible Metallic Conduit: Shall be zinc-coated steel, single strip type, UL listed. Use Anaconda "Sealtite" flexible, liquid-tight conduit in damp or wet locations.

- E. Wireway: Shall be constructed of code gauge steel and shall be in accordance with Underwriters Laboratories Standard UL-870 for Wireways, Auxiliary Gutters and Associated Fittings. Wireway shall be lay-in type (no cross bars or straps) with hinged cover. Indoor wireway shall be constructed with knockouts. Outdoor wireway shall be raintight with no knockouts. Sheet metal parts shall be coated with a rust-inhibiting primer and a gray baked enamel finish. Hardware shall be plated to prevent corrosion. Wireway shall be of standard dimensions and sized in accordance with the National Electrical Code for the particular installation. Wireway shall be Square D "SQUARE-DUCT" or approved equivalent.

2.2 OUTLET BOXES

- A. Provide outlet boxes; pull boxes, and conduit fittings as described below. Catalog numbers shown are those of Appleton Electric Company. Steel City, National Electric Products Corp., and Racor are equally acceptable. Comply with NEMA OS-1 and FB
 1. Lighting Boxes (concealed) - No. 40-3/4
 2. Lighting Boxes (concrete) - No. OCR Series
 3. Lighting Boxes (exposed) - No. 4S-3/4 or 40-3/4
 4. Switch, Receptacle, Telephone and Junction Boxes (flush) - No. 4S-3/4 or No. 225 where separate extension or plaster ring cannot be used.
 5. Switch, Receptacle, Telephone and Junction Boxes (exposed) - FS Series
 6. Switch and Telephone Boxes (concealed in narrow mullions) - Bell Electric Co. No. 447, 448, or 449.
 7. Weatherproof or Exterior Boxes - FS Series with weatherproof while-in-use cast metal cover and neoprene gasket.
- B. Where space is limited, No. 4CS-3/4 handy boxes may be used for a switch, receptacle, telephone or other outlet.
- C. Provide extension and plaster rings as required.
- D. Size outlet boxes in accordance with the allowable fill permitted by the National Electrical Code.

2.3 PULLBOXES

- A. Provide code gauge galvanized sheet metal pull boxes sized as per the National Electrical Code or as shown on the drawings. Provide a removable cover on the largest access side of the box unless otherwise detailed. Where cast boxes are specified, provide conduit entrances with threaded hubs. Provide stainless steel screws in all exterior locations and in wet or damp locations.

2.4 CONDUIT FITTINGS

- A. UL-514B, NEMA FB-1 and NEMA TC-3 listed. Steel material, die-cast is not acceptable.
- B. EMT Couplings:
 1. Series 95T gland compression (all locations).
 2. Series TWC set screw (indoor only but not encased in concrete or masonry)
 3. Steel material, die-cast is not acceptable.

- C. EMT Connectors:
 - 1. Series 86T gland compression (all locations)
 - 2. Series TW set screw (indoor only - but not encased in concrete or masonry)
 - 3. Steel material, die-cast is not acceptable.
- D. Insulating Bushings (1-1/4 inch rigid conduit and larger) - Series BBU
- E. Straight Box Connectors (flexible conduit) - Series 728 9V
- F. Angle Box Connectors (flexible conduit) - Series 738 2V
- G. Sealing Gland Assembly - OZ, Type FSK
- H. Expansion Joints - OZ, Type AX or TX with bonding jumpers and clamps.
- I. Expansion and Deflection Fittings - OZ, Type DX
- J. Cast Metal Conduit Fittings - Crouse-Hinds, Condulets form 7 with wedge nut cover.

PART 3 - EXECUTION

3.1 RACEWAYS - GENERAL

- A. Install all wiring, including low voltage, etc., in raceways as indicated on the plans and in this specification.
- B. Install raceways concealed, except in mechanical equipment rooms or where indicated on the plans.
- C. Minimum raceway size shall be 3/4" for interior applications and 1" for exterior applications.

3.2 APPLICATION

- A. Conduits located exposed, concealed inside shafts or column enclosure and all homeruns shall be EMT.
- B. Sleeves and conduits for feeders over 600 volts shall be rigid steel conduit.
- C. Conduits for connection to vibrating equipment such as motors, transformers, etc., and for heat loops to light fixtures from junction boxes above them shall be metallic flexible conduit, maximum length of six feet. Weatherproof Sealtite shall be used in damp or wet locations (cooling towers).
- D. Any type of conduit or raceway that is specifically labeled on the plans shall take precedence over the specification. Obtain written permission from the Engineer for any other deviation from the specification requirements.
- E. Keep emergency and normal raceways separate and follow separate routes. Normal and emergency conductors shall not be installed in the same raceway.

3.3 INSTALLATION

- A. Continuity. Provide metallic raceways continuous from outlet to outlet, and from outlets to cabinets, junction or pull boxes. Enter and secure conduit to all boxes to provide electrical continuity from the point of service to outlets. Provide double locknut and bushing on terminations of metallic conduits.
- B. Raceways Exposed. Run exposed raceways in straight lines at right angles or parallel with walls, beams or columns.
- C. Sleeves: Sleeves through floors and walls shall be not less than three diameters on centers. Conduit sleeves in floors shall be steel and shall extend 3 inches above the finished floor and flush with the underside of the floor slab. Size sleeves to provide $\frac{1}{4}$ " annular clear space (interior sleeves) or 1" (exterior sleeves) between sleeve and raceway.
- D. Sealing of Sleeves: Openings and sleeves through which a conduit passes in non-fire rated walls, floors, and ceilings shall be properly sealed after the conduit is installed to prevent transmission or leakage of liquids, smoke, and sound. Conduit passing through drywall construction or sleeves shall be sealed both sides of the opening shall be caulked with a resilient non-hardening caulking such as U.S.G. Acoustical Sealant, Tremco, or approved equal.
- E. Sealing of Sleeves: Conduit passing through fire rated floors, walls and ceilings shall be sealed by a UL Listed System with hourly rating equivalent to fire rated floors, walls or ceilings. Fire proofing materials by S.T.I., U.S.G., Tremco, 3M and Hilti must be installed according to UL Listed Systems.
- F. Sleeves for fire rated walls and ceilings where data, voice, etc., cables penetrate fire walls or fire rated ceilings provide a fire stopping system as manufactured by STI EZ-Path, Wiremold FlameStopper or equal. Fire stopping system shall be UL classified and FM approved in accordance with ASTM E814 (UL1479).
- G. Bends. Where more than one conduit in a bank of exposed conduit changes direction, all bends shall be concentric. Conduit bends shall not be less than standard radius. Conduit bends for power feeders over 600 volts and for telephone feeders shall be long radius.
- H. Threads. Clean all threads of rigid conduit. Coat all male threads of all steel conduit installed underground or in or under concrete slabs with teflon immediately before being coupled together.
- I. Running Threads. Use "Erickson" type couplings in lieu of running threads.
- J. Protection. Cap raceways stubbed up, including those in cabinets, immediately upon their installation. The use of paper or rag wads will not be permitted.
- K. Expansion Joints. Provide raceways crossing expansion joints with Type BJ bonding jumper for bonding conduit or tubing together. Where differential settlement may occur, use deflection fittings.
- L. General Location Requirements. Raceway runs shown are diagrammatic. Determine exact locations in the field except where otherwise noted or where dimensions are specified on the drawings. Conduits shall not run within 12 inches of pipes carrying hot liquids, steam, or gases.

- M. Pull Tapes. Empty conduits shall be provided with a pull tape.
- N. Provide accessories as required for a complete installation, including insulated bushings and inserts where required by the manufacturer or NEC. Provide insulated bushings on all conduit stub-ups, where conduit does not terminate in a box or enclosure, and on all enclosure openings where cables enter or exit unprotected by conduit.
- O. Install no more than the equivalent of three 90-degree bends in any conduit run except for communication conduits. Communications conduits shall have a maximum of two 90-degree equivalent bends for each raceway. Communication conduits 3/4" and less shall be installed in maximum lengths of 50 feet and 1" and larger at 75 feet maximum lengths.

3.4 RACEWAYS SUPPORTS

- A. Supports. Install raceway supports in accordance with the requirements of the National Electrical Code. Do not anchor or strap conduits to the ceiling furring channels or attach to ceiling hanger wires.
- B. Straps and Hangers. Conduit shall be supported from building structure on approved types of galvanized brackets, ceiling trapeze or pipe straps, or hangers secured by means of toggle bolts on hollow masonry; or expansion bolts in concrete or brick; or machine screws on metal surfaces; or wood screws on wood construction. Conduits shall be attached to the hanging systems by fittings equal to those manufactured by Caddy Fasteners. Nails shall not be used as a means of fastening boxes or conduits. Perforated flat steel straps shall not be used for supporting conduit. Conduits shall not be supported from ductwork or ductwork supports. Conduit shall be properly supported in order to deter any possible vibration, noise, or chatter.

3.5 JOINTS AND CONNECTIONS

- A. Metal Conduits. Make watertight all couplings and threaded connections in threaded conduit. Cut all joints square, ream smooth, and properly thread. Fit all box connections with a minimum of two approved locknuts and one steel, plastic or fiber bushing forming an approved tight bond with box. Provide locknuts both inside and outside of the enclosure to which the conduit is attached. Use rain tight compression type fittings for electrical metallic tubing systems and use at least one locknut on the inside of each enclosure entry. Provide grounding locknuts or bushings where required in Section 260455 GROUNDING SYSTEMS.
- B. Join raceways with fittings designed and approved for the purpose and make joints tight. Make raceway terminations tight. Use bonding bushings or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight. Use insulating bushings to protect conductors.
- C. Tighten set screws of threadless fittings with suitable tool.
- D. Terminations: Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely, and install the locknuts with dished part against the box.
- E. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed.

- F. Flexible Connections: Use maximum of 6 feet (1830 mm) of flexible conduit for recessed and semi-recessed lighting fixture; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use liquidtight flexible conduit in wet or damp locations. Install separate ground conductor in flexible connections.

3.6 BOX APPLICATIONS

- A. Outlet Boxes and Fittings: Install outlet and device boxes and associated covers and fittings of materials and NEMA types suitable for each location and in conformance with the following requirements:
 - 1. Interior Dry Locations: Sheet steel, NEMA type 1.
 - 2. Locations Exposed to Weather or Dampness: Cast metal, NEMA type 3R.
 - 3. Wet Locations: NEMA type 4X enclosures.
- B. Pull and Junction Boxes: Install pull and junction boxes of materials and NEMA types suitable for each location, except as otherwise indicated.

3.7 OUTLET BOX INSTALLATION

- A. Install items where indicated and where required to suit code requirements and installation conditions.
- B. Cap unused knockout holes where blanks have been removed and plug unused conduit hubs.
- C. Support and fasten items securely in accordance with Division 26 Section "Supporting Devices."
- D. Sizes shall be adequate to meet NEC volume requirements, but in no case smaller than sizes indicated.
- E. Remove sharp edges where they may come in contact with wiring or personnel.
- F. Mounting: Mount outlet boxes for switches with the long axis vertical. Mount boxes for receptacles vertically. Three or more gang boxes shall be mounted with the long axis horizontal. Locate box covers or device plates so they will not cover different types of building finishes either vertically or horizontally. Locate boxes for switches near doors on the side opposite the hinges.
- G. Ceiling Outlets: For fixtures, where wiring is concealed, use outlet boxes 4-inches square by 1-1/2 inches deep, minimum.
- H. Protect outlet boxes to prevent entrance of plaster and debris. Thoroughly clean foreign material from boxes before conductors are installed.

END OF SECTION 260110

SECTION 260120 - CONDUCTORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Applicable provisions of the General Conditions, Supplementary General Conditions and Special Conditions shall govern work performed under this section.

1.2 SUMMARY

- A. This section includes conductors, wires, cables and associated splices, connections and terminations for wiring systems rated 600V or less.

1.3 QUALITY ASSURANCE

- A. Conductors and cable shall conform to UL, NEMA WC70, NECA 120, NFPA 70 and ICEA S-95-658 requirements.
- B. Comply with NECA 120, "Standard for Installing Armored Cable (Type AC) and Metal Clad Cable (Type MC)."
- C. Comply with NECA / AA 104, "Standard for Installing Aluminum Building Wire and Cable."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Wires and Cables
 - 1. Alcan Products Corporation; Alcan Cable Division
 - 2. American Insulated Wire Corp.; Leviton Manufacturing Co.
 - 3. BICC Brand-Rex Company
 - 4. Carol Cable Co., Inc.
 - 5. Service Wire Company
 - 6. Southwire Company
 - 7. Alflec Corporation
 - 8. AFC Cable Systems, Inc.
 - 9. Colonial Wire and Cable Co., Inc.
 - 10. General Cable Corporation
 - 11. Okonite Company
 - 12. Pirelli Cable Company
 - 13. Superior Essex
- B. Connectors for Wires and Cables
 - 1. AMP Inc.
 - 2. General Signal; O-Z/Gedney Unit
 - 3. Tyco Electronics Corporation
 - 4. Square D Co.; Anderson
 - 5. 3M Company; Electrical Products Division

6. AFC Cable Systems, Inc.
7. Erico, Inc.
8. Hubbell Power Systems, Inc.
9. ILSCO Corporation
10. Thomas & Betts Corporation

2.2 CONDUCTORS

- A. Provide copper conductors with insulation rated for 600 volts, type THHN or THWN for interior use and type XHHW-2 for exterior installation.
- B. Conductors No. 10 AWG and smaller shall be solid. Conductors No. 8 AWG and larger shall be stranded.
- C. Provide single copper conductors throughout. Provide No. 12 AWG minimum branch circuit wire size. Provide No. 14 AWG for control circuits, unless otherwise specified or required by overcurrent protection.
- D. For exterior feeders or branch circuits, provide Type XHHW-2 conductors installed in underground raceways.

2.3 CONNECTORS FOR CONDUCTORS

- A. Provide UL-listed factory-fabricated, solderless metal connectors of sizes, ampacity ratings, materials, types and classes for application and for service indicated. Use connectors with temperature ratings equal to or greater than those of the wires upon which used.

2.4 CABLES

- A. Type MC cable shall be THHN/THWN insulated circuit conductors with full size insulated ground wire enclosed within flexible metal covering. Metal covering shall be galvanized steel.
- B. Type AC cable shall have THHN/THWN insulated circuit conductors with bonding conductor enclosed with flexible metal covering. Metal covering shall be galvanized steel.
- C. Connectors and fittings for type MC and type AC cable shall be manufactured and listed for that purpose.

2.5 TYPE NOT PERMITTED

- A. The following wire and cable types are not permitted to be used:
 1. BX
 2. NM/NME
 3. TW

PART 3 - EXECUTION

3.1 CONDUCTOR SIZES AND TYPES

- A. Low voltage wire and cable for audio, signal and control cables are specified elsewhere in this Specification.

- B. Any 120V circuit, whose home run length from panel to first fixture or device exceeds one hundred (100) feet for 120V circuits, shall not be less than 10 gauge for the entire length of run, to minimize voltage drop.
- C. Wire size and insulation type entering any lighting fixture or equipment shall be as recommended by the manufacturer and as minimally required by the codes. Where no recommendation is given by the manufacturer, the wire size and insulation type shall meet the minimum rating of the wiring or terminations used in the fixture or equipment.
- D. Conductor sizes for motors, equipment and feeders shall be as indicated. See Schedules on drawings.
- E. Type AC cable may be used only for flexible connections to recessed lighting fixtures from separately mounted outlet boxes. Length shall not exceed six feet.
- F. Type MC cable shall not be used for homeruns. Use EMT conduit for all homeruns and connection to Electrical Panels.

3.2 INSTALLATION

- A. Wire and cable shall be installed in conduit, duct, wireway or other raceway specified. No conductors or cables shall be installed in conduits, ducts or raceways until the raceway system has been completed and free of any dirt or water. When installing conductors, exercise due care to prevent damage to conductors and insulation.
- B. Wire 10 gauge or smaller shall be spliced, tapped or joined in outlet or junction boxes with solderless spring-type connectors. Bakelite insulated wire nuts are not approved.
- C. Conductors 8 gauge and larger shall be terminated using bolted pressure or compression type connectors. They shall be specifically designed for use with the type conductors being installed in compliance with manufacturer's recommendations.
- D. Uninsulated splices, joints and free ends of conductors shall be covered with rubber and friction tape or high dielectric polyvinylchloride Scotch No. 33 Plus electrical tape.
- E. Feeder cables shall be continuous from origin to panel or equipment termination without splices in intermediate pull or splice boxes or raceway runs. Where taps and splices are necessary, they shall be made in approved splice boxes with suitable compression type connectors.
- F. Coordinate wire installation with other work. Support cables in accordance with Section 260190.
- G. Pull conductors simultaneously where more than one is being installed in same raceway. Use UL listed pulling compound or lubricant, where necessary. Perform pull tension calculations and do not exceed those values.
- H. Use pulling means including fish tape, cable, rope and basket weave wire/cable grips which will not damage cable or raceways. Do not use rope hitches for pulling attachment to wire or cable. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

- I. Keep conductor splices to a minimum. Provide splice and tap connectors which possess better mechanical strength and insulation rating than conductors being spliced. Use splice and tap connectors which are compatible with conductor materials.
- J. Provide adequate length of conductors within electrical enclosures and train the conductors to terminal points with no excess. Make terminations so there is no bare conductor at the terminal. Bundle conductor sizes #12 and #10 together. Bundle individual circuits larger than #10 separately.
- K. Tighten electrical connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A and UL 486B.
- L. Connect wiring devices, light fixtures, panelboard devices and other electrical equipment to the wiring systems as indicated and in accordance with manufacturer's instructions.
- M. Leave a minimum of 12" pigtail at each outlet for termination purposes.
- N. Home runs shall be in conduit. Not more than three (3) branch circuits may be grouped in one (1) homerun to a branch circuit panelboard. Derate conductors per NEC requirements and count the neutral as a current carrying conductor.
- O. Install conductors with compression type motor pigtail connectors of sizes as required for motors and mechanical equipment. Connectors shall be rated for 600V, 90 degrees C, and tin plated copper with the thermoplastic elastomer insulator.
- P. Where lugs or termination points are not sized to accommodate the wire size specified or are not listed for the conductor material, provide pin connectors rated for use with copper/aluminum conductors and terminate with a tool and die size recommended by the connector manufacturer.
- Q. Keep emergency conductors independent and separate from all other conductors. Do not route emergency conductors and normal conductors in the same raceway.

3.3 FIELD QUALITY CONTROL

- A. Prior to energizing, check installed wires and cables with megohm meter to determine insulation resistance levels to assure requirements are fulfilled. Visually inspect all terminations are tight and proper and materials installed are in accordance with the specification section.
- B. Prior to energizing test wires and cables for electrical continuity and for short-circuits and proper phase relationship. Verify conductors are appropriately color coded.
- C. Subsequent to wire and cable hook-ups, energize circuits and demonstrate proper functioning. Correct malfunctioning units, and retest to demonstrate compliance.
- D. Torque all connections/lugs in accordance with manufacturer instructions. Where torque values are absent, follow ANSI/NETA Standard for acceptance testing specifications.

3.4 COLOR CODING FOR PHASE IDENTIFICATION

- A. Color code secondary service, feeder and branch circuit conductors with factory applied color as follows:

<u>208Y/120 Volts</u>	<u>Phase</u>	<u>480Y/277 Volts</u>
Black	A	Yellow
Red	B	Brown
Blue	C	Orange
White	Neutral	White/Gray Stripe
Green	Ground	Green

- B. Where the local jurisdiction requires, color code 480Y/277 phase C conductor purple.
- C. Phase conductors with special marking, such as in type MC cable assemblies, shall be acceptable.
- D. Conductors manufactured in only one color shall be marked with colored tape at each termination to identify each conductor as phase, neutral or ground.
- E. Ungrounded conductors supplied from more than one nominal voltage system shall be separately identified where accessible.

END OF SECTION 260120

SECTION 260160 – SAFETY SWITCHES

PART 1 - GENERAL

1.1 GENERAL

- A. This section covers Safety Switches.
- B. Furnish and install safety disconnect switches where indicated on the drawings, in the equipment schedules and as specified elsewhere herein.

1.2 RELATED DOCUMENTS

- A. Applicable provisions of the General Conditions, Supplementary General Conditions and Special Conditions shall govern work performed under this section.

1.3 RELATED SECTIONS

- A. Fuses are covered in Section 260180, LOW VOLTAGE FUSES.
- B. Individually-mounted starters are covered in Section 260150, Motors and Motor Controls.
- C. Refer to Section 260010, Basic Electrical Materials and Methods, for Nameplates.

1.4 QUALITY ASSURANCE

- A. Switches shall be Underwriter's Laboratories, Inc., listed, and shall meet Federal Specification WS-865c and NEMA Specifications KS1.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Safety Switches shall be as manufactured by Square D, Eaton, General Electric or Siemens.

2.2 SAFETY SWITCHES

- A. Disconnect safety switches shall be single-throw, positive quick-make, quick-break contact mechanism, fusible or non-fusible as indicated, heavy duty, horsepower rated, dead front, and front accessible. The switch handle shall physically indicate the ON and OFF positions. Such handles shall also be able to accept a padlock having heavy duty industrial type shackles, and be padlocked either in the ON or the OFF position. Covers shall be interlocked with the switch handles to prevent opening in the ON position. An interlock override device shall be provided to allow authorized personnel to release the interlock for inspection purposes when the switch is in the ON position. Switch ampere rating and number of poles shall be as indicated on the drawings or as required. Fuse clips shall be positive pressure cartridge type and shall accommodate the classification of fuses as indicated on the drawings and/or as specified.
- B. The disconnect handle shall be attached to the box or enclosure base, and not to the cover. Terminal lugs shall be Underwriter's Laboratories listed for copper and aluminum cables and shall be front removable. All current carrying parts shall be plated by electrolytic processes.
- C. Switch enclosures for indoor locations shall generally be NEMA 1 heavy duty, code gauge sheet steel. Switches located outdoors or in wet locations shall be NEMA 3R rain tight, code gauge

galvanized steel and are identified on the drawings as weatherproof (WP). Exterior switches located at cooling towers shall be NEMA 4 watertight, stainless steel. Switches located in food service preparation and dishwashing areas shall be NEMA 4 watertight, stainless steel. Switches located in hazardous areas shall have enclosures of the proper NEMA type construction for the location and application and will be so indicated on the drawings. Enclosures shall meet Underwriter's Laboratories Standard 98, and shall be treated with a rust-inhibiting phosphate and finished in gray baked enamel paint.

- D. Heavy duty switches shall have permanently attached arc suppressors hinged or otherwise attached to permit easy access to line-side lugs without removal of the arc suppressors.
- E. Switches used in circuits having a neutral conductor shall be provided with an insulated (isolated) ground able solid neutral terminal bar.
- F. Provide auxiliary contacts in all safety switches. Auxiliary contacts shall be (2) N.O. and (2) N.C. form C type. Connect auxiliary contacts to VFD controls to shut down when circuit is opened for safety switches used with VFDs.
- G. Provide an internally mounted ground bus kit labeled for copper or aluminum ground conductors in all safety switches.

PART 3 - EXECUTION

- 3.1 Properly align Safety Switches and adequately support independent of the connecting raceways. Provide steel straps and appurtenances necessary for the support of the equipment.
- 3.2 Furnish and install fuses in fusible safety switches where required. Verify rating of installed fuses.
 - A. Comply with NECA 1, NEMA PB1.1 and PB 2.1.
 - B. Install wall mounted switches with tops at uniform height, unless noted otherwise.
 - C. Install fuses so ratings are readable in the installed position.
- 3.3 On completion of installation, vacuum dirt and debris from interiors. DO NOT use compressed air to assist in cleaning.

END OF SECTION 260160

SECTION 260180 - LOW VOLTAGE FUSES - 600 VOLTS AND LESS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Applicable provisions of the General Conditions, Supplementary General Conditions and Special Conditions shall govern work performed under this section.

1.2 SUMMARY

- A. This section includes fuses for electrical systems operating at 600V or less.
- B. Provide fuses of the sizes and ratings shown on the drawings.

1.3 QUALITY ASSURANCE

- A. Comply with NFPA 70 "National Electrical Code" for components and installation.
- B. Comply with NEMA FU1.
- C. Comply with NECA 420, "Standard for Fuse Applications."

1.4 SUBMITTALS

- A. Product Data: Manufacturer's technical data on characteristics and ratings.
- B. Let-through current curves.
- C. Ambient temperature adjustment information and calculations

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. Provide fuses manufactured by Bussmann Manufacturing Division of Cooper Industries or equivalent from Mersen or Littelfuse.

2.2 FUSES

- A. All fuses for the distribution system shall be of the same manufacturer to ensure selective coordination. Fuses shall have a UL listed 200,000 ampere interrupting rating.
- B. Switchboards and panelboards shall not be shipped to the project with the fuses installed.
- C. Type of fuses to be used shall comply with the following, unless otherwise noted on the plans:
 - 1. Main, Feeders and Branch Circuits:
 - a. 0 to 600 ampere - use Bussmann LOW PEAK YELLOW, UL Class RK-1, dual-element, time delay fuses.
 - 1) Type LPN-RK (amp) SP for 250 volts
 - 2) Type LPS-RK (amp) SP for 600 volts

- b. or if the equipment has Class J fuse mountings, use Bussmann LOW PEAK YELLOW, Class J, dual-element, time delay fuses.
 - 1) Type LPJ (amp) SP

2.3 SUBSTITUTION APPROVALS

- A. The E.C.'s proposal shall be based upon the fuse specified using the manufacturer's catalog numbers as called for in the specification or on the drawings. Coordination and current limitation for protection of each part of the electrical system has been designed around the type, class and manufacturer specified.
- B. Different manufacturers' fuses of the same UL classification can have different electrical performance and/or electrical characteristics. Therefore, multiple manufacturers will not be acceptable. Provide fuses from a single manufacturer throughout the project.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Fuses shall not be installed until the electrical installation is complete, including thorough cleaning, tightening of all electrical connections, inspection of all grounding conductors, and a megger test for adequate installation to ground of all circuits.
- B. Provide Bussmann metal fuse reducers where the fuses are smaller than the fuse clips.
- C. A fuse identification label, showing type and size, shall be placed inside the door of each switch.
- D. Install fuses in fusible devices and arrange so rating information is readable without removing fuse.

END OF SECTION 260180

SECTION 260190 - SUPPORTING DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Conduit and equipment supports.
- B. Anchors and fasteners.

1.2 RELATED DOCUMENTS

- A. Applicable provisions of the General Conditions, Supplementary General Conditions and Special Conditions shall govern work performed under this section.

1.3 REFERENCES

- A. NECA 101- "Standard for Installing Steel Conduit (Rigid, IMC, EMT)."
- B. ANSI/NFPA 70 - National Electrical Code.
- C. Refer to 260025, SEISMIC RESTRAINTS Section for additional requirements.

PART 2 - PRODUCTS

2.1 Materials and Finishes: Provide adequate corrosion resistance.

2.2 Provide material, sizes and types of anchors, fasteners and supports to carry the loads of equipment and conduit. Consider weight of wire in conduit when selecting products. System shall be adequate in tension, shear and pullout forces to resist maximum loads calculated or imposed with a minimum structural safety factor of four times the applied force. Minimum static design load shall be the weight of supported components, plus 200 lbs.

2.3 Anchors and Fasteners:

- A. Concrete structural elements: Use expansion anchors.
- B. Steel structural elements: Use beam clamps, spring steel clips, steel ramset fasteners, or welded fasteners.
- C. Concrete surfaces: Use self-drilling anchors and expansion anchors.
- D. Hollow Masonry, plaster, and gypsum board partitions: Use toggle bolts and hollow wall fasteners.
- E. Solid masonry walls: Use expansion anchors.
- F. Sheet Metal: use sheet metal screws.
- G. Wood elements: Use wood screws.

2.4 Steel strut framework: Provide 12 gauge minimum size framework similar and equivalent to B-line or Unistrut for supporting electrical enclosures where noted or where necessary for a rigid installation.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Provide anchors, fasteners, and supports in accordance with NECA "Standard of Installation", NECA 1 and 101. Space supports as scheduled in NECA 1 where Table 1 lists maximum spacings less than those listed in NFPA 70.
- C. Do not fasten supports to pipes, ducts, mechanical equipment, and conduit.
- D. Do not drill or cut structural members.
- E. Fabricate supports from structural steel or steel channel. Rigidly weld members or use hexagon head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.
- F. Install surface-mounted equipment enclosures with minimum of four anchors.
- G. In wet and damp locations use steel channel supports to stand equipment enclosures one inch off wall.
- H. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.
- I. Install trapeze-type supports fabricated with steel slotted support system. Secure raceways to supports with two-bolt conduit clamps.
- J. Cast anchor bolts into concrete housekeeping bases and anchor equipment. Install anchor bolts per equipment manufacturer's setting drawings, templates, diagrams, instructions and directions at required elevations.

END OF SECTION 260190

SECTION 260455 – GROUNDING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Applicable provisions of the General Conditions, Supplementary General Conditions and Special Conditions shall govern work performed under this section.

1.2 SUMMARY

- A. This Section includes grounding of electrical systems and equipment and basic requirements for grounding for protection of life, equipment, circuits and systems. Grounding requirements specified in this section may be supplemented in other sections of these specifications.

1.3 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product Data for connectors and connection materials, and grounding fittings.
- C. Field tests and observation reports indicating and interpreting the test reports for compliance with performance requirements.

1.4 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. Comply with UL 467.
- C. Listing and Labeling: Provide products specified in this section that are UL listed and labeled.
- D. Comply with NECA 331, "Standard for Building and Service Entrance Grounding and Bonding."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Chance: A. B. Chance Co
 - 2. Erico, Inc.; Electrical Products Group
 - 3. Ideal Industries, Inc
 - 4. ILSCO
 - 5. O-Z/Gedney Co
 - 6. Raco, Inc
 - 7. Thomas & Betts

2.2 GROUNDING AND BONDING PRODUCTS

- A. Governing Requirements: Where types, sizes, ratings and quantities indicated are in excess of National Electrical Code requirements, the more stringent requirements and the greater size, rating and quantity indications govern.

- B. Grounding Bus: Rectangular bar of annealed copper with tapped holes and insulated spacers.

2.3 WIRE AND CABLE GROUNDING CONDUCTORS

- A. Comply with Division 26 Section 260120, "Conductors". Conform to NEC Article 250, except as otherwise indicated, for conductor properties, including stranding.
- B. Material: Use only copper wire for both insulated and bare grounding conductors and similar materials.
- C. Equipment Grounding Conductors: Insulated with green color insulation, Type THW, THHN or THWN insulation.
- D. Grounding-Electrode Conductors: Stranded cable.
- E. Underground Conductors: Bare, tinned, stranded, except as otherwise indicated.
- F. Bare Copper Conductors: Conform to the following:
 - 1. Solid Conductors: ASTM B3.
 - 2. Assembly of Stranded Conductors: ASTM B 8.
 - 3. Tinned Conductors: ASTM B 33.

2.4 MISCELLANEOUS CONDUCTORS

- A. Grounding Bus: Bare, annealed-copper bars of rectangular cross section.
- B. Braided Bonding Jumpers: Copper tape, braided No. 3/0 AWG bare copper wire, terminated with copper ferrules.
- C. Bonding Straps: Soft copper, 0.05 inch (1 mm) thick and 2 inches (50 mm) wide, except as indicated.

2.5 CONNECTOR PRODUCTS

- A. Pressure Connectors: High conductivity plated units.
- B. Bolted Clamps: Heavy duty type or Hammer Lock. Acorn clamps are not acceptable.
- C. Exothermic-Welded Connections: Cadweld type, provided in kit form and selected per manufacturer's instructions.

PART 3 - EXECUTION

3.1 GENERAL

- A. The entire electrical system and all electrical equipment shall be grounded in strict accordance with the National Electrical Code and as shown on the drawings.
- B. The grounding system shall be continuous throughout the electrical system. Route along shortest and straightest paths possible. Avoid obstructing access or installing where they may be subjected to strain, impact or damage.

- C. Neutral conductors shall be continuous throughout the electrical system and shall be grounded only at the service neutral at the service switch, or at the center point of a transformer secondary winding for a separately derived system as indicated on the drawings.
- D. When a steel conduit contains only ground wires, the ground wires shall be bonded to the conduit at both ends of the conduit run.
- E. Cabinets, panels, boxes, appliance frames, conduits and other non-current carrying metallic objects shall be grounded as required by the National Electrical Code.
- F. Install metallic raceways mechanically and electrically secure at all joints and at all boxes, cabinets, fittings and equipment.
- G. Refer to Section 260010 - BASIC ELECTRICAL MATERIALS AND METHODS for Grounding Continuity tests required.

3.2 APPLICATION

- A. Equipment Grounding Conductors: Comply with NEC Article 250 for types, sizes and quantities of equipment grounding conductors, except where specific types, larger sizes or more conductors than required by NEC are indicated.
 - 1. Install equipment grounding conductor with circuit conductors for the items below in addition to those required by Code:
 - a. Feeders and branch circuits.
 - b. Receptacle circuits.
 - c. Single-phase motor or appliance branch circuits.
 - d. Three-phase motor or appliance branch circuits.
 - e. Flexible raceway runs.
 - f. Armored and metal-clad cable runs.
- B. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.

3.3 EQUIPMENT GROUNDING

- A. Provide an equipment bonding jumper from the grounding terminals of switches and receptacles to the grounded box that they are mounted in, unless the device is listed for self-grounding.
- B. At motors, connect the ground conductor to the conduit with an approved grounding bushing, and to the metal frame with a bolted solderless lug. Bolts, screws and washers shall be bronze or cadmium plated steel.
- C. Provide a flexible bonding strap, No. 6 AWG equivalent, across each flexible duct connection at each air handler, cooling tower, exhaust fan, supply fan, etc., and install to preclude vibration.

END OF SECTION 260455