

**Construction Documents for**



**Jackson County  
Courthouse  
Chiller Replacement**

5000 Jackson Parkway  
Jefferson, GA 30549

**For Construction Documents**

**PRIME CONSULTANT / MECHANICAL ENGINEER**

Johnson, Spellman & Associates, Inc.  
350 Research Court, Suite 130  
Peachtree Corners, GA 30092  
(770) 447-4555  
[www.jsace.com](http://www.jsace.com)

**JSA PROJECT NUMBER 22JS07**

**April 1, 2022**

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**SECTION 006519  
RELEASE AND WAIVER OF CLAIM  
PRIME CONTRACTOR**

On \_\_\_\_\_, 20\_\_ there personally appeared before me the undersigned authority in and for said County of \_\_\_\_\_ State of \_\_\_\_\_ (Name) \_\_\_\_\_, the \_\_\_\_\_ of (Company) \_\_\_\_\_, who being duly sworn by me, states that all payrolls, materials bills, sales tax, privilege tax or license, old age benefits tax, state and federal unemployment insurance and other liabilities have been paid in full, incurred for use in the performance of the contract for \_\_\_\_\_ and waives any claims and releases \_\_\_\_\_, from any rights or claims for debts due and owing by virtue of the furnishing of any material or supplies of any lien thereon.

Sworn to and subscribed before me this \_\_\_\_\_ day of \_\_\_\_\_, 20\_\_\_\_.

By: \_\_\_\_\_ (Signature)

Title: \_\_\_\_\_

Date: \_\_\_\_\_

\_\_\_\_\_ SEAL:

(Notary Public)

Date: \_\_\_\_\_

**END OF SECTION 006519**

**SECTION 006536  
CONTRACTOR WARRANTY FORM**  
(To be typed on Contractor's letterhead)

**PROJECT:** \_\_\_\_\_

**LOCATION:** \_\_\_\_\_

**OWNER:** \_\_\_\_\_

We, \_\_\_\_\_ contractor for  
(Company Name)

The above referenced project, do hereby warrant that all labor and materials furnished and work performed are in accord with the Contract Documents and authorized modifications thereto, and will be free from defects due to defective materials or workmanship for a period of one (1) year from Date of Final Completion.

This warranty commences on (Date of Final Completion affixed by Architect), and expires on (Expiration Date). Should any defect develop during warranty period due to improper materials, workmanship or arrangement, the same shall, upon written notice by the Owner, be made good by the undersigned at no expense to the Owner.

Nothing in the above shall be deemed to apply to work which has been abused or neglected by the Owner.

DATE: \_\_\_\_\_

FOR: \_\_\_\_\_  
(Company Name)

BY: \_\_\_\_\_

TITLE: \_\_\_\_\_

**END OF SECTION 006536**

**SECTION 009400  
MODIFICATION PROCEDURES**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

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

**1.2 SUMMARY**

- A. This Section specifies administrative and procedural requirements for handling and processing contract modifications.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
1. Division I Section "Shop Drawings and Submittals" for requirements for the Contractors Construction Schedule.
  2. Division I Section "Applications for Payment" for administrative procedures governing Applications for Payment.
  3. Division 1 Section "Substitution Procedures" for administrative procedures for handling requests for substitutions made after award of the Contract.

**1.3 CHANGE ORDER PROPOSAL REQUESTS**

- A. Owner-Initiated Proposal Requests: The Engineer will issue a detailed description of proposed changes in the Work that will require adjustment to the Contract Sum or Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
1. Proposal requests issued by the Architect are for information only. Do not consider them as an instruction either to stop work in progress or to execute the proposed change.
  2. Within 10 days of receipt of a proposal request, submit an estimate of cost necessary to execute the change to the Engineer for the Owner's review.
    - a. Include a list of quantities of products required and unit costs, with the total amount of purchases to be made. Where requested, furnish survey data to substantiate quantities.
    - b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
    - c. Include a statement indicating the effect the proposed change in the Work will have on the Contract Time.
- B. Contractor-Initiated Proposals: When latent or unforeseen conditions require modifications to the Contract, the Contractor may propose changes by submitting a request for a change to the Engineer.
1. Include a statement outlining the reasons for the change and the effect of the change on the Work.

2. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and Contract Time.
3. Include a list of quantities of products required and unit costs, with the total amount of purchases to be made. Where requested, furnish survey data to substantiate quantities.
4. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
5. Comply with requirements in Section "Substitution Procedures" if the proposed change requires substitution of one product or system for a product or system specified.

#### **1.4 CHANGE ORDER PROCEDURES**

- A. Upon the Owner's approval of a Proposal Request, the Engineer will issue a Change Order for signatures of the Owner and the Contractor on AIA Form G701.

#### **PART 2 - PRODUCTS (NOT APPLICABLE)**

#### **PART 3 - EXECUTION (NOT APPLICABLE)**

**END OF SECTION 009400**

**SECTION 011100  
SUMMARY OF WORK**

**PART 1 - GENERAL**

**1.1 THE WORK IS GENERALLY DESCRIBED AS THE CHILLER REPLACEMENT AT THE JACKSON COUNTY COURTHOUSE, JEFFERSON GEORGIA.**

- A. Construction shall take place in a single phase:
1. The scope of work shall be performed during a 30 calendar day period, beginning at an approximate time that the longest lead item (Chiller) is available to the job site.
- B. Scope of work shall be as follows:
1. Replace one existing water cooled interior mounted chiller with a new variable speed chiller of similar capacity.
  2. Provide electrical service associated with the new chiller noted above.
  3. All existing Convergent Building Automation System (BAS) components, sequence of control and control points associated with the Mechanical Equipment noted above to be modified to provide a fully functional BAS system.
- C. The Contractor shall also provide as-built drawings to the Owner and Engineer at the end of each Phase of construction. As-built drawings shall be to scale and dimensioned.

**1.2 GENERAL DESCRIPTION OF WORK**

- A. Contractor shall furnish all material, labor, tools, plant, supplies, equipment, transportation, superintendence, temporary construction of every nature, insurance, taxes, contributions and all services and facilities, unless specifically excepted, and install all materials, items and equipment required to complete the construction of the project, as set forth in the contract documents.
- B. Contract: Construct the Work under the Owner's General Conditions and Agreement between Owner and Contractor where the basis of payment is a Lump Sum.
- C. Contractor's Responsibilities:
1. Secure and pay for, as necessary, execution of the Work and as applicable, all building permits, fees, and licenses. The Owner will pay for land disturbance and utility impact fees (if applicable).
  2. Pay all required sales, consumer and use taxes.
  3. Give all notices required by the Contract Documents or by governing regulations.
  4. Comply with codes, ordinances, rules, regulations, orders and other legal requirements of public authorities, which pertain to proper performance of the Work, and promptly submit written notice to the Architect of any observed variance of the Contract Documents from legal requirements.
  5. The Contractor will maintain in good condition an up-to-date set of as-built field drawings reflecting all changes made to the Contract Documents at the jobsite. One set of new prints, reflecting all changes, will be made from these drawings and presented to the Owner prior to issuance of final payment to the Contractor.



- D. Survey of Existing Conditions:
1. By executing the Form of Agreement, the Contractor has acknowledged that:
    - a. He has visited and inspected the Project site and building area, in which the work is to be performed,
    - b. He has satisfied himself as to the nature and location of the work, including any obstructions, amount of work, actual levels, the equipment and facilities needed preliminary to and during the prosecution of the Work.
  2. Contractor shall locate drainage or sewer lines, water, gas and other utility and electrical service lines, piping and conduits in the way of this work.
  3. Failure by Contractor to have acquainted himself with available information concerning Site conditions, including factors affecting costs and liabilities, shall not relieve Contractor of responsibility for performance of work in accordance with requirements of Contract Documents, and for amount of consideration named or other determined.
- E. Ten percent (10%) retainer shall be withheld from the Contractor's Application for Payment until the following have been achieved or provided by the Contractor.
1. Original Building Permits.
  2. Final Change Orders agreed to and executed by all parties.
  3. Original and notarized lien waivers.
  4. Engineer's certification that punchlist has been completed.
  5. As-built drawings and O&E manuals.

### 1.3 CONTRACTOR USE OF THE PREMISES

- A. General: The Contractor shall limit his use of the premises to the work indicated, so as to allow for Owner occupancy.
- B. Use of the site: Confine operations at the site to the back of house, Mechanical Room, Electrical Room, or other areas of the building where work is shown to take place on the contract documents. Portions of the site beyond areas on which work is indicated are not to be disturbed.
- C. Contractor shall be provided with an escort within the building and secured areas as needed. No keys or access cards shall be provided to the contractor.
- D. Keep driveways and entrances clear and available at all times. Do not use for parking or storage of materials.
- E. Do not encumber the site with materials and equipment. Confine stockpiling of materials and location of storage sheds to areas approved by the owner.
- F. Lock automotive type vehicles and other mechanized and motorized construction equipment, when parked and unattended. Do not leave vehicles or equipment unattended with motor running or ignition key in place.

### 1.4 OWNER OCCUPANCY

- A. The Owner will continuously occupy the buildings and areas immediately adjacent to the site and premises during the entire stage of project construction.

- B. Cooperate with Owner to minimize conflict, and to facilitate Owner's operations.
- C. Schedule the Work to accommodate owner occupancy and utility system shutdown restrictions.
- D. The Contractor shall make accommodations as noted to minimize the down time of all mechanical and electrical systems in the building as noted in the construction documents.

**END OF SECTION 011100**

**SECTION 011400  
WORK RESTRICTIONS**

**PART 1 - GENERAL**

**1.1 WORK RESTRICTIONS**

- A. Contractor shall schedule and control all work persons employed on the Project. Contractor shall instruct all workers to prevent tracking dirt and debris into existing buildings. Profanity, inappropriate dress, or inappropriate conduct shall not be permitted on any Project. Owner reserves the right to have the Contractor remove from the Project anyone who, in the sole opinion of the Owner, exhibits such behavior.

**PART 2 - NOT USED**

**PART 3 - NOT USED**

**END OF SECTION 011400**

**SECTION 012500  
SUBSTITUTION PROCEDURES**

**PART 1 - GENERAL**

**1.1 RELATED SECTIONS**

- A. Section 013323 Shop Drawings and Submittals

**1.2 REQUEST FOR SUBSTITUTION**

- A. If the Contractor desires to use materials or products of manufacturers different from those indicated in the Contract Documents, the contractor shall make written application as described herein. The burden of proving the equality of the proposed substitution rests on the Contractor. To be acceptable, the proposed substitution shall meet or exceed all expressed requirements of the Contract Documents and shall be submitted upon the Contractor's letterhead.
1. Submit to the Engineer at the earliest date possible in order to afford him ample time to process the request.
  2. Submit copies of shop drawings, product data or samples as required in Section 013323. The Engineer will consider reports from reputable independent testing laboratories, verified experience records from previous users and other written information valid in the circumstances.
  3. Completely and clearly indicate in what respects the materials or products differ from those indicated in the Contract Documents.
  4. Include the manufacturers printed recommendations clearly describing the installation use and care, as applicable, of the proposed substitutions.
  5. Include a complete schedule of changes in the Contract Documents, if any, which must be made to permit the use of the proposed substitutions.

**PART 2 - PRODUCTS (NOT APPLICABLE)**

**PART 3 - EXECUTION (NOT APPLICABLE)**

**END OF SECTION 012500**

**SECTION 012976  
APPLICATIONS FOR PAYMENT**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

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

**1.2 SUMMARY**

- A. This Section specifies administrative and procedural requirements governing the Contractors Applications for Payment.
1. Coordinate the Schedule of Values and Applications for Payment with the Contractors Construction Schedule, Submittal Schedule, and List of Subcontracts.
- B. Related Sections: The following Sections contain requirements that relate to this Section.
1. Schedules: The Contractors Construction Schedule and Submittal Schedule are specified in Division I Section "Shop Drawings and Submittals."

**1.3 SCHEDULE OF VALUES**

- A. Coordination: Coordinate preparation of the Schedule of Values with preparation of the Contractors Construction Schedule.
1. Correlate line items in the Schedule of Values with other required administrative schedules and forms, including:
- a. Contractor's Construction Schedule.
  - b. Application for Payment forms, including Continuation Sheets.
  - c. List of subcontractors.
  - d. Schedule of allowances.
  - e. Schedule of alternates.
  - f. List of products.
  - g. List of principal suppliers and fabricators.
  - h. Schedule of submittals.
2. Submit the Schedule of Values to the Engineer at the earliest possible date but no later than 7 days before the date scheduled for submittal of the initial Applications for Payment.
- B. Format and Content: Use the Project Manual table of contents as a guide to establish the format for the Schedule of Values. Provide at least one line item for each Specification Section.
1. Identification: Include the following Project Identification on the Schedule-of Values:

- a. Project name and location.
  - b. Name of the Engineer.
  - c. Project number.
  - d. Contractor's name and address.
  - e. Date of submittal.
2. Arrange the Schedule of Values in tabular form with separate columns to indicate the following for each item listed:
- a. Related Specification Section or Division.
  - b. Description of Work.
  - c. Name of subcontractor.
  - d. Name of manufacturer or fabricator.
  - e. Name of supplier.
  - f. Change Orders (numbers) that affect value.
  - g. Dollar value: Percentage of Contract Sum to nearest one hundredth percent, adjusted to total 100 percent.
3. Provide a breakdown of the Contract Sum in sufficient detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with the Project Manual table of contents. Break principal subcontract amounts down into several line items.
4. Round amounts to nearest whole dollar; the total shall equal the Contract Sum. Provide a separate line item in the Schedule of Values for each part of the Work where Applications for Payment may include materials or equipment, purchased or fabricated and stored, but not yet installed.
- a. Differentiate between items stored on-site and items stored off-site. Include requirements for insurance and bonded warehousing, if required.
5. Provide separate line items on the Schedule of Values for initial cost of the materials, for each subsequent stage of completion, and for total installed value of that part of the Work.

#### **1.4 APPLICATIONS FOR PAYMENT**

- A. Each Application for Payment shall be consistent with previous applications and payments as Certified by the Engineer and paid for by the Owner.
1. The initial Application for Payment, the Application for Payment at time of Substantial Completion, and the final Application for Payment involve additional requirements.
- B. Payment-Application Times: Each progress payment date is indicated in the Agreement. The period of construction Work covered by each Application for Payment is the period indicated in the Agreement. The Application for Payment is due on the 1st of each month and will be paid by the 30th of each month.
- C. Payment-Application Forms: Use AIA Document G702 and Continuation Sheets G703 as the form for Applications for Payment.

- D. Application Preparation: Complete every entry on the form. Include notarization and execution by a person authorized to sign legal documents on behalf of the Contractor. The Engineer will return incomplete applications without action.
1. Entries shall match data on the Schedule of Values and the Contractor's Construction Schedule. Use updated schedules if revisions were made.
  2. Include amounts of Change Orders and Construction Change Directives issued prior to the last day of the construction period covered by the application.
- E. Transmittal: Submit 4 signed and notarized original copies of each Application for Payment to the Engineer by a method ensuring receipt within 24 hours. One copy shall be complete, including waivers of lien and similar attachments, when required.
1. Transmit each copy with a transmittal form listing attachments and recording appropriate information related to the application, in a manner acceptable to the Engineer.
- F. Waivers of Mechanics Lien: With each Application for Payment, submit waivers of mechanics lien from every entity who is lawfully entitled to file a mechanics lien arising out of the Contract and related to the Work covered by the payment.
1. Submit partial waivers on each item for the amount requested, prior to deduction for retainage, on each item.
  2. When an application shows completion of an item, submit final or full waivers.
  3. The Owner reserves the right to designate which entities involved in the Work must submit waivers.
  4. Waiver Delays: Submit each Application for Payment with the Contractor's waiver of mechanics lien for the period of construction covered by the application.
    - a. Submit final Applications for Payment with or preceded by final waivers from every entity involved with performance of the Work covered by the application who is lawfully entitled to a lien.
  5. Waiver Forms: Submit waivers of lien on forms, and executed in a manner, acceptable to the Owner.
- G. Initial Application for Payment: Administrative actions and submittals, that must precede or coincide with submittal of the first Application for Payment, include the following:
1. List of subcontractors.
  2. List of principal suppliers and fabricators.
  3. Schedule of Values.
  4. Contractor's Construction Schedule (preliminary if not final).
  5. List of Contractor's staff assignments.
  6. Copies of building permits.
- H. Application for Payment at Substantial Completion: Following issuance of the Certificate of Substantial Completion, submit an Application for Payment.
1. This application shall reflect Certificates of Partial Substantial Completion issued previously for Owner occupancy of designated portions of the Work.
  2. Administrative actions and submittals that shall precede or coincide with this application include:
    - a. Occupancy permits and similar approvals.

- b. Warranties (guarantees) and maintenance agreements.
  - c. Test and Balance records.
  - d. Maintenance instructions.
  - e. Meter readings.
  - f. Startup performance reports.
  - g. Changeover information related to Owner's occupancy, use, operation, and maintenance.
  - h. Final cleaning.
  - i. Application for reduction of retainage and consent of surety.
  - j. List of incomplete Work, recognized as exceptions to Engineer's Certificate of Substantial Completion.
- I. Final Payment Application: Administrative actions and submittals that must precede or coincide with submittal of the final Application for Payment include the following:
- 1. Completion of Project closeout requirements.
  - 2. Completion of items specified for completion after Substantial Completion.
  - 3. Ensure that unsettled claims will be settled.
  - 4. Transmittal of required Project construction records to the Owner.
  - 5. Removal of temporary facilities and services.

**PART 2 - PRODUCTS (NOT APPLICABLE)**

**PART 3 - EXECUTION (NOT APPLICABLE)**

**END OF SECTION 012976**



## **SECTION 013113 PROJECT COORDINATION**

### **PART 1 - GENERAL**

#### **1.1 DESCRIPTION**

- A. This section specifies the requirements for the coordination of work and trades during construction phase services.

#### **1.2 RELATED SECTIONS**

- A. Section 007200 General Conditions
- B. Section 007320 Special Conditions
- C. Section 011400 Work Restrictions
- D. Section 013513 Special Project Procedures
- E. Section 017416 Cleaning

#### **1.3 ADMINISTRATION AND SUPERVISION**

- A. Coordination: Coordinate various elements of the work and entities engaged to perform the work; and coordinate the work with existing facilities/conditions, and with work by separate contractors (if any) and the Owner.

#### **1.4 SURVEY/RECORDING**

- A. General: Working from established lines and levels at or near the project site, establish and maintain dependable markers for lines and levels of the work. Calculate dimensions and measure for layout of the work; do not scale the drawings. Record deviations (if any) from drawing information on existing conditions and review with Engineer at time of discovery.
- B. Installer Inspections: Require installer of each major unit of work to inspect substrate and conditions of installation, and to report (in writing) unsatisfactory conditions.
- C. Correct unsatisfactory conditions before proceeding. Inspect each product immediately before installation. Do not install damaged or defective products, materials or equipment.

#### **1.5 INSTALLATION, GENERAL**

- A. Comply with manufacturer's instructions and recommendations to extent that printed information is more stringent than requirements contained directly in the contract documents.

- B. Timing: Install work during time and under conditions which will assure best possible results, coordinated with required inspections and testing.
- C. Anchor work securely in place, properly located by line and level, organized for best possible uniformity, visual effect, operational efficiency, durability, and similar benefit to Owner's use. Isolate non-compatible materials from contact, sufficiently to prevent deterioration.
- D. Mount individual units of work at industry recognized heights, if not otherwise indicated; refer uncertainties to Engineer before proceeding.

**END OF SECTION 013113**

**SECTION 013216  
PROGRESS SCHEDULES**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. General provisions of the Contract, including General and Supplementary Conditions and General Requirements, Division 1, apply to all work specified in this Section.

**1.2 PROGRESS SCHEDULE**

- A. General: Prior to the start of construction, prepare and submit to the Owner for approval a progress schedule outlining the major sequences of construction from start to final completion of the project. The work shall be carried on at such locations and in such sequence as indicated in the progress schedule.
- B. Line-item breakdown:
1. The breakdown of the schedule must correspond to the line items referenced in the Schedule of Values AIA Document G703.
  2. The progress schedule will include all major trades and activities, the time required for each construction category and a final completion date for the entire project.
  3. The progress schedule shall define the latest possible start date for the relieve finishing of individual shop spaces as shown on the drawings.
  4. The absence of references in said schedule to specific location, details or construction sequence for any portion of the work shall not relieve the Contractor from his obligation to complete the work according to said schedule and the completion date.

**1.3 SCHEDULE OF SUBCONTRACTORS**

- A. Provide the Engineer with a list of subcontractors 10 business days after the award of the contract.

**END OF SECTION 013216**

**SECTION 013323  
SHOP DRAWINGS AND SUBMITTALS**

**PART 1 - GENERAL**

**1.1 GENERAL REQUIREMENTS**

- A. Submit shop drawings, product information and samples to the Engineer for review as required in each section of the Specifications. All submittals shall be made promptly, allowing a minimum of 10 business days for Engineer's review. The Contractor shall schedule submittals in accordance with the Construction Schedule so as to prevent delay in the work.

**1.2 SPECIFIC SUBMITTAL REQUIREMENTS**

- A. Submittals shall be provided in Portable Document Format (PDF) and in the following minimum quantities:
1. One (1) set of drawings submitted; One (1) copy returned.
  2. Product Information: One (1) copy submitted; One (1) returned.
  3. Samples: Two (2) submitted; one (1) returned.

**1.3 SHOP DRAWINGS**

- A. Shop drawings shall be made to conform, with the design drawings. Contract Drawings shall take precedence over shop drawings unless otherwise authorized in writing. Review of the shop drawings by the Engineer does not constitute a change to the Contract.
- B. In case the Contractor is in doubt regarding certain dimensions shown on the Contract Drawings, or if there is a discrepancy on the Contract Drawings, the Contractor shall clearly mark the dimensions in question to be especially checked or verified.
- C. All drawings for review must be submitted in quantities listed above. A minimum of two sets will be returned to the Contractor marked with one of the following:
1. "No Exceptions Taken" – Indicates the shop drawings have been reviewed for conformance with the Contract Documents and that no exceptions have been taken. Proceed with the work.
  2. "Make Corrections Noted" – Indicates the shop drawings have been reviewed for conformance with the Contract Documents and that minor exceptions have been taken. Contractor may proceed with the work provided he corrects the work as noted. Resubmittal will not be required.
  3. "Revise and Resubmit" – Indicates the shop drawings have been reviewed for conformance with the Contract Documents and that work may not proceed. After items to which exceptions have been taken are corrected, the Contractor shall again submit copies for review.

4. "Rejected" – Indicates the shop drawings have been reviewed for conformance with the Contract Documents and major exceptions have been taken. Work shall not proceed. After items to which exceptions have been taken are corrected, the Contractor shall again submit copies for review.  
(In case exceptions are noted on one sheet, which affect details on other sheets, the exception is to be taken as applying to such other details.)
- D. All drawings and details must be checked by the Contractor and show the initial of the Contractor's checker before they are submitted for review.
- E. Review of shop drawings by the Engineer shall not constitute an authorization or approval of a change to the contract. Changes to the Contract Documents shall be made only by Change Order.
- F. All shop drawing submittals must be complete for that category of work required before the Engineer will review the submittal. No partial submittals will be accepted.

#### **1.4 PRODUCT DATA**

- A. Submittal requirements and approval process for product information shall be as listed above for shop drawings except as follows:
  1. A minimum of one of the required copies must be an original of the manufacturer's printed literature.
  2. When more than one product or type of item is shown, the specific item submitted shall be clearly marked in every instance where it occurs in the literature, and unrelated items shall be struck out so that consideration of only the item submitted is possible.
  3. The name of the manufacturer and supplier of each item is required on each copy of each submittal.

#### **1.5 SAMPLES**

- A. Submit actual samples of products or materials in a finished state in quantities as listed above. Minimum requirements for sample submittals shall be as follows:
  1. Size of each sample shall be large enough to show repeated patterns, joints or ranges of color and texture.
  2. Samples of coatings or other products dependent on substrate for texture or other prominent characteristics shall be submitted as applied over that substrate.
  3. The name of the manufacturer and supplier of each item shall be permanently affixed to each sample.

**END OF SECTION 013323**

**SECTION 015000  
TEMPORARY FACILITIES AND CONTROLS**

**PART 1 - GENERAL**

**1.1 RELATED SECTIONS**

- A. Section 017416 Cleaning

**1.2 RELATED DOCUMENTS**

- A. Drawings and General provisions of the Contract, including General and Supplementary Conditions and General Requirements, Division 1, apply to all work specified in this Section.

**PART 2 - PRODUCTS – NOT APPLICABLE**

**PART 3 - EXECUTION**

**3.1 SAFETY**

- A. Comply with applicable provisions and standards of the Occupational Safety and Health Act of 1980 and any other applicable statute, standard, regulation or code.

**3.2 SCAFFOLDING AND HOISTING**

- A. Provide all ladders and furnish and install all materials required for all scaffolding, staging, platforms, temporary floorings and railings, in compliance with all local and state laws governing same. The Contractor shall be held responsible for the maintenance, cleaning and removal of all scaffolding and equipment erected.

**3.3 ELECTRICAL SERVICE**

- A. The existing electrical service shall be allowed for contractor(s) use, including extensions and connections necessary for construction work. If supplemental temporary electrical service is required by the contractor(s), the contractor(s) shall pay costs of installing and maintaining service for duration of project. Pay costs associated with use of permanent electrical system until Date of Final Completion, except as otherwise indicated below.

**3.4 TEMPORARY LIGHTING**

- A. Provide the following minimum light levels for construction purposes:
  - 1. General construction and safety lighting: 5 footcandles.
  - 2. Finishing work and testing: 25 footcandles.

**3.5 TEMPORARY HEAT AND VENTILATION**

- A. Provide temporary heat in enclosed spaces to provide minimum temperatures of 40° Fahrenheit until finishing work begins; then maintain temperatures at levels indicated in specification sections.
- B. Provide ventilation to prevent accumulation of dust, fumes, or gases, to properly cure materials and disperse humidity.

**3.6 SANITARY TOILET FACILITIES**

- A. Provide and maintain temporary toilet facilities for construction personnel. Permanent facilities may not be used by personnel.

**3.7 FIRE PROTECTION**

- A. Provide one 20 pound, ABC type fire extinguisher for each 5,000 SF of floor area during the entire construction period.

**3.8 TRASH REMOVAL**

- A. Keep the premises clean at all times and remove all rubbish and debris in containers at the end of each working day in accordance with Section 017416.

**3.9 TEMPORARY ENCLOSURES AND PROTECTION**

- A. The contractor may elect to furnish and maintain temporary stairs, ramps, barricades, enclosures, railings, shoring, bracing and staging in conformance with O.S.H.A. requirements for the areas of construction. Contractor shall coordinate location and accessibility of all the above with the Owner during the Pre-Construction meeting.

**3.10 COMPLETION OF WORK**

- A. At completion of work, or at time of permanent utility connections, as applicable, remove temporary facilities, including connections and debris resulting from temporary installation.

**3.11 CONSTRUCTION OFFICE**

- A. The Contractor may elect to staff and maintain a temporary construction office area with temporary tables, chairs, etc. on the site and in the Chiller Room throughout the entire duration of the Contract.

**END OF SECTION 015000**



**SECTION 017123  
FIELD ENGINEERING****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and General provisions of the Contract, including General and Supplementary Conditions and General Requirements, Division 1, apply to all work specified in this Section.

**PART 2 - PRODUCTS****2.1 MATERIALS**

- A. The Contractor shall provide all instruments, tools and appurtenances to accurately execute the work of this Section.

**PART 3 - EXECUTION****3.1 FIELD ENGINEERING**

- A. Lay out work from the established base lines, elevations and bench marks referenced on the Drawings.
- B. Furnish templates, stakes and materials required.
- C. Preserve all monuments, stakes and markers.
- D. Coordinate and supervise layout of utility service lines and rough in requirements.
- E. Verify all dimensions and conditions shown on the Drawings, Specifications and Addenda shall be verified before work is begun, and further verify at the site.
- F. Where installed work interferes with other work, the Architect will designate what work is to be removed and replaced.

**END OF SECTION 017123**

**SECTION 017329  
CUTTING AND PATCHING****PART 1 - GENERAL****1.1 GENERAL**

- A. Definition: "Cutting and patching" includes cutting into existing construction to provide for the installation of or performance of other work and subsequent fitting and patching required to restore surfaces to their original condition or patching and repair of surfaces where equipment is removed or relocated.
- B. Refer to other sections of these specifications for specific cutting and patching requirements and limitations applicable to individual units of work.
- C. Structural work: Do not cut and patch structural work in a manner resulting in a reduction of the load carrying capacity or load/deflection ratio. Submit proposal and request and obtain Engineer's approval before proceeding with cut and patch of structural work.
- D. Operational/Safety Limitations: Do not cut and patch operational elements and safety components in a manner resulting in decreased performance, shortened useful life, or increased maintenance. Submit proposals and requests and obtain Engineer's approvals before proceeding with cut and patches.
- E. Visual/Quality Limitations: Do not cut and patch work exposed to view (interior or exterior) in a manner resulting in a noticeable reduction in the esthetic qualities and similar qualities, as judged by the Engineer.
- F. Limitations on approvals: Engineer's approval to proceed with cutting and patching does not waive the right to later require removal/replacement of work found to be cut and patched in an unsatisfactory manner as judged by the Architect/Engineer.

**1.2 MATERIALS**

- A. General: Use material for cutting and patching that is identical to existing materials. If identical materials are not available, use materials that match existing adjacent surfaces to the greatest extent possible with regard to visual effect. Use materials for cutting and patching that will result in equal-or-better performance characteristics.

**1.3 EXECUTION**

- A. Inspection: Before cutting, examine surfaces to be cut and patched and conditions under which work is to be performed. If unsafe or otherwise unsatisfactory conditions are encountered, take corrective action before proceeding with the work.
- B. Temporary Support: To prevent failure, provide temporary support of work to be cut.
- C. Protection: Protect other work during cutting and patching to prevent damage. Provide protection from adverse weather conditions for that part of the project that may be exposed during cutting and patching operations.

- D. Take precautions not to cut piping, conduits or ducts serving the building and scheduled to be relocated until provisions have been made to bypass them.
- E. Cutting: Cut the work using methods that are least likely to damage work to be retained or adjoining work.
- F. Where cutting is required use hand or small power tools designed for sawing and grinding, not hammering or chopping. Cut through concrete and masonry with equipment such as a carborundum saw or core drill. Cut holes and slots neatly to size required with minimum disturbance of adjacent work. To avoid marring existing finished surfaces, cut and drill from the exposed or finished side into concealed surfaces. Temporarily cover openings when work is not being performed.
- G. Patching: Patch with seams which are durable and as invisible as possible. Comply with specified tolerances for the work.
- H. Restore exposed finishes of patched area and where necessary extend finish restoration into adjoining work in a manner which will eliminate evidence of cutting or patching and refinishing.
- I. Where existing panels, devices, structural supports or equipment is removed, the area exposed shall be patched to match existing and painted as specified.

**END OF SECTION 017329**

**SECTION 017416  
CLEANING****PART 1 - GENERAL****1.1 RELATED SECTIONS**

- A. Section 015000 Temporary Facilities and Controls
- B. Section 017719 Project Closeout

**1.2 RELATED DOCUMENTS**

- A. Drawings and General provisions of the Contract, including General and Supplementary Conditions and General Requirements, Division 1, apply to all work specified in this Section.

**1.3 GENERAL REQUIREMENTS**

- A. Contractor shall keep the Project site free from accumulation of waste materials and rubbish at all times during the construction period. At completion of the Work, he shall remove all waste materials and rubbish from and about the Project, as well as his tools, construction equipment, machinery and surplus materials, except those specifically required by the Contract Documents to be left for the Owner's use.
- B. If Contractor fails to keep project clean or to clean up prior to Date of Substantial Completion, the Owner may do so as provided in Paragraph 3.4 of the General Conditions and the cost thereof will be charged to the Contractor.

**1.4 SAFETY REQUIREMENTS**

- A. Store volatile waste in covered metal containers. Remove from project site daily.
  - 1. Allow no volatile wastes to accumulate on volatile substances.
  - 2. Provide adequate ventilation during use of volatile substances.
- B. Comply with local anti-pollution laws. Do not burn waste materials and rubbish on project site.
- C. Do not dispose of volatile wastes such as mineral spirits, oil or paint thinner on project site.
- D. Dispose of no waste or cleaning materials, which contain materials harmful to plant growth on project site. Clean up materials, which are accidentally spilled as quickly as possible.
- E. Clean disturbed areas of project site of debris.
  - 1. Broom clean paved surfaces. Remove oil and similar deleterious substances.
  - 2. Remove debris from grassed and landscaped areas, if contaminated, in most expeditious manner.

- F. Replace or clean air conditioning filters as applicable, if units were operated during the construction period.

**END OF SECTION 017416**

**SECTION 017600  
PROTECTIVE MEASURES DURING CONSTRUCTION**

**PART 1 - GENERAL**

**1.1 WORK INCLUDED**

- A. Provide and maintain suitable barriers to prevent access of unauthorized personnel into designated work areas.
- B. Provide fire protection and prevention measures in work areas.
- C. Institute accident prevention procedures.
  - 1. Assume full responsibility for complying with and enforcing of all rules and regulations of all Federal, State and Municipal authorities having jurisdiction including those of the U.S. Environmental Protection Agency (P.L. 98-616), Occupational Safety and Health Act, the Office of the State Fire Marshall, and the local fire Marshall. OSHA requires a "Confined Space Program" which requires a written entry procedure, monitor procedure, and extraction procedure.
  - 2. The requirements outlined hereinafter are to be considered as minimal, and where the requirements of any of the above authorities having jurisdiction conflict with the requirements of this section, the maximum condition shall prevail.
  - 3. Any items damaged due to failure to comply with these requirements shall be corrected or replaced, to the satisfaction of the Owner without cost to the Owner.
  - 4. Assume full responsibility for enforcing compliance with any protective measures indicated in specific sections of the Work.

**1.2 FIRE PROTECTION**

- A. Contractor shall take all precautions to eliminate possible fire or explosion hazards at the site, including, but not limited to, enforcing the following requirements:
  - 1. Any fuels, sludges, etc. removed from the fuel storage tanks shall be stored, handled, and maintained in accordance with the most recent edition of the Uniform Fire Code and publications developed by the American Petroleum Institute and the National Fire Protection Association, and local, state, or federal regulations, whichever supersedes.
  - 2. All combustible material shall be removed from the site storage areas on a daily basis; including oil rags, empty solvent or paint containers, etc.
  - 3. All tarpaulin or other covers for stored materials, shall be flameproof.
  - 4. Solvents, paints, thinners, coatings, or other highly flammable materials, shall be stored only in well-ventilated areas, and all mixing and preparation shall be restricted to such areas. All such materials shall be handled in accordance with safe practice and the requirements of the authorities having jurisdiction.
  - 5. Containers containing flammable or combustible materials shall remain capped or closed at all times, unless in immediate use.
  - 6. No open fires on the site. Smoking is prohibited on site, except in areas designated by the Owner.
  - 7. Avoid storage of large quantities of flammable or combustible materials at the site.
  - 8. Gasoline may not be stored in any quantity on the site during any stage of construction.

- B. Provide and maintain at least one fire extinguisher station on the site, in a designated location within the Contract Limits. Additional fire extinguishers shall be furnished in each enclosed area used as a storeroom. Each fire extinguisher station shall be located so as to be easily accessible while providing minimum interferences with operations, and shall contain one standard UL listed, 10 pound: ABC rated carbon-dioxide unit. Contractor shall check units frequently to maintain in operable condition.
- C. Welding and flame cutting will be allowed only upon authority of the Owner. All such equipment when used shall be kept in a safe and functional condition and be of a type which will minimize hazards. Great care must be exercised in the use of the tools near adjacent properties.

### 1.3 ACCIDENT PREVENTION AND PROCEDURES

- A. Site safety will be the Contractor's responsibility.
  - 1. Safety responsibility will include the supply and use of approved and personal protection equipment, fire extinguishers, combustible gas/oxygen indicators, storage of hazardous materials, and other safety equipment required to complete the Work.
  - 2. All safety equipment will be stored in a designated storage area, and will be maintained in proper working order.
- B. Promptly report in writing to the Owner and the Engineer all accidents which cause death, personal injury, or property damages, arising out of or in connection with the performance of the work whether on or adjacent to the site. Where death or serious injuries or serious damages are caused, the accident shall be reported immediately by telephone or messenger to the Owner.
- C. If any claim is made by anyone against the Contractor or any subcontractor on account of any accident, promptly report the facts in writing to the Owner giving full details of the claim.

**END OF SECTION 017600**

**SECTION 017719  
PROJECT CLOSEOUT****PART 1 - GENERAL****1.1 RELATED SECTIONS**

- A. Section 006536 Contractor Warranty Form
- B. Section 017416 Cleaning

**1.2 RELATED DOCUMENTS**

- A. General provisions of the Contract, including General and Supplementary Conditions and General Requirements, Division 1, apply to all work specified in this Section.

**PART 2 - PRODUCTS****2.1 AS REFERENCED HEREIN****PART 3 - EXECUTION****3.1 CLEAN UP**

- A. Clean entire project at the end of the job in accordance with Section 017416 to accomplish the following:
  - 1. Remove stains from glass and metal, clean and polish same.
  - 2. Clean and polish all hardware and fixtures.
  - 3. Clean and polish all tile work and finishes.
  - 4. Clean and touch-up all paint, trim and floors.
  - 5. Clean exterior of all debris and refuse.

**3.2 OPERATING INSTRUCTIONS/MAINTENANCE MANUALS**

- A. The Contractor shall provide to the Owner three (3) bound copies of Operating Instructions, line diagrams, color code, etc. for all equipment. These instructions shall include a complete description of all equipment, diagrams indicating the connections, oiling requirements, type of oil and grease to be used, and the method to be used in the operation of equipment. Maintenance instructions and warranties shall also be included.
- B. Final acceptance of the project shall be contingent upon receipt by the Owner from the Contractor of the following information not later than 30 days after Date of Substantial Completion.
  - 1. Cuts and brochures of all installed equipment including manufacturer's operation and maintenance manuals.



2. List of all suppliers and subcontractors including addresses and telephone numbers and who is to be contacted in case of malfunction while equipment is under warranty or guarantee.
- C. Operating, Maintenance Instructions: Arrange for each installer of product/services requiring continuing maintenance (by Owner) or operation to meet with Owner's personnel at project site to provide basic instructions needed for proper operation and maintenance of entire work. Include instructions by manufacturer's representatives where installer are not expert in required procedures.
- D. Review maintenance manuals, record documents, tools, spare parts and materials, lubricants, fuels identification system, control sequences, hazards, cleaning and similar procedures and facilities.
- E. For operational equipment demonstrate start up, shut down, emergency operations, noise and vibration adjustments, safety, economy and efficiency adjustments, and similar operations.
- F. Listing of Instructions: specifically, but not by way of limitation, provide instructions to Owner's personnel on categories of work listed below.
  1. Mechanical/Electrical work.
  2. Live plant materials and lawns.
  3. Roofing, flashing, joint sealers and similar elements of work.
  4. Finish flooring.

### **3.3 WARRANTIES**

- A. Provide to the Owner three (3) copies of warranties, guarantees and service contracts. Include in maintenance manuals.
- B. Effective date of warranties, guarantees and service contracts shall be Date of Substantial Completion of the Project by the Owner.
- C. Warranty shall be in written form for the Contractor's work and the work of each subcontractor. Specimen format for warranty are provided herein under Section 006536.

### **3.4 CERTIFICATE OF OCCUPANCY**

- A. Furnish to the Owner the final certificate of occupancy, or its equivalent, covering the Project issued by the building department having jurisdiction, or a certified copy of such certificate, prior to the delivery of possession of the premises and one copy to the Engineer.
- B. Prior to Substantial Completion, the Contractor shall furnish certificates from local governmental agencies that the construction has been inspected as required by law or ordinances and that the building is accepted by the following:
  1. Local Building Inspector
  2. Local Plumbing Inspector
  3. Local Fire Marshal
  4. Local Electrical Inspector

**3.5 AS-BUILT RECORD PRINTS**

- A. Provide to the Owner one complete set of drawings and specifications which have been revised to clearly indicate all changes to the documents which were made during the construction of the project either by instruction from the architect or to accommodate field conditions.

**3.6 RELEASE OF LIENS**

- A. Neither the final payment nor any part of the retained percentage shall become due until the Contractor delivers to the Owner a complete release of all liens arising out of this Contract. The Contractor may, if any subcontractor refuses to furnish a release, furnish a bond satisfactory to the Owner to indemnify the Owner against any lien. If any lien remains unsatisfied after all payments are made, the Contractor shall refund to the Owner all monies that the latter may be compelled to pay in discharging such a lien, including all costs and a reasonable attorney's fee.

**3.7 EQUIPMENT**

- A. Coordinate demonstrations and trial runs of equipment for Owner and complete such demonstrations prior to final acceptance.

**3.8 PUNCH LIST**

- A. Provide a letter certifying that all items on the "Punch List" have been completed or corrected.

**3.9 SUBCONTRACTORS LIST**

- A. Provide list of Subcontractors with addresses, telephone numbers, and name of the responsible person who worked on the job.

**END OF SECTION 017719**

**SECTION 099000  
PAINTING AND COATING**

**PART 1 - GENERAL**

**1.1 SECTION REQUIREMENTS**

- A. Submittals:
1. Product Data.
  2. Color Samples.

**PART 2 - PRODUCTS**

**2.1 PAINT**

- A. Manufacturers:
1. Behr Process Corporation
  2. Benjamin Moore & Co.
  3. PPG Architectural Finishes, Inc.
  4. Pratt & Lambert.
  5. Sherwin-Williams Company (The).
- B. Material Compatibility: Provide materials that are compatible with one another and with substrates.
1. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
- C. Use paints and coatings that comply with the following limits for VOC content:
1. Flat Paints and Coatings: 50 g/L.
  2. Nonflat Paints, Coatings: 150 g/L.
  3. Primers, Sealers, and Undercoaters: 200 g/L.
  4. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.
  5. Zinc-Rich Industrial Maintenance Primers: 340 g/L.
  6. Floor Coatings: 100 g/L.

## **PART 3 - EXECUTION**

### **3.1 PREPARATION**

- A. Comply with recommendations listed in the paint manufacturer's instructions.
- B. Do not apply paint in temperatures below 40° For during periods of greater than 85% relative humidity.
- C. Remove hardware, lighting fixtures, and similar items that are not to be painted. Mask items that cannot be removed. Reinstall items in each area after painting is complete.
- D. Clean and prepare surfaces in an area before beginning painting in that area. Schedule painting so cleaning operations will not damage newly painted surfaces.

### **3.2 APPLICATION**

- A. Paint exposed surfaces, new and existing, unless otherwise indicated.
  - 1. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces.
  - 2. Paint surfaces behind permanently fixed equipment or furniture with prime coat only.
  - 3. Paint the back side of access panels.
  - 4. Color-code mechanical piping in accessible ceiling spaces.
  - 5. Do not paint prefinished items, items with an integral finish, operating parts, and labels unless otherwise indicated.
- B. Apply paints according to manufacturer's written instructions.
  - 1. Use brushes where the use of other applicators is not practical.
  - 2. Use rollers for finish coat on interior walls and ceilings.
- C. 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.
  - 1. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

### **3.3 INTERIOR PAINT APPLICATION SCHEDULE**

- A. Concrete, Traffic Surfaces: 1 coat Sherwin Williams, Armour Seal 33 Epoxy Primer/Sealer plus 2 coats of Sherwin Williams; Armour Seal 1000; Haze Gray.
  - 1. To be provided for concrete floors where concrete pads, equipment or supports have been removed from the wall and therefore created an area dissimilar to the adjacent areas of the wall.
- B. Equipment Pads (new and existing): 1 coat Sherwin Williams, Armour Seal 33 Epoxy Primer/Sealer plus 2 coats of Sherwin Williams; Armour Seal 1000; Safety Yellow.

- C. Concrete Masonry Units (Walls): 1 coat of Sherwin William Loxon Concrete and Masonry Primer plus of Sherwin Williams ProMar 400 Interior Latex Flat, SW 7014; Elder White.
  - 1. To be provided for CMU walls where panels, devices or equipment has been removed from the wall and therefore created and an area dissimilar to the adjacent areas of the wall.
- D. Steel (New columns, New beams joists, New equipment supports, etc.): 1 coats of Sherwin Williams Kem Kromik Universal Metal Primer plus 2 coats of Sherwin Williams Industrial Enamel; SW 7019; Gauntlet Grey.

**END OF SECTION 099000**

**SECTION 230010  
GENERAL PROVISIONS – HVAC**

**PART 1 - GENERAL****1.1 DESCRIPTION**

- A. These Mechanical General provisions specified herein apply to all Sections of Division 23.

**1.2 WORK INCLUDED**

- A. Provide all materials, labor and services as specified in Division 23 and shown on the accompanying drawings.

**1.3 RELATED SECTION**

- A. Section 230100 Operation and Maintenance of HVAC Systems

**1.4 DEFINITIONS**

- A. Terms: The following definitions of terms supplement those of the General Conditions and are applicable to all Mechanical Sections.
1. Provide: Furnish, install, and connect completely.
  2. Piping: Pipe installed with all required fittings, valves, and accessories, and forming a complete system.
  3. Wiring: Wire or cable installed in raceway with all required boxes, fittings, connectors, and accessories completely installed.
  4. Power Wiring: Wiring that supplies the electrical current that flows through a connected motor or heater.
  5. Exposed: Revealed to view or subject to weather.
  6. Control, interlock and starting circuit wiring: All wiring required by all Mechanical Sections that is not power wiring.
  7. Fittings: All connecting pieces of a system.
- B. Drawings: The Mechanical Drawings are diagrammatic except where otherwise specifically indicated. Refer to Architectural and Structural Drawings for building dimensions.
- C. Materials: Refer to the General Conditions. All material shall be suitable for the service and operating conditions of this Specification.

**1.5 ABBREVIATIONS**

- A. The following abbreviations are used in this Division of the Specifications:

AABC	Associated Air Balance Council
ABMA	American Boiler Manufacturers Association
AHRI	Air-Conditioning, Heating, and Refrigeration Institute
AMCA	Air Movement Control Association

ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
CTI	Cooling Tower Institute
IEEE	Institute of Electrical and Electronics Engineers
ISO	International Organization for Standardization
NEMA	National Electrical Manufacturers Association
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
TEMA	Tubular Exchanger Manufacturers Association
UL	Underwriters Laboratories

## 1.6 APPLICABLE CODES

- A. The latest amended editions of the codes applicable to the work of the municipality having jurisdiction.
- B. In the absence of any municipal adopted codes, the following shall apply:
  - 1. International Building Code, 2018 Edition, with Georgia Amendments (2020)
  - 2. International Residential Code, 2018 Edition, with Georgia Amendments (2014) (2015)
  - 3. International Fire Code, 2018 Edition, with Georgia Amendments (2020)
  - 4. International Plumbing Code, 2018 Edition, with Georgia Amendments (2020)
  - 5. International Mechanical Code, 2018 Edition, with Georgia Amendments (2020)
  - 6. International Fuel Gas Code, 2020 Edition, with Georgia Amendments (2020)
  - 7. National Electrical Code, 2020 Edition, with Georgia Amendments (2021)
  - 8. International Energy Conservation Code, 2015 Edition, with Georgia Supplements and Amendments (2020)
  - 9. All City, County, State, Regional, and other ordinances applicable to the work shall apply.

## 1.7 RELATED WORK

- A. The following work is generally specified in other Divisions of the Specifications, except as specifically otherwise stated in this Division.
  - 1. Electric power wiring.
  - 2. Installation of access panels in walls and ceiling construction.
  - 3. Installation of starters, contactors, thermal overload switches, and remote push buttons.
  - 4. Curbs, other than pre-fabricated.
  - 5. Furnishing and installation of motor control center.
  - 6. Structural support for heat rejection equipment.
  - 7. Cutting and patching of walls, floors, ceilings, roofs, and structure of existing buildings.
  - 8. Demolition.

**1.8 SPACE CONDITIONS**

- A. All work shall fit the spaces available. Verify all dimensions of the work before commencing fabrication and/or installation.
- B. Minor deviations from the drawings required to conform to space conditions and to provide the required operation, service, or maintenance accessibility shall be made at no additional cost, and subject to approval.
- C. Piping, equipment, or ductwork shall not be installed in electrical equipment rooms. Outside of electrical equipment rooms, do not run piping or ductwork, or locate equipment, with respect to switchboards, panel boards, power panels, motor control centers, or dry-type transformers:
  - 1. Within 42" in front (and rear if free standing) of equipment; or
  - 2. Within 36" of sides of equipment
  - 3. Clearances apply vertically from floor to ceiling structures.
- D. Hydronic piping shall not be installed above any electrical or control panels.

**1.9 RECORD DRAWINGS**

- A. Upon completion of the Project, the Contractor shall submit one set of contract prints with red marks indicating as-built conditions of all piping, ductwork, and equipment, and incorporating changes made during construction. A record of as-built conditions shall be kept throughout the project and shall be used in the preparation of the final record drawings.

**1.10 REFRIGERANT WARRANTY**

- A. Repair of refrigerant systems shall include prompt correction of all leaks and replacement of lost oil and refrigerant.

**1.11 GUARANTEES**

- A. Furnish a written guarantee covering each category of work for a period of one year from date of legal acceptance for the project. Guarantee shall include prompt correction of all leaks.
- B. Guarantee shall be furnished in exact conformity with the requirements of the General Conditions.

**1.12 CONTINUITY OF SERVICE**

- A. All work shall be scheduled with that of other trades. The following conditions shall apply to all affected work.
  - 1. Before disconnecting any existing systems for changes, the Contractor shall:
    - a. Have all needed materials stored at the job site.
    - b. Have assurance that all labor and skilled mechanics needed will be available at the proper time.



- c. Estimate the time the system will be out of service and inform the Owner in writing at the pre-construction meeting.
  - d. Secure approval of the shutdown dates from the Owner in writing a minimum of 4 weeks before disconnecting the system.
2. The operation of the cooling systems shall not be interrupted but one time and that period of shutdown shall be kept to a minimum.
3. All shutdown of air conditioning systems shall be made when the temperature is projected to be below 55°F or coordinated with the owner a minimum of 30 days prior to shutdown.
4. Work shall be done at such time and in such manner as to cause minimum inconvenience to the Owner and as approved by him or his representative. No allowance will be made for lack of knowledge of existing conditions.

### 1.13 EXISTING CONDITIONS

- A. Existing systems and equipment shall remain unchanged except where otherwise specified or shown on the drawings.
- B. Where pipes, ducts, or controls that are to remain in service are disconnected for removal of equipment or because of building alterations, they shall be reconnected to match the existing installation.
- C. The remodeling work to be done in the existing building shall be coordinated with work of other trades. New piping, ducts, or controls shall be run to point of connection to existing piping and tie-ins shall be made in such a manner as to afford minimum inconvenience to building occupants and operation.
- D. All pipe, valves, fittings, etc. that are removed from the existing building shall become the property of the Contractor and shall be removed from the premises. Due allowances shall be made for this material in the bid.
- E. Existing work shall be relocated as shown on the drawings.
- F. Existing work shall be removed as shown on the drawings.
- G. Work shall include the removal or extension of and connection to parts of the existing work, and all changes in the existing system to make it conform to changes in the building.

### 1.14 OPERATING INSTRUCTIONS

- A. Instructions: Instruct the Owner's representative in operation of the installed systems. The basis of these instructions shall be those written for inclusion in the maintenance and operating instruction data specified herein. Obtain certificates, signed by the Owner's representative, that these instructions have been received.
- B. Notification: Notify the Owner at least five days before commencing operating period for refrigeration and heating equipment, as specified herein, in order that the Owner's representative may be present during that period.

**1.15 DOCUMENTATION**

- A. Documents to be submitted prior to request for final inspection:
  - 1. Maintenance Manuals per Section 230100 Operation and Maintenance of HVAC Systems.
  - 2. Test and Balance Report.
  - 3. Three copies of multi-year warranties bound in a brochure with index listing equipment.
- B. Data to be Delivered at Final Inspection:
  - 1. Record Drawings.
  - 2. Certificate by Owner's representative confirming that operating instructions have been received.

**1.16 SUBMITTALS**

- A. Procedure: Refer to the GENERAL CONDITIONS and SUPPLEMENTS thereto for submittal procedure of items called for in the Contract Documents.
- B. Submittal data covering the work of this Division will be reviewed only after such items have been reviewed in detail and approved by the Contractor, such approval being indicated by suitable notations or stamp on the data.
- C. **Each submittal shall be clearly marked indicating Specification Section and paragraph for which it is intended. Any deviations, exclusions or substitutions from specified material requirements shall be specifically identified in a summary sheet at the front of the submittal.**
- D. **Where submittal sheets contain multiple products or selections, the specific item being submitted for review shall be clearly indicated with a red arrow (stamped or hand written). "Catalog" submittals (multiple items contained in the submittal, specific items not identified) will be rejected and not reviewed.**
- E. Submit the requested submittals in sufficient quantity to provide two copies in addition to those required by Contractor.
- F. Motor Tabulation on all motors furnished, listing the following nameplate data: horsepower, voltage, phase, and full load amps.
- G. Submittal List: See the individual Mechanical Specification Sections for specific submittal requirements.

**END OF SECTION 230010**

**SECTION 230100  
OPERATION AND MAINTENANCE OF HVAC SYSTEMS**

**PART 1 - GENERAL**

**1.1 MAINTENANCE AND OPERATING MANUALS**

- A. Provide manual in number of copies indicated under Section 230010 General Provisions - HVAC.
- B. Material submitted in the manuals shall represent the equipment manufacturer, model, and type installed on the project.

**PART 2 - PRODUCTS**

**2.1 MAINTENANCE AND OPERATING MANUALS**

- A. Maintenance and Operating Manuals shall consist of the following as a minimum:
  - 1. Hardback three-ring binders with job name, Owner's name, work order (WO #), and Bid number on the cover.
  - 2. Typed index listing name, address, and phone number of the General Contractor, HVAC Subcontractor, Insulation Subcontractor, Sheetmetal Subcontractor, and Controls Subcontractor, and all major equipment suppliers.
  - 3. Typed table of contents, listing each Section, title, and number.
  - 4. All Sections shall be tabbed with plastic tabs listing Section numbers.
  - 5. Each item of equipment requiring maintenance and operation data as noted in each specification section shall be provided with an index listing the types of equipment installed. Submittal data shall be included to the extent necessary to identify equipment, including summary sheet, such as model, size, air or water flow, pressure developed, speed, and motor size. Instructions shall include type and suggested frequency of maintenance, oiling, cleaning, disassembly and reassembly directions, and wiring diagrams.
  - 6. Make, model, serial number, and purchase order number of every item of equipment shall be identified on all documentation.
  - 7. One section shall include a complete set of record control drawings, bound in a plastic insert, full size, complete with a written sequence of operation for all control systems.
  - 8. Letters, where factory startup or checking has been required, certifying completion of performance.
  - 9. Provide three (3) hard copy sets and one electronic set of all aforementioned items in PDF format to the owner.
  - 10. Contractor's signed warranty letter certifying all work has been completed as required and stating what date warranty shall end.
  - 11. Table showing all major pieces of equipment and when the warranty of the equipment expires.

**PART 3 - EXECUTION****3.1 MAINTENANCE AND OPERATING MANUALS**

- A. All maintenance and operating manuals shall be complete and ready to turn over to Owner's representative at final inspection.
- B. Incomplete manuals will be returned to the Contractor for complete resubmission. Loose-leaf submittal of material at various stages of completion will not be acceptable.
- C. Contractor to submit to Engineer of Record for review two (2) weeks prior to completion of project.

**END OF SECTION 230100**

**SECTION 230500  
COMMON WORK RESULTS FOR HVAC**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This Section of specifications deals with materials and methods pertaining to all work specified under Division 23.

**1.2 RELATED SECTIONS**

- A. Section 230010 General Provisions Mechanical
- B. Section 230523 HVAC Valves and Strainers

**1.3 SUBMITTALS**

- A. See General Conditions for submittal procedure.
- B. Provide submittal data showing motor horsepower, electrical requirements, and efficiency.
- C. Provide submittal data showing firestop systems, including details for penetrations and instructions for installation
- D. Provide manufacturer's instructions, indicate installation and support requirements.

**1.4 JOB CONDITIONS**

- A. Install all apparatus to maintain maximum headroom and clearances consistent with requirements of the drawings and specifications.
- B. All equipment requiring service shall be installed to permit access for servicing without damage to building structure or finishes.

**PART 2 - PRODUCTS**

**2.1 MOTORS**

- A. Provide motors for all equipment required by the Mechanical Sections unless otherwise specified. Motors shall operate using Electrical characteristics shown on the Drawings and as specified. Multiple units of the same manufacturer's equipment shall be furnished with motors by one manufacturer. Motors shall be Century, Louis-Allis, Baldor-Reliance, General Electric, Westinghouse, Marathon, or US Motors, except where furnished as part of packaged equipment.

- B. Sizes:
1. Motors with standard NEMA Electrical characteristics shall be selected for the design brake horsepower without overload current at rated voltage. Motor horsepower rating shall not exceed 125% of the calculated maximum load being served. If a standard rated motor is not available within the range, the next larger standard motor size shall be used.
  2. Motors with special electrical characteristics, such as hermetic refrigeration motors, shall be selected to produce the brake horsepower required for the specified load without overload current at rated voltage.
  3. Motors used with variable speed adjustable frequency controllers shall be suitable for inverter duty use, constructed in compliance with NEMA Standard MG 1, latest edition, and selected to operate with the control characteristics and amperage limitations of the specific inverter selected. All motors associated with variable frequency drives shall be furnished with a factory-installed shaft grounding ring (SGR) of conductive micro-fibers to redirect shaft currents from shaft to frame. SGR shall be maintenance-free, brushless, split-ring or complete-ring configuration directly attached with mechanical fasteners. Attachment with adhesives in lieu of mechanical fasteners shall not be an acceptable substitution. SGR shall be by Aegis or equivalent.
- C. Enclosures: Motor enclosures shall be open drip-proof, except where otherwise specified. Motors for equipment installed where subject to weather shall be fan cooled, totally enclosed weatherproof type, unless fully protected by a waterproof housing.
- D. Nameplates: All motors shall have a nameplate showing the specified nominal system voltage as nameplate rated voltage. Each motor shall be guaranteed to operate satisfactorily at the specified nominal system voltage, plus or minus 10%.

## 2.2 SUPPORTS AND HANGERS

- A. Individual horizontal piping shall be supported as follows:
1. Steel with painted clevis hangers, except steam and steam condensate 4" and larger shall be on roller hangers.
  2. Hangers in contact with copper piping shall be copper-plated swivel-ring type.
  3. Hangers around insulated copper piping shall be galvanized steel swivel-ring type.
  4. Copper piping exposed adjacent to structure shall be secured with copper-plated pipe clamp.
  5. All attachments in contact with copper piping shall be copper, copper plated, or plastic coated.
  6. Horizontal, parallel, and adjacent piping shall be supported by gang hangers utilizing PVC-coated channel and PVC-coated standard pipe clamps or approved equivalent.
- B. Concealed vertical piping shall be supported as follows:
1. Steel piping with painted riser clamps.
  2. Copper piping with copper-plated riser clamps.
- C. Exposed vertical piping shall be supported by attachment to wall at midpoint with offset pipe clamps. Clamp for uninsulated copper piping shall be copper plated or plastic coated.

- D. Pipe in Chases: Piping in pipe chases shall be secured to building structure using attachments hereinbefore specified. Hangers for water piping within plumbing chases shall be supported with rods bolted to pipe clamps which shall be affixed to cast iron pipe. Piping may be supported from the more rigid cast iron pipe with the use of plastic brackets designed for that purpose.
- E. Hangers and pipe attachments, except where otherwise specified shall be Elcen, Hilti, B-Line, or Grinnell.

### 2.3 STRUCTURAL ATTACHMENTS

- A. Inserts
  - 1. Individual inserts shall be malleable iron type selected for the type and thickness of the slab and the load to be carried.
  - 2. Continuous inserts shall be formed galvanized steel type selected for the type and thickness of the slab and the load to be carried. Inserts shall be furnished with end caps, closure strips and shall be anchored at 6" O.C.
  - 3. Inserts shall be used in poured-in-place concrete slabs.
  - 4. Inserts shall be Elcen, Michigan Hanger, B-Line, or Grinnell.
- B. Concrete Fasteners/Anchors
  - 1. Fasteners shall be self-drilling type, Bull Dog, Phillips "Red Head", or Diamond "Blue-Cut".
  - 2. Fasteners shall be used in solid masonry walls and shall be used in solid concrete walls.
- C. Toggle Bolts with not less than 1/4" diameter bolts shall be used in hollow-type wall construction.
- D. Clamps of configuration compatible with beams and steel members shall be used in steel construction. Clamps shall be Grinnell, Michigan Hanger, Elcen, or B-Line.
- E. Hanger rods shall be selected to safely carry the load to be supported and shall not be less than the diameter listed by the hanger manufacturers for the specific size hanger used.

### 2.4 FOUNDATIONS

- A. Provide reinforced concrete foundations for all equipment located on floors, 4" high unless noted otherwise.
- B. Concrete shall be 1:2:4 mix with neatly beveled edges and all surfaces rubbed smooth prior to mounting equipment. Foundations shall be reinforced with No. 3 bars a maximum of 12" o.c. each way and held in place with dowel rods at each corner anchored in the slab. Dowel rods shall not penetrate the slab waterproofing.

### 2.5 ASBESTOS

- A. All materials used in this work shall be asbestos free.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. All work shall be installed plumb and square unless clearly indicated otherwise. Installation shall be performed by competent persons, trained in their respective skills.
- B. Furnish and install equipment complete, including connections, services and adjustments for systems to operate safely and in compliance with requirements of the contract.
- C. Install each item in full compliance with current recommendations of the manufacturer. Equipment manufacturer or his authorized representative shall furnish services and/or supervision necessary to ensure compliance with this provision. Conflict between manufacturer's recommendation and other contract requirements shall be resolved before installation.
- D. Requirements of the several acceptable manufacturers for each specified item of equipment may vary as to installation details, location and number of connections, dimensions and weight. Provide all drawings, services, material, and labor necessary for the installation and proper functioning of the equipment furnished.

### **3.2 PROTECTION OF MATERIALS AND EQUIPMENT**

- A. Take precautions to protect all materials and equipment from damage during the construction process.
- B. Do not store materials and equipment outdoors subject to weather without complete weather protection.
- C. Do not install materials or equipment in a partially constructed structure exposed to weather, unless all material and equipment is continuously protected from damage by weather or the construction process.
- D. Material and equipment damaged by improper protection during construction is subject to replacement based on the judgment of the Engineer at no cost to the Owner.

### **3.3 CUTTING AND REPAIRING**

- A. Cut and repair all walls, floors, and ceilings necessary for the installation of the mechanical work, but no cutting of work of other trades will be permitted without the consent of the Architect or his representative.
- B. All cutting and repairing of walls, floors, and ceilings shall be subject to the supervision and approval of the Contractor.

### **3.4 CLEANING AND FINAL CLEAN-UP**

- A. Keep the premises free of waste, debris, and surplus materials.



- B. The installing contractor must take appropriate precautions during construction to prevent dust and debris from getting into ductwork and piping systems by covering equipment, controls, and open-ended ducts and pipes while installation progresses.
- C. After equipment has been installed, remove all extraneous materials, rust and stains; blow, vacuum or flush all foreign matter from all equipment.
- D. Identification plates on equipment shall be free of paint and shall be polished.

### **3.5 MOTOR VOLTAGES**

- A. All motor voltages shall be checked with the electrical drawings prior to preparation of submittals or ordering of equipment.

### **3.6 MOTOR STARTER OVERLOADS**

- A. Motor overload heaters shall be sized and installed to protect the actual motor furnished.

### **3.7 PIPING SUPPORTS AND ANCHORS**

- A. Hang all piping so that equipment flanges and connections bear none of weight of piping. At pump suction and discharges, piping shall be supported free of pump casing through the use of base elbows.
- B. Horizontal supports shall be spaced as follows:
  - 1. Steel piping at not more than 10' intervals.
  - 2. Copper piping 1" and smaller at 8' intervals; larger than 1" at 10' intervals.
- C. Vertical supports shall be spaced as follows:
  - 1. Steel piping at every other story height.
  - 2. Copper piping larger than 1" at every other story height; 1" and smaller at every story height.

### **3.8 HANGER SIZES**

- A. Hangers shall be sized to fit the pipe except for the insulated piping, in which case hangers shall be of size for pipe and insulation to pass through.
- B. See Section 230700 HVAC Insulation for pipe shields.

### **3.9 STRUCTURAL ATTACHMENTS**

- A. Shooting of fasteners into the slab shall be allowed only in approved locations.
- B. Devices for connection to the structure shall not be loaded more than 75% of the manufacturer's rated load.

**3.10 PAINTING**

- A. Finishes of factory-painted apparatus shall be touched up where finish is marred in installation.
- B. Where galvanizing is broken during fabrication or installation, recoat exposed areas with cold galvanizing compound.
- C. Interior ferrous pipe and supports exposed to view without removing ceilings or access panels shall be primed and topcoated with two coats of semi-gloss paint, color selected by Engineer.

**3.11 REFRIGERATION SYSTEMS**

- A. Any work required on new or existing refrigeration systems shall involve the use of a refrigeration recovery/recycling unit. All refrigerants shall be stored and reused in the system where the refrigerant condition allows. Intentional release of refrigerant is prohibited and will not be allowed.

**3.12 LUBRICATION**

- A. All equipment installed under this division shall be properly lubricated in accordance with the manufacturer's instructions and recommendations before it is operated during the installation period and shall be checked again before final acceptance.

**END OF SECTION 230500**

**SECTION 230518  
REFRIGERANT MONITORS AND ACCESSORIES**

**PART 1 - GENERAL****1.1 DESCRIPTION**

- A. This section specifies the requirements for refrigerant monitoring systems and refrigerant machinery room accessories.

**1.2 RELATED SECTIONS**

- A. Section 230010 General Provisions HVAC
- B. Section 230100 Operation and Maintenance of HVAC Systems
- C. Section 236426 Water Cooled Rotary Chiller

**1.3 SUBMITTALS**

- A. See General Conditions for submittal procedure.
- B. Provide shop drawing showing detector dimensions, capacities, and electrical requirements.
- C. Provide shop drawings for monitoring panel showing the proposed wiring diagram with accompanying complete typewritten sequence of operations. A symbols list defining all abbreviated components shall be included. A cut sheet on each component used in the system shall be included. The diagram shall delineate between power and control wiring and shall indicate all contactors, relays, and other components of the system. Normally open positions for the relays shall be indicated.
- D. Provide manufacturer's instructions; indicate installation and support requirements.
- E. Provide operation and maintenance procedures; include start-up instructions, assembly drawings, and parts list.

**1.4 QUALITY ASSURANCE**

- A. Refrigerant monitor systems shall meet the requirements of the most recent ASHRAE Standard 15.

**1.5 REFRIGERANT MONITOR SYSTEM**

- A. Existing refrigerant monitoring system shall remain and shall interface with new remote alarm horn and strobe light modules as shown on the Drawings. All system components, including controllers and sensors, shall be suitable for interfacing with the DDC system.

1. Two alarm levels shall be provided, indicating “alarm” and “spill” conditions. Thresholds for both alarms are to be individually field adjustable with a factory setting as follows:
  - a. Level 1 “Leak” alarm – Shall be set at 50% of the TLV-TWA limit as set forth in Chapter 11 of the International Mechanical Code 2000 Edition; see table below. Upon activation of Level 1 “leak”, the associated “Low-Level Refrigerant Leak” alarm contact monitored by the DDC system shall be activated.
  - b. Level 2 “Spill” alarm – Shall be set at 100% of the TLV-TWA limit as set forth in Chapter 11 of the International Mechanical Code 2000 Edition; see table below. Upon activation of Level 2 “Spill”, the associated “High-Level Refrigerant Leak” alarm contact monitored by the DDC system shall be activated. Audible and visual alarms shall be activated. Ventilation fan(s) shall start. Upon manual reset of the refrigerant monitoring panel, fan(s) shall revert to normal operating procedures.

1103 - Refrigerant TLV-TWA

Refrigerant Type		50% (PPM)	100% (PPM)
HFC	R134a	500	1000

2. Automatic re-zero capability.
- B. Provide remote alarm horn and strobe light modules in the quantity shown on the drawings.

**1.6 SIGNS AND IDENTIFICATIONS**

- A. Provide 24”w x 18”h minimum-size signage in compliance with the most recent ASHRAE Standard 15. Signs shall be wall-mounted, permanent Bakelite signs with the following information in letters that shall be a minimum of 0.5” in height and in a location as described below:
1. Emergency Shutdown Procedures, including precautions to be observed or actions to be taken in case of breakdown or leak from the refrigeration system shall be located as near as possible to the refrigerant compressor. A duplicate sign shall also be placed outside and adjacent to each refrigeration machinery room door.
    - a. The following information shall be included in the Emergency Shutdown Procedures
      - (1) Entry into the refrigerating machinery room shall be forbidden to all unqualified personnel.
      - (2) Instructions for shutting down the system in case of emergency.
      - (3) Name, phone number, and address of installer.
      - (4) Refrigerant number and amount in machine.
      - (5) Lubricant identity and amount.
      - (6) Field test pressure applied (if any field piping involved).
  2. Refrigeration Machinery Rooms shall be labeled by a sign located immediately outside and adjacent to each Refrigeration Machinery Room door that shall state “Machinery Room – Authorized Personnel Only”, Entrance to be Restricted to Qualified Personnel during Refrigerant Leak Emergency”.

3. Refrigerant Leak Alarms shall be labeled as to clearly identify the meaning of the alarm and the precautions to be observed or actions to be taken in event of such alarm.

**SECTION 230520  
PRESSURE GAUGES AND VALVES**

**PART 1 - GENERAL****1.1 DESCRIPTION**

- A. This section specifies the pressure gauge and gauge valve requirements.

**1.2 RELATED SECTION**

- A. Section 232113 Hydronic Piping

**1.3 QUALITY ASSURANCE**

- A. Gauges shall be Terrice Model 450SS, or equivalent by Ashcroft, Marsh, Moeller, Terrice, or Weksler.

**PART 2 - PRODUCTS****2.1 GAUGES**

- A. Hydronic:
1. Gauges shall be ANSI Grade A, dial indicating type, with 4½" dial 316 stainless steel tube and socket, fiberglass reinforced polypropylene turret case, threaded fiberglass reinforced polypropylene ring, acrylic window, lower connection.
  2. Accuracy shall be within 0.5% of full-scale range.
  3. Maximum operating temperature of 250°F.
  4. Pressure ranges of gauges shall be as follows:

Unless otherwise specified: 0-160 psig

**PART 3 - EXECUTION****3.1 INSTALLATION**

- A. Gauges shall be located and installed so as to be conveniently read from the floor.
- B. Gauges shall be installed upright in a vertical plane when not more than seven feet (7') above the floor.
- C. Provide an isolation ball valve at each pressure gauge installation.

**END OF SECTION 230520**

**SECTION 230521  
TEMPERATURE GAUGES AND TEST WELLS**

**PART 1 - GENERAL****1.1 DESCRIPTION**

- A. This section specifies the thermometer and thermometer well requirements.

**1.2 RELATED SECTION**

- A. Section 232113 Hydronic Piping

**1.3 QUALITY ASSURANCE**

- A. Manufacturers: Thermometers shall be by Ashcroft, Marsh, Moeller, Trerice, or Weksler. Test wells shall be by same manufacturer.

**PART 2 - PRODUCTS****2.1 THERMOMETERS**

- A. Thermometers shall be industrial type with 9" aluminum case, every angle adjustment mount, plexiglass cover, 6" stem, and separable brass socket with 2½" lagging extension.
- B. Temperature range of thermometers shall be as follows:
- |                             |            |
|-----------------------------|------------|
| Chilled Water Piping:       | 30°-130°F. |
| Cooling Tower Water Piping: | 30°-130°F. |
- C. Accuracy within 1% of full scale range.

**2.2 TEST WELLS**

- A. Test wells shall be brass with brass plug and chain. Wells shall have 2½" lagging extension.

**2.3 TEST PLUGS**

- A. Test plugs shall be solid brass temperature and pressure test station, ¼" MPT size, standard length, Nordel valve core, manufactured by Peterson Equipment Company Inc.
- B. Furnish a test kit consisting of 0-100 psi pressure gauge, gauge adapter, 25°F-125°F pocket thermometer, and protective carrying case.

**PART 3 - EXECUTION****3.1 INSTALLATION**

- A. Install thermometers in wells where shown on the plans.
- B. Gauges shall be located and installed so as to be conveniently read from the floor.
- C. Gauges shall be installed upright in a vertical plane when not more than seven feet (7') above the floor.
- D. Provide an isolation ball valve at each pressure gauge installation.
- E. Test plugs shall not be covered by insulation.
- F. Obtain receipt from Owner's representative for test plug kit.

**END OF SECTION 230521**



## **SECTION 230523 HVAC VALVES AND STRAINERS**

### **PART 1 - GENERAL**

#### **1.1 DESCRIPTION**

- A. This section specifies the valves and strainers common to the heating and air conditioning piping systems of Division 23.

#### **1.2 RELATED SECTIONS**

- A. Section 230500 Common Work Results for HVAC
- B. Section 232000 Pipe, Fittings, and Accessories
- C. Section 232113 Hydronic Piping

#### **1.3 QUALITY ASSURANCE**

- A. All gate, globe, and check valves provided under Mechanical Sections shall be of the same domestic manufacturer, except as otherwise specified.
- B. All other valves of a given type shall be by the same domestic manufacturer.
- C. All valves shall have asbestos-free packing and gaskets.
- D. All brass alloys used in valves shall contain a maximum of 15% zinc.

### **PART 2 - PRODUCTS**

#### **2.1 BALL VALVES**

- A. Ball valves 2" and under shall be bronze body, threaded or solder, full port, blowout proof stem, solid stainless or chromed ball, 2" extended handles of non-thermal conductive material to accommodate pipe insulation, memory stop, rated for 600 psi non-shock WOG, and meeting MSS SP-110.
- B. Ball valves shall be Apollo, Hammond, Nibco, or Watts.

#### **2.2 BUTTERFLY VALVES**

- A. Butterfly valves 2½" and larger shall be 150 lb class meeting MSS-SP-67 lugged type with ASTM A-126 class B cast iron or ductile iron body, extended neck, lever type, infinite position memory stop handle, stainless steel shaft, bronze or ductile iron disc, stainless steel or bronze shaft bushings and rigid EPDM (BUNA-N) seat designed for service at 200°F minimum.

- B. Valves 6" and larger shall be furnished with weatherproof ASTM A-126 class B iron body worm gear operator and 6" minimum diameter malleable iron rim handwheel.
- C. All valves shall be factory tested and guaranteed bubble tight at 150 psi differential.
- D. Valves shall be rated for dead end service with downstream flange removed.
- E. Butterfly valves shall be Bray, Center Line, Grinnell, Hammond, Keystone, Milwaukee, or Watts.

### **2.3 PLUG VALVES**

- A. Plug valves shall be non-lubricated type with resilient coated plugs or lubricated type with non-resilient coated plugs. Body and plug shall be semi-steel with port area of not less than 80%.
- B. Valves 2" and smaller shall be threaded; 2½" and larger flanged.
- C. Valves 4" and smaller shall be wrench operated with memory stop. Valves 5" and larger shall be furnished with handwheel and gear operator.
- D. Plug valves shall be DeZurik, Homestead, or Rockwell Nordstrom.

### **2.4 GAUGE ISOLATORS**

- A. Gauge isolators shall be PVC construction with Teflon diaphragm and stainless steel hardware. Isolator shall be filled with glycerin prior to mounted pressure gauge. Plastic gauge isolators shall be Chemline, Nibco, or Georg Fischer.

## **PART 3 - EXECUTION**

### **3.1 BUTTERFLY VALVES**

- A. Butterfly valves may be used in lieu of gate and globe valves at the contractor's option in chilled water, condenser water, and tempered water systems sizes 2½" and larger.

### **3.2 BALL VALVES**

- A. Ball valves may be used in lieu of gate and globe valves at the contractor's option in chilled water, condenser water, and tempered water systems in pipe sizes 2" and smaller.

### **3.3 GENERAL**

- A. Valves shall be line size unless otherwise noted.
- B. Ball valves installed in horizontal piping shall have valve stems upright where possible. Butterfly valves shall be installed with the stem in the horizontal position where possible.

- C. Set pressure-reducing valves for pressures noted on the plans.

**END OF SECTION 230523**

## **SECTION 230549 VIBRATION ISOLATION**

### **PART 1 - GENERAL**

#### **1.1 DESCRIPTION**

- A. This Section specifies vibration isolation requirements for Mechanical Systems.

#### **1.2 RELATED SECTIONS**

- A. Section 230010 General Provisions - HVAC
- B. Section 230500 Common Work Results for HVAC

#### **1.3 SUBMITTALS**

- A. See General Conditions for submittal procedure.
- B. Provide product data, including schedule of isolator type, associated equipment, and load at each point based on manufacturer's operating weight, and actual deflection at each loading point for each piece of isolated equipment.
- C. Provide manufacturer's installation instructions, including setting and anchoring instructions.

### **PART 2 - PRODUCTS**

#### **2.1 MANUFACTURER**

- A. All vibration isolation equipment shall be furnished by one manufacturer. Equipment shall be by Aeroflex (VMC), Amber/Booth (VMC), Mason, or Vibro-Acoustics (Swegon).

#### **2.2 ISOLATION EQUIPMENT**

- A. Isolation equipment selection shall be based on actual mechanical equipment to be installed, providing uniform load distribution and deflection.

#### **2.3 ISOLATORS**

- A. Isolators shall conform to the following:
  - 1. Type 7. Molded neoprene isolator pad, waffle molded surface top and bottom, selected for a minimum loading of 40 psi unless noted otherwise. Pad shall be a minimum of ½" thick. Isolator shall be provided by chiller manufacture.

**PART 3 - EXECUTION****3.1 INSTALLATION**

- A. There shall be no direct contact of isolated piping or equipment with shaft walls, floor slabs, partitions, or conduits.
- B. Where recommended by the manufacturer, isolator base plates shall be bolted to the structure or foundation. Bolting shall incorporate neoprene bushings and washers.
- C. After installation, verify isolators are properly adjusted, with springs perpendicular to bases or housing, adjustment bolts are tightened up on equipment mountings, and hangers are not cocked.

**END OF SECTION 230549**

**SECTION 230553  
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT**

**PART 1 - GENERAL****1.1 DESCRIPTION**

- A. This section specifies the identification requirements for the mechanical systems.

**1.2 RELATED SECTIONS**

- A. Section 230010 General Provisions HVAC  
B. Section 230500 Common Work Results for HVAC Systems  
C. Section 232113 Hydronic Piping

**1.3 SUBMITTALS**

- A. See General Conditions for submittal procedure.  
B. Provide product data showing label illustrations and application locations.

**1.4 SUMMARY:**

- A. Section includes:
1. Plastic Coiled Pipe Markers.
  2. Pressure Sensitive Adhesive Pipe Markers.
  3. Valve Tags and Schedules.
  4. Engraved Plastic Signs.
  5. Engraved Equipment Markers.
  6. Plastic Tags.

**1.5 REFERENCES**

- A. American National Standards Institute (ANSI): ANSI A13.1 Scheme for the Identification of Piping Systems, current edition.  
B. Department of Labor 29 CFR 1910.1200.

**1.6 SUBMITTALS**

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each identification material and device required.

- B. Schedules: Submit valve schedule for each piping system, typewritten and produced on 8½" x 11" bond paper. Include valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and any variations for identification. In addition to framed copies, furnish extra copies for maintenance manuals as specified in Division 1.

## 1.7 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of identification products of types and sizes required, whose products have been in satisfactory use for a period of five (5) years.
- B. Codes and Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification products.

## PART 2 - PRODUCTS

### 2.1 MECHANICAL IDENTIFICATION MATERIALS

- A. Provide manufacturer's standard products for each application as referenced in this section.

### 2.2 PIPE MARKERS

- A. Pressure-Sensitive Type: Provide manufacturer's standard preprinted, permanent adhesive, color-coded pressure sensitive vinyl labels complying with ANSI A13.1. Color-coded plastic adhesive flow directional arrow tape, full circle at both ends of the pipe marker, tape overlapped 1½". Use 1" tape for piping less than 2½", 2" tape for 2½" through 8" piping, and 4" tape for larger piping.
- B. Lettering: Comply with ANSI A 13.1 for piping system nomenclature. Abbreviate only as necessary to accommodate marker length.

### 2.3 VALVE TAGS

- A. Plastic Tags: Provide manufacturer's standard 1/16" plastic engraved tags, 1½" square, black with white lettering, with ¼" high service indicator on top line and ½" numbers below.
- B. Valve Tag Fasteners: Use solid brass "S" hooks for installation of valve tags.
- C. Chart Frames: Provide one (1) aluminum 8½" x 11" valve chart frame with glass lens for each valve schedule provided.
- D. Access Panel Markers: Provide manufacturer's standard 1/16" thick engraved plastic access panel markers with abbreviations and numbers corresponding to the concealed valve.

**2.4 ENGRAVED PLASTIC EQUIPMENT MARKERS**

- A. Contractor to match existing equipment labeling as close as possible. Coordinate with existing systems.
- B. Provide manufacture’s standard 1/16” engraved equipment tags matching the terminology on schedules as closely as possible. Use black with white letters, 1” x 3” or 1½” x 4” for control devices, dampers, and valves and 4” x 6” for equipment.

**PART 3 - EXECUTION**

**3.1 GENERAL INSTALLATION REQUIREMENTS**

- A. Where identification is to be applied to surfaces requiring painting, insulation, or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting.

**3.2 MARKER LOCATION**

- A. Install pipe markers on each system indicated, include arrows showing normal direction of flow.
- B. Schedule of Piping Identification:

Piping Systems and Contents	Tape Background Color	Stenciled Legends
<u>Water Supply</u> Chilled Water Condenser Water Supply/Return	Blue Green	Chilled Water Supply/Return Condenser Water

Contractor to match existing piping Tape Background Color and Stenciled Legends as close as possible. Coordinate with existing systems.

- C. Locate pipe markers and/or color bands (if required) wherever piping is exposed to view, and at least one marking per room above suspended ceilings. Per the following:
  - 1. Near each valve and control device.
  - 2. Near each branch, excluding short take-offs for fixtures and terminal units mark each branch where there might be a question of flow direction.
  - 3. Near locations where pipes pass through walls, floors, or ceilings or where they enter non-accessible locations.
  - 4. Near major equipment items and other points of origination and termination.



**3.3 PAINTING OF PIPING**

- A. See Section 230500 – Common Work Results for HVAC Systems for painting requirements.
- B. Schedule of Piping Paint Color (Note that painting of copper piping is not required):

<u>Piping Systems and Contents</u>	<u>Paint Color</u>
<u>Water Supply</u>	
Chilled Water	None
Condenser Water	Dark Green

Contractor to match existing piping paint color as close as possible. Coordinate with existing systems.

**3.4 VALVE IDENTIFICATION**

- A. Provide a valve tag on every, cock, and control device in each piping system. Exclude check valves and valves within factory fabricated equipment units. List each tagged valve in a valve schedule for each piping system.

**3.5 EQUIPMENT IDENTIFICATION**

- A. Install engraved plastic signs or equipment markers on or near each major item of mechanical equipment and each operational device, per the equipment schedule. Attached tag to the ceiling grid directly under equipment installed above lay-in ceilings. Provide markers for the following general categories of equipment and operational devices.
1. Chillers, Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
- B. Method of Installation: Use stainless steel screws except where adhesive is necessary because substrate cannot or should not be penetrated. Use rivets for tags attached to the ceiling grid.

**END OF SECTION 230553**

**SECTION 230593  
TESTING, BALANCING, AND ADJUSTING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the requirements for testing and balancing the Heating, Ventilating, and Air Conditioning Systems.

**1.2 RELATED SECTION**

- A. Section 230010 General Provisions HVAC

**1.3 QUALIFICATIONS**

- A. The test and balance work shall be performed by an independent firm certified by the Associated Air Balance Council (AABC), or National Environmental Balancing Bureau (NEBB).

**1.4 PROCEDURES**

- A. All air distribution systems and hydronic systems shall be tested, adjusted, and balanced to the conditions specified and/or shown on the drawings.
- B. Performance of systems and components at specified conditions shall be verified by testing.
- C. Before request for final inspection, calibrate, adjust, set, test and check all valves, dampers, temperatures, pressures, and flow rates of systems for operation and performance.
- D. All test and balance work shall be performed in accordance with AABC or NEBB procedures.

**1.5 REPORTS**

- A. Submit completed and certified report to Architect in triplicate.

**PART 2 - PRODUCTS**

**2.1 GENERAL**

- A. Provide all instruments, charts, materials, and equipment required to develop a complete test and balance report.

**PART 3 - EXECUTION****3.1 TEST AND BALANCE REPORT**

- A. Test and balance report shall be a complete document, not limited to, but including at least the following:
1. Coils, Pumps and Heat Exchangers:
    - a. Entering medium temperature, flow rate, and pressure.
    - b. Leaving medium temperature, flow rate, and pressure.
  2. Pumps:
    - a. Flow rates.
    - b. Entering and leaving pressures.
    - c. Verify alignment.
    - d. Pump speed.
  3. Electric Motors:
    - a. Full load amperes, voltage, and horsepower.
    - b. Installed starter heater size.
  4. Controls:
    - a. Operational setting of controllers and instruments.
    - b. Positioning and function of valves and dampers.
    - c. Interlock and operation of system functions.
    - d. Thermostat differential setting.
  5. Refrigeration System:
    - a. Compressor safety and operating controls.
    - b. Capacity reduction and low ambient controls.
    - c. Expansion valve superheat.
    - d. Operating pressure at each controller position.
    - e. Compressor full load amperage in each phase and voltage.
    - f. Condenser fan amperage and voltage, if applicable.

**END OF SECTION 230593**

**SECTION 230700  
HVAC INSULATION****PART 1 - GENERAL****1.1 DESCRIPTION**

- A. Insulation specified in this Section is for insulation used in Division 23 work.

**1.2 RELATED SECTIONS**

- A. Section 230010 General Provisions HVAC
- B. Section 232113 Hydronic Piping
- C. Section 232114 Hydronic Water Specialties
- D. Section 236426 Water Cooled Rotary Chiller

**1.3 DEFINITIONS**

- A. Exposed piping is work that can be seen when the building is complete without opening or removing access doors or panels.
- B. Other piping and ductwork is considered to be concealed.

**1.4 INSPECTION**

- A. Surfaces to be insulated shall be clean, dry, and free of foreign material such as rust, scale, and dirt when insulation is applied. Perform pressure tests required by other Sections before applying insulation.
- B. Where existing insulation is damaged due to the new work, repair damage to match existing work or replace damaged portion with insulation specified for new work.

**1.5 QUALITY ASSURANCE**

- A. Products of the listed manufacturers will be acceptable for use for the specific functions noted. All materials shall be compatible with the materials to which they are applied, and shall not corrode, soften, or otherwise attack such material in either the wet or dry state.
- B. Materials shall be applied subject to their temperature limits. Any methods of application of insulating materials or finishes not specified in detail herein shall be in accordance with the particular manufacturer's published recommendations.
- C. Insulation shall be applied by experienced workers regularly employed for this type work.

**1.6 SUBMITTALS**

- A. See General Conditions for submittal procedure.
- B. Provide a table/matrix of all insulation types (D-1, P-3, etc.) being submitted and at a minimum the associated usage location, specification paragraph, manufacture, thickness, layers required, finish type.
- C. Clearly identify what insulation type is being submitted on each submittal page. Submittal cut sheets intended for multiple insulation types shall have each insulation type clearly marked on the respective manufactures cut sheet charts, tables, matrixes, etc.
- D. Provide manufacturer's instructions indicating installation and support requirements.

**1.7 RATING**

- A. Insulation and accessories, unless specifically exempted, shall have a composite flame-spread rating of not more than 25 and a smoke-developed rating of not more than 50. Materials that are factory applied shall be tested as assembled. Materials that are field applied may be tested individually. No fugitive or corrosive treatments shall be employed to impart flame resistance.
- B. Flame-spread and smoke-developed ratings shall be determined by Method of Test of Surface Burning Characteristics of Building Materials, ASTM E-84 or UL 723.
- C. Products or their shipping cartons shall bear a label indicating flame-spread and smoke-developed ratings.
- D. Treatment of pipe jackets to impart flame and smoke safety shall be permanent.

**1.8 ASBESTOS**

- A. All materials used in this work shall be asbestos free.

**PART 2 - PRODUCTS****2.1 INSULATION APPLICATIONS**

- A. Mechanical Equipment: Insulation - denoted by Type E:
  - 1. Interior cold equipment (chillers, chilled water pumps, chilled water storage tanks, chilled water heat exchangers, or any other equipment subject to sweating):
    - a. Type E1 elastomeric, 1" thick.
- B. Pipe Insulation – Denoted by Type P:
  - 1. Interior exposed chilled water piping:
    - a. Type P1 cellular glass, 1½" thickness for piping up to 4" diameter and 2" for piping larger than 4" diameter.

## 2.2 ACCESSORY MATERIALS

- A. Low VOC adhesives, sealants and mastics shall be selected as recommended by the insulation manufacturer. Adhesives shall be water based, and must comply with the current VOC content limits of the South Coast Air Quality Management District (SCAQMD) Rule #1168, with a maximum VOC emission of 70 grams per liter. Low VOC water based sealants and mastics shall be manufactured to comply with NFPA 90A, UL listed and complying with ASTM E84 and comply with the current VOC limits of the SCAQMD Rule #1168, with a maximum VOC emission of 250 grams per liter. They shall be manufactured by the insulation manufacturer or by Foster, Hardcast, or 3M.
- B. Adhesives, sealants and mastics which secure a vapor barrier material shall be of the vapor barrier type.
- C. Adhesives, sealants and finishes for surfaces above 70°F shall be of the “breather” type.
- D. Insulation jackets shall have a vapor barrier when applied to surfaces subject to sweating in an ambient environment up to 90°F D.B. and 80°F W.B., including chilled water, condensate drain, refrigerant suction, and ice water.
- E. Where specified, finish jackets for all insulation in the building shall be not less than 8 oz./sq. yd. white, pre-sized glass cloth kraft paper reinforced by Carolina or Twinsburg-Miller.
- F. All finish mastics and sealants shall be white in color, unless noted otherwise.
- G. Pre-formed fitting jackets shall be one piece molded PVC with a 25/50 flame spread smoke developed rating.
- H. T-304 stainless steel jackets shall be corrugated type, with 3/16” corrugations, .016” thick for all pipe sizes. T-304 stainless steel jacketing shall have an integrally bonded moisture barrier over the surface in contact with the insulation. Provide two-piece pre-formed T-304 stainless steel at fittings.
- I. Staples shall be “outward clinch” or “flare” type.
- J. Galvanized steel wire shall be 20 gauge.
- K. Stainless steel wire shall be 20 gauge.

## 2.3 INSULATION PIPE SHIELDS

- A. Shields shall be galvanized rolled to form a 180° arc. Length of shields shall conform to the following:

<u>Insulation O.D.</u>	<u>Shield Length</u>	<u>Shield Gauge</u>
0-4”	12”	14 gauge
5-9”	18”	14 gauge

## 2.4 INSULATION DESIGNATION

- A. Type E1 shall be Elastomeric Insulation, suitable for interior application.

1. Elastomeric sheet and tape shall be a closed cell rubber material with a minimum density of 3.0 lbs./cu.ft. Operating temperature range shall be -70°F to 180°F, with a mean thermal conductivity of 0.27 at 75°F. Material shall have a water vapor permeability not exceeding 0.08 perm-inch, and shall resist mildew development. Flame spread rating shall not exceed 25 and smoke developed rating shall not exceed 50. Manufacturer shall be Armacell (Armaflex) or Rubatex.
- B. Type P1 shall be Cellular Glass Insulation, suitable for interior application.
1. Insulation shall be composed of multiple glass cells each of which is a sealed air cell and each cell sealed to the adjacent cells. Minimum density shall be 7 lbs./cu.ft. Temperature range shall include -450°F to 800°F per ASTM C552. Mean thermal conductivity shall not exceed 0.29 at 75°F. Absorption of moisture shall be not more than 0.2% by volume when tested according to ASTM Designation C-240-61. Adhesive shall be compatible with temperature range of pipe service. Manufacturer shall be Pittsburgh Corning or Cellutech Cellufoam.
  2. Insulation finish shall be glass fabric and mastic jacket, Pittsburgh Corning PC Fabric 79 and Pittcote 404, or equivalent by Foster.
  3. All valves, thermometer wells, gauge cocks, hose bibbs, air vent piping, and any other components shall be insulated with molded insulation fittings or same thickness elastomeric insulating tape finished with flexible glass cloth and mastic.

### **PART 3 - EXECUTION**

#### **3.1 GENERAL APPLICATION**

- A. The following general conditions apply to the insulation installation.
1. Insulation shall be clean and dry during installation and during application of any finish.
  2. Provide removable and replaceable covers on all portions of equipment requiring insulation that must be opened periodically for inspection, cleaning, or repair.
  3. Banding wires shall have the twisted terminals turned down into the insulation, except where vapor barrier would be punctured.
  4. Finish open ends of pipe insulation as specified for fittings.
  5. All piping and equipment which are scheduled to be insulated shall have a finished jacket, either factory or field applied.
  6. Staples shall be installed only on insulation that does not contain a vapor barrier.
  7. For all cold piping systems (chilled water, condensate), all components of the piping system shall be insulated and provided with a continuous vapor barrier. Vapor barriers shall be continuous for entire piping system and shall not be pierced except as specified otherwise.
  8. Factory applied jacket shall be the finish jacket unless otherwise noted.
  9. Maintain vapor barrier where dissimilar insulation products abut.
  10. Control devices shall be installed on the outside surface of insulation except devices such as firestats. All resulting penetrations and edges of insulation shall be sealed as specified above.

### 3.2 PIPE SHIELDS

- A. For all piping, insulation shall be continuous on pipe at pipe hangers with protection shields bearing on the outside of the insulation.
- B. For pipes 2" and larger, where insulation would be crushed by hangers, provide 180° foamed glass inserts between pipe and hanger protector and finish with jacket same as adjacent pipe.

### 3.3 INSULATION APPLICATION

- A. Type E1 – Elastomeric Insulation:
  - 1. Foamed plastic insulation shall be cut into shaped sections and applied over 100% surface coverage of adhesive. Insulation shall be applied when surface is clean and dry. Butt joints together in a staggered fashion and butter with adhesive before joining to provide a continuous vapor barrier jacket. Install insulation with the skin side outside.
- B. Type P1 - Cellular Glass Interior Insulation:
  - 1. Cover pipe with insulation held in place with stainless steel wire not more than 12" on center.
  - 2. All joints shall be filled and pointed up with Pittseal (R) 44N sealant, or equal, applied so as to maintain continuous vapor barrier.
  - 3. All pipe insulation on exposed piping inside the building shall be finished with a coating of Pittcote (R) 404 coating, or equal. For cold piping, coating shall be vapor barrier type.
  - 4. All pipe insulation on concealed piping shall be finished with two coats of mastic with flexible glass cloth embedded in the initial layer. For cold piping, sealer shall be vapor barrier type.
  - 5. Valves, fittings and unions shall be covered and finished with mitered insulation sections as described for pipe: Maintain specified insulation thickness.
  - 6. Riser clamps, anchors, etc., which are in contact with cold pipe shall be insulated with cellular glass as described for piping extending for a distance of 6" beyond the outside surface of the pipe insulation.

### 3.4 FINISH JACKETS

- A. Field installed jackets shall be provided when specifically noted.
- B. Pre-sized glass cloth jackets shall be secured by a continuous coating of adhesive applied to a uniform thickness. Jacket shall be smooth without wrinkles. Jacket shall be applied to straight lengths of covering only.
- C. Flexible glass cloth shall be applied to equipment, valves, fittings, and curved surfaces. Cloth tape shall be smoothly applied and secured with a continuous coat of adhesive. White fabric and mastic to be used on exposed pipe fittings. Tape shall overlap itself and adjacent jackets not less than 2".

**END OF SECTION 230700**



**SECTION 230923  
BUILDING AUTOMATION AND TEMPERATURE CONTROL SYSTEM**

**PART 1 - GENERAL****1.1 DESCRIPTION**

- A. This section specifies the requirements of the Building Automation and Temperature Control System (BAS). The BAS shall utilize direct digital control (DDC) technology to maintain the space conditions and provide automatic control of the associated mechanical equipment.

**1.2 SCOPE OF WORK**

- A. Furnish and install a complete building automation system in all respects, including any and all equipment, wiring, instrumentation, enclosures, labor, engineering, coordination with other trades, etc. No information given in these specifications shall relieve the contractor of this absolute requirement. Include all associated electrical work. It is the intent of these specifications that the Contractor shall furnish and install the systems complete in every respect and ready to operate. Furnish and install equipment, miscellaneous items, and accessories required for the correct and convenient operation of the entire installation, whether or not such item is shown on the plan or mentioned herein.
- B. Work Included:
1. System engineering and design documents.
  2. Pre-assembled control panels.
  3. System programming.
  4. Actuators, thermostats, sensors, thermowells, and mounting hardware as applicable.
  5. Control valves, control dampers, linkages, and mounting hardware.
  6. Construction supervision.
  7. Start-up and system check out.
  8. Demonstration and training.
  9. Warranty.

**1.3 RELATED SECTIONS**

- A. Section 230500 Common Work Results for HVAC
- B. Section 236426 Water Cooled Rotary Chiller

**1.4 SUBMITTALS**

- A. See General Conditions for submittal procedure.
- B. Drawings:

1. Prepare instrumentation and control diagrams labeled accurately and showing the system architecture and the interrelationship of all controls and the areas and equipment served. Clearly show point-to-point connections.
  2. Wiring diagram shall delineate between power and control wiring and shall indicate all starters, contactors, relays, sensors, and other components of the system. Normally open positions for valves, dampers, and relays shall be indicated. All wiring between equipment, modules, and control panels shall be shown. A ladder diagram detailing control functions shall be included.
- C. Submit the above diagrams as post construction control record drawings derived from redlined prints maintained during construction by this Contractor.
- D. One (1) copy of the control record drawing shall be secured to the associated control panel. Mounting diagram(s) in a resealable plastic pouch is acceptable.
- E. Submit shop drawings and manufacturer's data for the following:
1. Sensors.
  2. Controllers and set points.
  3. Actuators.
  4. Automatic control valve and damper schedules.
  5. Points List.
  6. Thermostats.
  7. Thermometers and indicators.
  8. System diagrams, including system architecture.
  9. Point-to-point wiring or tubing diagrams.
  10. Control panels and panel layout.
  11. Installation and calibration instructions.
  12. Software programs and sequences written in the program language and in English.
- F. Operating and Maintenance Data (after construction):
1. Submission: Submit three (3) 8½" x 11", 3-ring, hard cover, bound and typed copies of Operating and Maintenance Manual to the Architect for approval prior scheduling any systems demonstration for the Owner.
  2. Required Contents: Typed index with tab dividers for each major equipment section to facilitate locating information on specific pieces of equipment. Identify data within each section with drawing code numbers as they appear on Drawings and Specifications. Include as a minimum the following data:
    - a. Alphabetical list of system components with the name, address, and 24-hour telephone number of the company responsible for servicing each item during the first one year of operation.
    - b. Operating instructions for each piece of equipment and the complete system including:
      - (1) Emergency procedures for fire or failure.
      - (2) Start, operation, maintenance, disassembly, and shutdown procedures.
      - (3) Maintenance instructions for each piece of equipment.
      - (4) Valve tags and other identified equipment lists.
      - (5) Proper lubricants and lubricating instructions.
      - (6) Cleaning, replacement and/or adjustment schedule.
      - (7) Product data on each piece of equipment.

- (8) Installation instructions.
- (9) Manufacturer's shop drawings and specifications.
- (10) Parts list.
- (11) Wiring and temperature control diagrams "as-built" as detailed above.

## 1.5 QUALITY ASSURANCE

- A. Control installation work shall be performed by mechanics regularly employed in the installation of the control manufacturer. Control work shall be Convergent.
- B. Provide a one (1) year labor and material warranty from date of system acceptance by Owner. Warranty shall cover hardware, software, and programming. The contractor shall correct any work found defective or not in accordance with the contract documents.
- C. The contractor shall provide all maintenance including parts, labor, and expenses for correction of any deficiency, breakdown, and routine preventative maintenance for the one (1) year warranty period.
- D. Provide written guarantee the system will be upwardly compatible for at least five (5) years without requiring wholesale replacement of hardware to upgrade to new generations. Failure to provide guarantee will result in immediate rejection of bid and proposal.
- E. Components: All system components shall be approved and listed by Underwriters Laboratories under UL916 for Direct Digital Control systems, and FCC-Part 15, Subparagraph J, Class A Emissions Requirements.

## PART 2 - PRODUCTS

### 2.1 SENSING/CONTROL FIELD DEVICES

- A. Field devices include all sensors, wells, relays, pressure switches, control valves, valve actuators, dampers, damper actuators, and other interfaces necessary for connecting the DDC panels to the facility equipment to be controlled under this specification.
- B. Analog Electronic Transmitters:
 

Limit of error:	$\pm 0.50\%$ of span
Deviation from Linearity	$\pm 0.50\%$ of span
Hysteresis	$\pm 0.10\%$ of span
Deadband	$\pm 0.10\%$ of span
Frequency Response	3 db at 10Hz
Variations due to temp. change	$\pm 0.01\%$ of span °F
Variations due to voltage change	0.05% of span per volt
Ambient limits:	-20°F to 130°F
- C. I/P Converters:
 

Input signal	4-20mA
Output signal	3 to 15 psig
Accuracy	$\pm 0.75\%$ of span

Linearity	± 0.50% of span
Hysteresis	± 0.50% of span
Deadband	± 0.10% of span

- D. Rate/Reset Controllers: Use proportional type with adjustable integral and derivative actions. The controllers shall be field adjustable and provide a switch to eliminate the integral and derivative functions for calibration.
- E. Communications Ports: Provide all sensors and controllers with RS-232 serial communications port for the control network communication.

## 2.2 ELECTRONIC DEVICES FOR HYDRONIC AND/OR GASEOUS SYSTEMS

- A. Temperature Transmitters shall have elements suitable for immersion into tanks and piping and have platinum RTD for use with bridge circuit controllers or transmitters. Sensors to be single, dual, averaging, dual wound or suitable to maintain stable control. Provide stainless steel immersion wells with heat conducting compound in tanks and piping. Minimum range shall be -30°F to 240°F.
- B. Differential Pressure Switch: Rate for 120V, 60Hz single-phase power. Provide switches equipped with adjustable setpoint, dust-tight enclosures and snap-acting contacts, housed in a NEMA 4 enclosure.
- C. Differential Pressure Transmitters shall be stainless steel with ceramic capacitive sensing element with temperature compensation. Sensor shall have overpressure rating three times the sensing range, 3,000 psi burst pressure, and housed in a splash-proof enclosure with gauge. Minimum range shall be 15 to 75 psi or 100 to 500 psi, as best meets system operation.
- D. Pressure Transmitters: Provide an electronic device with pressure ranges from -30" Hg to 400 psig that generates a 4 – 20 ma signal, suitable for gaseous or water applications. Device shall be housed in a watertight polystyrene enclosure. Device shall be suitable for temperature ranges of -12°F to 167°F. Device shall be provided with a pressure gauge in a corresponding pressure range.
- E. Stainless Steel Pressure Transmitter: Provide a stainless steel pressure transmitter with ranges from -30" Hg to 2000 psi, made of 304 stainless, suitable operating range from -40°F to 200°F, compatible with gases or liquids. Output will be 4-20 ma with 10-30 VDC supply voltage at 25 ma.
- F. Water Flow Switches: Provide stainless steel or bronze paddle switches. For chilled water, provide vapor-proof type to prevent condensation in the electrical switch. Provide pressure-flow switches of below-actuated mercury or snap-acting type with appropriate scale range and differential adjustment for service indicated.
- G. Water Flow Transmitters shall be turbine in-stream type with nickel-plated brass wetted components, electronic impedance sensing and 2% accuracy manufactured by Onicon. Device shall be fitted with hot tap adapter and proper stem length. Minimum range shall be 30° to 180°F.
- H. Liquid Level Transmitter: Provide electronic probe-type level control and monitoring sensor. Level sensors shall provide analog signal monitoring of tank liquid level.

- I. pH Transmitter: Provide a sensor with a range of 2 to 12pH, 120V 60Hz, 1" MNPT pipe connection, 35°F to 100°F operating range.

## 2.3 MISCELLANEOUS ELECTRONIC DEVICES

- A. Current switches shall be solid state switch with adjustable setpoint (set at no load condition for fan or pump run status). Switch capacity shall be selected based on motor monitored.
- B. Electric actuators shall either be push-pull magnetic or hydraulic type, or rotary (gear-train) type for two-position or modulating service as required by application. All electric actuators shall be UL listed with NEMA 1 enclosures, unless otherwise acceptable.
  1. Thermally powered (heat motor) actuators are not acceptable.
  2. Actuators shall fail to the position as indicated on the drawings.
  3. Actuators shall be permanently lubricated; gear-train units shall be oil-immersed type. Actuator housings shall be metal or plastic. Ambient temperature range shall be at least 40°F to 120°F, except actuators subjected to outdoor ambients shall have ambient range of -20°F to 130°F minimum. Actuator size and rating shall be suitable for intended application.
  4. Modulating magnetic or electric actuators with adjustable end switches to prevent overstroking are acceptable in sizes  $\leq 1"$ .
  5. Positive positioners shall be provided on actuators for AHU's control, to provide smooth modulation or proper sequencing:
    - a. Positioner start-point shall be adjustable (or selectable).
    - b. Positioner span shall be adjustable, or at least three fixed spans for sequencing applications shall be available.
- C. Control Relays: Interposing control relays shall be rated for the application, have a minimum of two (2) sets of Form C contacts, and be enclosed in a dustproof enclosure. The coils shall be equipped with transient suppression devices to limit transients.
- D. Emergency Fan Stop Switch: Provide a recessed, normally closed glass break pull station permanently marked "EMERGENCY FAN STOP SWITCH" where shown.
- E. Water detector shall use gold-plated probes mounted in an adjustable height watertight enclosure with N.O. and N.C. contacts.

## 2.4 CONTROL PANELS

- A. All controllers, relays, switches, etc., for equipment located within equipment rooms shall be mounted in enclosed control panels with hinged locking doors. Indicating devices and switches shall be mounted on the face of the control panel door. All control devices, including indicators, for equipment located in exposed areas subject to outside weather conditions, shall be mounted inside weatherproof enclosures. Location of each panel is to be convenient for adjustment service. Name plates shall be provided beneath each panel-mounted control device describing the function of the device.
- B. All electrical devices within the panel shall be prewired to terminal strips with all inter-device wiring within the panel completed prior to installation of the system.

- C. All enclosures shall be fully enclosed cabinets with 12-gauge, furniture steel construction with baked enamel finish and hinged key door locks and shall have removable face and back panels. Panels shall be Underwriters Laboratories, Inc. listed for line voltage applications.
- D. All panels will be documented with schematics, parts layout, parts listing, component and board identifiers consistent on all documentation, theory of operation and service manuals.
- E. Mount panels adjacent to associated equipment on vibration free walls or free standing steel angle supports.

## 2.5 GENERAL PRODUCT DESCRIPTION

- A. The Building Automation System shall be capable of integrating multiple building functions including equipment supervision and control, alarm management, energy management, fire management, lighting control, information management, and historical data collection and archiving.
- B. The facility management system shall consist of the following:
  - 1. Standalone DDC panels.
  - 2. Application specific controllers (ASPs).
  - 3. Remote Display Devices.
  - 4. The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, standalone DDC panels, and operator devices.
  - 5. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. Each DDC panel shall operate independently by performing its own specified control, alarm management, operator I/O, and historical data collection. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.
  - 6. Standalone DDC panels shall be able to access any data from, or send control commands and alarm reports directly to any other DDC panel or combination of panels on the network without dependence upon a central processing device, such as a central file server.

## 2.6 NETWORKING/COMMUNICATIONS (LOCAL AREA NETWORK)

The design of the BAS shall network operator workstations and Standalone DDC panels. Inherent in the system's design shall be the ability to expand or modify the network.

- A. Local Area Network:
  - 1. Panel Support: DDC panels shall directly reside on a single shared high speed local area network such that communications may be executed directly between controllers, directly between workstations, and between controllers and workstations on a peer-to-peer basis.
  - 2. Dynamic Data Access: All operator devices, shall have the ability to access all point status and application report data, or execute control functions for any and all other devices via the local area network. Access to data shall be based upon logical identification of building equipment.

3. Access to system data shall not be restricted by the hardware configuration of the facility management system. The hardware configuration of the FMS network shall be transparent to the user when accessing data or developing control programs.
4. General Network Design: Network design shall include the following provisions:
  - a. High speed data transfer rates for alarm reporting, quick report generation from multiple controllers, and upload/download efficiency between network devices. The minimum baud rate shall be 1 Megabaud.
  - b. Support of any combination of controllers and Operator Workstations directly connected to the local area network.
  - c. Detection and accommodation of single or multiple failures of either workstations, DDC panels or the network media. The network shall include provisions for automatically re-configuring itself to allow all operational equipment to perform their designated functions as effectively as possible in the event of single or multiple failures.
  - d. Message and alarm buffering to prevent information from being lost.
  - e. Error detection, correction, and re-transmission to guarantee data integrity.
  - f. Default device definition to prevent loss of alarms or data, and ensure alarms are reported as quickly as possible in the event an operator device does not respond.
  - g. Commonly available, multiple sourced, networking components shall be used to allow the FMS to coexist with other networking applications. The following are acceptable technologies: ETHERNET.

## 2.7 STANDALONE DDC PANELS

- A. General: Standalone DDC panels shall be microprocessor based, multi-tasking, multi-user, real-time digital control processors. Each standalone DDC panel shall consist of modular hardware with plug-in enclosed processors, communication controllers, power supplies, and input/output modules. A sufficient number of controllers shall be supplied to fully meet the requirements of this specification and the attached point list.
- B. Memory: Each DDC panel shall have sufficient memory to support its own operating system and databases including:
  1. Control Processes.
  2. Energy Management Applications.
  3. Alarm Management.
  4. Historical/Trend Data for all points.
  5. Maintenance Support Applications.
  6. Custom Processes.
  7. Operator I/O.
  8. Dial-Up Communications.
  9. Manual Override Monitoring.
- C. Point types: Each DDC panel shall support the following types of point inputs and outputs:
  1. Digital Inputs for status/alarm contacts.
  2. Digital Outputs for on/off equipment control
  3. Analog Inputs for temperature, pressure, humidity, flow and position measurements

4. Analog Outputs for valve and damper position control, and capacity control of primary equipment
  5. Pulse Inputs for pulsed contact monitoring
- D. Expandability: The system shall be modular in nature, and shall permit easy expansion through the addition of software applications, workstation hardware, field controllers, sensors, and actuators. The system architecture shall support 25% expansion capacity of all types of DDC panels, and all point types included in the initial installation.
- E. Serial Communication Ports: Standalone DDC panels shall provide at least two RS-232C serial data communication ports for simultaneous operation of multiple operator I/O devices such as industry standard printers, laptop workstations, PC workstations, and panel mounted or portable DDC panel Operator's Terminals. Standalone DDC panels shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers, or network terminals.
- F. Hardware Override Switches: As indicated in the point schedule, the operator shall have the ability to manually override automatic or centrally executed commands at the DDC panel via local, point discrete, onboard hand/off/auto operator override switches for binary control points and gradual switches for analog control type points. These override switches shall be operable whether the panel is powered or not.
- G. Hardware Override Monitoring: DDC panels shall monitor the status or position of all overrides, and include this information in logs and summaries to inform the operator that automatic control has been inhibited. DDC panels shall also collect override activity information for daily and monthly reports.
- H. Local Status Indicator Lamps: The DDC panel shall provide local status indication for each binary input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device.
- I. Integrated On-Line Diagnostics: Each DDC panel shall continuously perform self-diagnostics, communication diagnosis and diagnosis of subsidiary equipment. The DDC panel shall provide both local and remote annunciation of any detected component failures, or repeated failure to establish communication. Indication of the diagnostic results shall be provided at each DDC panel and shall not require the connection of an operator I/O device.
- J. Surge and Transient Protection: Isolation shall be provided at all network terminations, as well as all field point terminations to suppress induced voltage transients.
- K. Powerfail Restart: In the event of the loss of normal power, there shall be an orderly shutdown of all standalone DDC panels to prevent the loss of database or operating system software. Non-Volatile memory shall be incorporated for all critical controller configuration data, and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours. Upon restoration of normal power, the DDC panel shall automatically resume full operation without manual intervention. Should DDC panel memory be lost for any reason, the panel will automatically receive a download via the local area network, phone lines, or connected computer. In addition, the user shall have the capability of reloading the DDC panel via the local area network, via the local RS-232C port, or via telephone line dial-in.



## 2.8 OPERATOR INTERFACE

- A. All BAS connected workstations shall function in a true multi-user, multi-tasking environment:
  - 1. All terminals can access the same network at the same time.
  - 2. All terminals can access and/or control the same DCU at the same time.
  - 3. All terminals can access and/or modify the same database at the same time.
  - 4. All terminals shall be able to archive data, alarms, and network actions to hard disk regardless of what application programs are being currently executed (i.e., LAN operating system, word processing, etc.). All archiving disk traffic shall be accomplished on-line without effecting the operation of the current programs.
  
- B. Additional on-line functions, supported concurrently in every workstation without rebooting, shall include, but not limited to:
  - 1. On-line database development and editing.
  - 2. On-line BAS implementation and tuning.
  - 3. On-line graphics development.
  - 4. Real time facility control.

## 2.9 FRONT END GRAPHICS

- A. The BAS contractor shall provide all the necessary hardware, data, information, and graphical images for the DDC system to publish fully interactive web-page graphics for monitoring and operating the DDC system's controllers using only a standard web browser. Support for both Microsoft Internet Explorer and Netscape Navigator must be provided.
  
- B. The contractor shall include developed graphics for each piece of equipment being controlled and/or monitored by the BAS. BAS graphics will include the following screen pages as a minimum, but not limited to:
  - 1. System Pages:
    - a. Initial Screen. Provide building address and links to system screens on a scanned-in background of the building front elevation. Elevation will be from an architectural rendering or photograph. Links will be provided to each floor plan and as applicable, each mechanical chiller plant, electrical monitoring system and fuel monitoring systems.
    - b. Building floor plan layouts will show every room. Where temperature and humidity sensors are installed in the building, show readings on the floor plan. Show all equipment including chillers, AHUs, PIUs, VAVs, generators, etc. Provide links to each piece of equipment and to system pages.

- c. Chiller plant will default to the chilled water system loop. Show each chiller and chilled water pump with double lined water piping. Show all water temperatures and flows, basic chiller operating points and equipment status. Layout of the chiller plant will resemble the equipment layout in the building. Leave and identify spaces for future equipment as shown in the construction drawings. Provide links to the other system pages and condenser water page. Condenser water page to be similar to the chiller page. Provide link to integrated chiller data. Show data for chillers on one page.
2. Equipment Pages:
    - a. Chillers: Show all information for the chiller(s) on a single page. Show high and low alarm limits for each item. Provide links to condenser and chilled water pages. Layout of the chiller pages will resemble the equipment layout in the building. Leave and identify spaces for future equipment as shown in the construction drawings.

## **PART 3 - EXECUTION**

### **3.1 WIRING**

- A. All electrical wire, conduit, cable, fittings, junction boxes, connectors, etc., associated with the systems, including interlock wiring, shall be furnished and installed complete under these specifications.
- B. Installation shall be in accordance with the requirements of Division 26, the National Electrical Code and local codes. All electrical work included under this section shall be complete with labor, materials and installations.
- C. Run all wiring and conduit concealed unless conditions do not allow. Secure approval from Engineer prior to installing surface raceway. Where surface raceway is required, it shall be wire mold or approved equal.
- D. All control wiring routed in conduit shall not have any other type of wiring (power, etc.) routed in the same conduit.
- E. Where required for electronic controls or interfacing, provide relays and other devices with low impedance contacts. Where required to maintain proper relay operation and prevent chatter, increase minimum control wire gauges specified herein.
- F. All line voltage electrical wiring shall be enclosed in conduit. All exposed low voltage electrical wiring shall be installed in conduit or EMT. All low voltage wiring located above ceilings in plenums shall be 25/50 flame spread/smoke developed rated and UL listed. Support wiring 24" OC by clips to structure.

### **3.2 INSTALLATION REQUIREMENTS**

- A. Any panels associated with the control system shall be furnished and installed under this section of the work. Connected to numbered terminal strips shall terminate panel wiring. Wire nut connections shall not be allowed.

- B. All devices, panels, etc. furnished and/or installed shall be located where they can be calibrated and maintained from the floor without use of a ladder. These items shall be identified by means of plates made of plastic, suitably engraved, embossed or punched.
- C. Any conduit on roof shall be at an absolute minimum and shall have prior written approval.
- D. All conduit and fittings used indoors and outdoors shall be metal to minimize corrosion and moisture entry.

### **3.3 LOCATING DDC PANELS**

- A. In order to minimize wiring costs, DDC panels should be installed near equipment or systems, which are to be monitored and/or controlled. Panels located in administrative, common areas, or equipment aisles will be recessed mounted. Panels mounted in electrical or mechanical rooms will be surface mounted.
- B. Consider providing sub-unit controllers or I/O expansion units near each cluster of sensor/actuator points, with sub-unit controllers and I/O expansion units reporting to the stand-alone controllers. Where practical, Application Specific Controllers or stand-alone controllers should be installed in mechanical equipment rooms.
- C. All PC boards enclosed in metal boxes shall be mounted to a non-conductive, non-metallic surface to avoid shorting or grounding.

### **3.4 POWER/ENVIRONMENT/SPACE REQUIREMENTS**

- A. The environmental conditions in the space in which the stand-alone controllers and associated equipment are located shall meet the manufacturer's requirements of 30°F to 120°F and 5% RH to 95% RH.
- B. Provide adequate space in front of the equipment for easy access and repairs. Provide adequate lighting over all DDC equipment and panels enclosing interfacing devices.

### **3.5 OPERATOR INSTRUCTION AND TRAINING**

- A. During system commissioning and at such time as acceptable performance of the system hardware and software has been established, the BAS contractor shall provide on-site operator instruction to the Owner's operating personnel. Operator instruction during normal working hours shall be performed by a competent BAS contractor representative familiar with the system's BAS software, hardware and accessories.
- B. At a time mutually agreed upon during system commissioning as stated above, BAS contractor shall give 16 hours of instructions to the Owner's designated personnel on the operation of all central processing and peripherals and describe intended use with respect to the programmed functions specified. Operator orientation of the FMS shall include, but not be limited to, the overall operational program, equipment functions (both individually and as part of the total integrated system), commands, advisories, and appropriate operator intervention required in responding to the system's operation. An Owner's Manual, prepared for this project by the BAS contractor, shall be used in addition to the instruction. Two (2) copies of the Owner's Manual shall be provided.

- C. Sixteen hours of additional instruction by the BAS contractor shall be provided to the Owner's designated personnel. This instruction shall provide a description of the chronological information flow from field sensors, contacts and devices to the centrally located system. The overview of the system's communication network shall be to provide a better understanding to the operator of the interplay between initiating devices, field processing units, system communications, and their importance within the operating system.

### **3.6 SEQUENCE OF OPERATION**

- A. The sequences of operations are to be used in conjunction with the I/O Summaries. Points indicated on the I/O shall be used to accomplish the sequences. Any points required to accomplish the sequences shall be provided whether indicated on the I/O or not. Points indicated on the I/O, but not utilized to accomplish any sequences, shall be provided for information and alarming purposes.

**END OF SECTION 230923**

**SECTION 232000  
PIPE, FITTINGS AND ACCESSORIES – HVAC**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Piping specified in this Section is for types of pipe and accessories used in Division 23.

**1.2 RELATED SECTION**

- A. Section 230500 Common Work Results for HVAC.
- B. Section 232113 Hydronic Piping
- C. Section 232114 Hydronic Specialties

**1.3 QUALITY ASSURANCE**

- A. Pressure piping systems shall meet requirements of the ASME and ANSI Standards (and all addenda) as noted below:
1. Above Grade Chilled Water Piping      B31.9 Building Services Piping.
- B. Codes and regulations referred to are minimum standards. Where the requirements of these specifications or drawings exceed those of the codes and regulations, the drawings and specifications govern.
- C. Pressure/temperature ratings of all components and accessories shall meet or exceed design conditions for the system in which they are installed.
- D. Welding shall be in accordance with procedures of the National Certified Pipe Welding Bureau and shall comply with the requirements of the ANSI Code for Pressure Piping. Welders shall be qualified under referenced standards cited hereinbefore and certified by the National Certified Pipe Welding Bureau.
1. All required certifications and documentation of welder's qualifications shall be provided with submittals and under no circumstances shall welding be allowed prior to approval of certification by engineer. All documentation shall include the following at a minimum:
    - a. Welder Performance Qualification Record (WPQ)
    - b. Welding Procedure Specification (WPS)
    - c. Procedure Qualification Record (PQR)
    - d. Continuity Log (If applicable)
  2. All welding certification documentation to be kept on site at job trailer and shall be made available to the owner/engineer upon request. Documentation shall include a recent (6 months max) photo of the welder.

3. If the contractor requires additional welding labor that has not been previously approved by the engineer, the contractor shall provide certification one week in advance of personnel's presumed arrival on job site to allow engineer adequate time to review all documentation.
- E. The owner reserves the right to x-ray and/or ultrasonically test all piping welds by a third-party testing firm, which shall be hired by the owner. If welds fail testing qualifications outlined in the above-mentioned standards, the welding contractor shall be responsible for all costs associated with resolving the failed weld, including the costs of owner's testing agency retesting failed weld until it has been resolved to owner's level of satisfaction.

## PART 2 - PRODUCTS

### 2.1 PIPE AND FITTINGS

#### A. Steel Piping:

##### 1. Pipe (up to 12" diameter):

Material	Specification
Schedule 40 Black steel	ASTM A53-97b Grade B
Schedule 80 Black steel	ASTM A53-97b Grade B
Schedule 40 Galvanized steel	ASTM A53-97b

##### 2. Fittings:

- a. 150 lb. SWP malleable iron screwed fittings conforming to ANSI B16.3.
- b. 125 lb. SWP cast iron flange fittings conforming to ANSI B16.1.
- c. Standard weight factory fabricated butt-welding fittings conforming to ANSI B16.9 and ASTM A234.
- d. 150 lb. forged steel welding neck or flat face slip-on flanges conforming to ASTM A181.
- e. Socket fittings conforming to ANSI B16.11.
- f. Dielectric couplings and/or flange kits shall be provided at connections between ferrous and non-ferrous pipe. Provide with high temperature gaskets rated for 300°F steam service.
- g. Unions:
  - (1) Except where otherwise specified, unions in welded piping shall be flanges.
  - (2) Unions in piping 2" and smaller shall be 150 lb. malleable iron, ground joint, bronze to iron, screw type.
  - (3) Unions in screwed piping 2½" and larger shall be 125 lb. cast iron flanges.
- h. Fittings, flanges, and unions in galvanized steel pipe shall be galvanized.

##### 3. Joints, unless specified otherwise:

- a. Screwed Joints: Joint compound shall be "Tite-Seal" or Teflon tape, except where otherwise specified.

- b. Welded Joints: Welding rods shall be compatible with the material to be welded. Welding shall be by electric arc or oxyacetylene methods.
- c. Flanged joints shall be made up with 1/16" thick, ring type, compressed composition sheet gasket, except for gas piping which shall be made up with aluminum "O" ring type gaskets. Flange bolts shall be steel hexagon head type, conforming to ASTM A307. Nuts shall conform to ASTM A193.

B. Copper Piping:

1. Pipe:

<u>Material</u>	<u>Specification</u>
Type L tube	ASTM B88-99
Type K tube	ASTM B88-99

2. Fittings:

- a. Wrought copper solder joint type conforming to ANSI B16.22. Cast fittings conforming to ANSI B16.18, except where otherwise specified, may be used only in patterns not available in wrought fittings, and where desired changes in direction and/or reduction in size cannot be accomplished with two wrought fittings.
- b. Adapter fittings shall be provided at all copper to brass pipe connections. Adapters 2" and smaller shall be cast bronze or wrought copper. Adapters larger than 2" shall be 150 lb. cast bronze flanges. Adapters between the meter and the pressure reducing valve shall be 250 lb. cast bronze flanges.
- c. 150 lb. cast bronze flange fittings conforming to ANSI B16.24 downstream of the pressure reducing valves.
- d. Dielectric couplings and/or flanged kits shall be provided at all copper to steel pipe connections.
- e. Unions:
  - (1) Except where otherwise specified, unions shall be wrought copper or cast bronze.
  - (2) Unions in piping 2½" and larger shall be 150 lb. cast bronze flanges, downstream of the pressure reducing valve and 250 lb. between the meter and the PRV.
  - (3) Insulating unions shall be provided at all equipment having ferrous connections.

3. Joints, unless specified otherwise:

- a. Solder Joints: Solder shall be 95/5 (95% tin, 5% antimony) except where otherwise specified. Where specified or noted on the drawings, solder shall have a silver alloy solder having a melting point of not less than 1100°F. NO LEAD SOLDER SHALL BE PERMITTED.
- b. Solder flux shall be the type recommended by the manufacturer of the 95/5 solder used, meeting NSF/ANSI 61. Silver brazing flux shall be used for solder of 1100°F. or higher melting point.

## **PART 3 - EXECUTION**

### **3.1 PIPING – GENERAL**

- A. All piping shall be run straight and parallel to building construction. All changes in directions shall be made with fittings as specified herein and shown on the drawings.
- B. All piping shall be installed with allowance for expansion and contraction. Anchors and guides shall be provided where shown on the drawings. Swing joints shall be provided at top and bottom and risers and in branch connection at each floor.
- C. Pipe connections to equipment that is supported independent of the pipe, including pumps, shall be aligned with the equipment.
- D. Install piping so as to preserve access to all valves, air vents, and other equipment and to provide the maximum headroom possible.
- E. Equipment Drains, Drips, Etc.:
  - 1. All devices and equipment having drain, drip or blowdown connection shall be piped to nearest floor drain terminating with an elbow over grate, except where otherwise specified.
  - 2. Piping shall be run parallel and plumb to walls and shall be braced to walls, floor, other piping or equipment.
  - 3. Piping shall be full size of device or equipment connection. Except for relief valve discharges, horizontal drains may be combined into one pipe that is one pipe larger than largest connecting pipe.
  - 4. Condensate drains shall be trapped and provided with unions and cleanouts.
- F. Unions shall be provided at all connections to flow control valves, equipment and apparatus.

### **3.2 PROCEDURES FOR PIPE JOINTS**

- A. Welded Joints:
  - 1. All welding of pipe shall conform to the ASME and ANSI Standards B31.1 Power Piping and B31.9 Building Services Piping.
  - 2. Mitering or notching pipe to form elbows and tees will not be permitted. Field and shop bevels shall be in accordance with the recognized standards and shall be done by mechanical means or flame cutting. Where beveling is done by flame cutting, surfaces shall be cleaned of slag, scale and oxidation prior to welding.
  - 3. Before welding, the component parts to be welded shall be aligned so no strain is placed on the weld when finally positioned. Height shall be aligned so that no part of the pipe wall is offset by more than 20 percent of the wall thickness. Flanges and branches shall be set true. This alignment shall be preserved during the welding operations. Connections larger than 6" shall be made with backing rings at welds.
  - 4. Where the temperature of the component parts being welded reaches 32°F or lower, the material shall be heated to approximately 100°F for a distance of 3' on each side of the weld before welding, and the weld shall be finished before the material cools to 32°F. All welds shall be full penetration welds.



5. Defective welds shall be removed and replaced at no additional cost to the Owner. Repairing of defective welds by adding new materials over the defects or by peening will not be permitted.
  6. Electrodes shall be stored in a dry, heated area and shall be kept free of moisture or dampness during fabrication operations. Electrodes that have lost part of their flux shall be discarded.
  7. Fire protection safeguards shall be employed in connection with welding operations.
  8. No welding will be permitted where communication equipment has been installed.
  9. Before any welder shall perform any pipe welding, submit a copy of the Welding Operator Qualification Test as required by the referenced standards cited hereinbefore.
- B. Screwed Joints:
1. All threads shall be standard, clean cut and tapered. All burrs shall be reamed from inside of the pipe and pipe shall be turned on end and all loose dirt and scale knocked out.
  2. Pipes with threads stripped, chipped or damaged, or split pipe or defective fittings shall not be used.
  3. Joint compound shall be applied to the male threads only.
- C. Flanged Joints: Gaskets shall extend to inside the bolt holes, and flanges shall be brought up truly and water and airtight on gaskets by tightening bolts on opposite sides of the pipe.
- D. Copper Tubing Solder Joints:
1. Ends of pipe shall be cut square and cleaned with sand cloth so as to remove all oxides before soldering. Fittings shall be similarly cleaned with sand cloth or wire brush.
  2. Flux shall be evenly applied to both pipe end and fittings.
  3. Solder shall completely fill all parts of joint. Clean excess flux from pipe after joint completed.

### 3.3 PRESSURE TESTING

- A. See particular piping section for pressure testing requirements.

**END OF SECTION 232000**

**SECTION 232113  
HYDRONIC PIPING****PART 1 - GENERAL****1.1 DESCRIPTION**

- A. This section specifies the piping component types and other requirements for the hydronic piping associated with the mechanical systems.
- B. Hydronic water piping shall connect heat transfer equipment, pumps, components, and accessories to form a complete and operable system.

**1.2 RELATED SECTIONS**

- A. Section 230500 Common Work Results for HVAC
- B. Section 230523 HVAC Valves and Strainers
- C. Section 230700 Mechanical Systems Insulation
- D. Section 232000 Pipe, Fittings, and Accessories - HVAC
- E. Section 232114 Hydronic Specialties

**1.3 SYSTEM CONDITIONS**

- A. The chilled water system shall be installed for the following conditions:
  - Design Pressure: 125 psig.
  - Working Pressure: 40 psig.
  - Operating Temperature Range: 40°F to 80°F.
- B. The condenser (cooling tower) water system shall be installed for the following conditions:
  - Design Pressure: 125 psig.
  - Working Pressure: 40 psig.
  - Operating Temperature Range: 35°F to 100°F.

**PART 2 - PRODUCTS****2.1 PIPE**

- A. Chilled Water Black Steel      Schedule 40
  - 1. Copper piping shall be used in lieu of steel for sizes 2" and smaller.
- B. Condenser (Cooling Tower) Water Black Steel      Schedule 40

1. Copper piping may be used in lieu of steel at the contractor's option for sizes 2" and smaller.
- C. Strainer Blowdown, Drains, and Relief Valve Discharge Galvanized Steel Schedule 40
1. Copper piping may be used in lieu of steel at the contractor's option for sizes 2" and smaller.

## 2.2 FITTINGS AND JOINTS

- A. Black steel piping 2½" and larger shall be butt welded.
- B. Black steel piping smaller than 2½" shall be screwed.
- C. Copper piping shall be brazed.

## 2.3 VALVES

- A. Chilled water valves:
  1. Valves 2½" and larger shall be gate or butterfly type, except where otherwise indicated. Balancing valves, where shown, shall be plug valves.
  2. Valves smaller than 2½" shall be gate, plug, and ball types as shown on the plans.
- B. Condenser water valves:
  1. Valves 2½" and larger shall be butterfly type except where otherwise specified.
  2. Valves smaller than 2½" shall be gate, globe, and angle types.

## 2.4 PIPE REDUCERS

- A. Eccentric type and concentric type.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install pipe to slope upward in the direction of flow, 1" in 40'.
- B. Install reducers so as to eliminate unvented high points. Use eccentric reducers on horizontal pipe with flat side on top.
- C. Install interconnecting piping for apparatus and equipment.
- D. Exercise care to prevent dirt and foreign matter from entering system. All piping ends shall be capped during construction.

**3.2 CLEANING OF PIPING SYSTEM**

- A. Piping systems shall be cleaned prior to connection to an existing system and prior to the application of water treatment. Clean all piping systems with a degreaser as recommended by the chemical treatment supplier. Flush piping completely after cleaning. Contractor shall provide necessary piping taps to accommodate flushing requirements.
  - 1. Contractor shall make all necessary accommodation required to contain and properly dispose of all materials used during the cleaning application.
- B. Equipment and systems shall be operated only for testing prior to the application of water treatment.
- C. Remove strainer baskets, clean, and reinstall.
- D. After operation of the system, remove all Chilled Water pumps and Condenser Water pumps strainer baskets, clean, and reinstall. Coordinate with owner's representative to witness strainer basket cleaning.

**3.3 PIPE PRESSURE TEST**

- A. Hydrostatically pressure test piping before insulating or concealing. Pipe shall hold the test pressure without perceptible leakage or pressure loss. Test piping at not less than 1½ times working pressure, but not greater than design pressure for two hours. Isolate equipment and apparatus that may be damaged during pressure test. Pressure testing shall be witnessed by the owner or an owner's representative and testing shall be documented by the contractor. Coordinate testing times and dates with the owner/engineer/commissioning agent a minimum of 1 week prior to testing commencement.

**END OF SECTION 232113**

## **SECTION 232114 HYDRONIC SPECIALTIES**

### **PART 1 - GENERAL**

#### **1.1 DESCRIPTION**

- A. This Section specifies the hydronic system specialty equipment requirements.

#### **1.2 RELATED SECTIONS**

- A. Section 230010 General Provisions HVAC
- B. Section 230500 Common Work Results for HVAC
- C. Section 230523 HVAC Valves and Strainers
- D. Section 230700 Mechanical Systems Insulation
- E. Section 232000 Pipe, Fittings, and Accessories - HVAC
- F. Section 232113 Hydronic Piping

#### **1.3 SUBMITTALS**

- A. See General Conditions for submittal procedure.
- B. Provide product data showing equipment dimensions, capacity, weight, pressure rating with associated Code compliance, and pipe connection sizes and locations.
- C. Provide manufacturer's instructions, indicate installation and support requirements.
- D. Provide operation and maintenance data; include start-up instructions, assembly drawings and parts list.

### **PART 2 - PRODUCTS**

#### **2.1 PIPING FLEXIBLE CONNECTORS**

- A. Flexible hose connectors shall be manufactured complete with section of corrugated metal hose, compatible braid, with inlet and outlet connections as required.
- B. Piping flexible connectors shall be 150 lb plate carbon steel with flanges, 321 stainless steel corrugated hose. Assembly shall be tested at 1.5 times rated maximum working pressure and shall operate with water temperature range of -400°F to +1500°F. Fittings Materials of construction and end fitting type shall be consistent with pipe material and equipment/ pipe connection fittings. Connector shall provide a maximum of 3/8" intermittent and 3/4" permanent offset capability. Copper fittings shall not be attached to stainless steel hose.

- C. Piping flexible connectors shall be Metraflex, model SLP or preapproved equal.

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

- A. Align piping flexible connector flanges and pipe flange holes. Do not compensate for flange or pipe misalignment by install connector in a manner where it may increase torsional, compressive, extension or offset loads on flexible connector.
- B. Install and guide per manufacturers' installation instructions

**END OF SECTION 232114**

**SECTION 232500  
WATER TREATMENT SYSTEMS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the requirements for equipment and installation of the water treatment systems.

**1.2 RELATED SECTIONS**

- A. Section 230010 General Provisions HVAC
- B. Section 230100 Operation and Maintenance of HVAC Systems
- C. Section 230500 Common Work Results for HVAC
- D. Section 232113 Hydronic Piping

**1.3 SUBMITTALS**

- A. See General Conditions for submittal procedure.
- B. Provide product data showing chemical treatment materials, equipment, and electrical connection requirements.
- C. Provide shop drawings showing piping schematic, wiring diagram, pump dimensions and pipe connection size.
- D. Provide manufacturer's field report stating how system start-up was performed, current status of system and analysis of system water before and after treatment.
- E. Provide operation and maintenance data; include start-up instructions, assembly drawings and parts list.

**1.4 QUALITY ASSURANCE**

- A. Water treatment shall be performed by an independent firm regularly engaged in the business of water treatment.
- B. Water treatment supplier shall be ChemAqua, contact Drew Ellis, 470-302-0676, [drew.ellis@chemaqua.com](mailto:drew.ellis@chemaqua.com). Water treatment contractor shall be employed by the mechanical contractor to review design, preparation, cleaning flushing and start-up.

**1.5 SYSTEM CONDITIONS**

- A. Piping systems shall be cleaned prior to connection to an existing system (if applicable) and prior to the application of water treatment. Clean all piping systems with a degreaser as recommended by the chemical treatment supplier. Flush piping completely after cleaning.
- B. Equipment and systems shall be operated only for testing prior to the application of water treatment.

**PART 2 - PRODUCTS****2.1 WATER TREATMENT SYSTEMS**

- A. Existing systems shall remain.

**PART 3 - EXECUTION****3.1 TESTING AND TREATMENT**

- A. The chemical supplier shall review drawings and visit the job site to verify that all accommodations needed for them to provide their services have been provided. Job Site visit shall take place 2 weeks prior to cleaning/flushing procedures beginning. Chemical supplier shall immediately notify engineer and mechanical contractor of any deficiencies noted.
- B. The chemical supplier shall check the equipment for proper installation.
- C. Water samples shall be collected and analyzed with report forwarded to the Engineer.
- D. No hydronic system shall be started until cleaning, flushing and pre-treatment has been performed to the satisfaction of the water treatment contractor.

**END OF SECTION 232500**



**SECTION 236426  
WATER-COOLED ROTARY CHILLERS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the requirements for water-cooled rotary chillers.

**1.2 RELATED SECTIONS**

- A. Section 230010 General Provisions HVAC
- B. Section 230100 Operation and Maintenance of HVAC Systems
- C. Section 230500 Common Work Results for HVAC
- D. Section 230518 Refrigerant Monitors and Accessories
- E. Section 230548 Seismic Restraints
- F. Section 230700 Mechanical Systems Insulation
- G. Section 232113 Hydronic Piping System
- H. Section 232500 Water Treatment System

**1.3 SUBMITTALS**

- A. See General Conditions for submittal procedure.
- B. Provide data on unit performance including, but not limited to, entering water temperatures, leaving water temperatures, minimum capacity, total capacity, AHRI COP and IPLV values, chilled water and condenser water flow and associated pressure drop, and number of passes.
- C. Provide shop drawing showing chiller dimensions, weight, pressure rating, electrical requirements, service access requirements, and pipe connection sizes and locations.
- D. Provide shop drawing showing starter dimensions, capacities, weight, withstand rating, electrical requirements, and wiring connections and locations.
- E. A control diagram showing power and suggested interlock wiring, interlocking the compressor, oil heater and oil pump, along with the necessary documentation of the interface and protocol utilized by the chiller control system shall be furnished by the manufacturer for use in incorporation into the control diagrams. A separate diagram showing motor interlock wiring between the chiller and a separate motor starter(s) shall be submitted for approval. Control voltage and line voltage shall be separated on the diagram.
- F. Provide manufacturer's instructions; indicate installation and support requirements.

- G. Provide operation and maintenance procedures; include start-up instructions, assembly drawings and parts list.

#### **1.4 QUALITY ASSURANCE**

- A. Chillers shall be rated in accordance with the latest AHRI Standard 550/590.
- B. Chillers shall be charged with R-134a.
- C. Chiller assembly shall be UL listed.
- D. Chiller shall be factory pressure-tested, evacuated and fully charged with refrigerant and oil, and shall be factory operational run tested with water flowing through the vessel.

#### **1.5 WARRANTY**

- A. Manufacturer shall warrant all equipment and material of its manufacture against defects in workmanship and material for a period of eighteen (18) months from date of shipment or twelve (12) months from date of start-up, whichever occurs first.

### **PART 2 - PRODUCTS**

#### **2.1 SUMMARY**

- A. The unit shall be a complete assembly consisting of condenser, cooler, compressors, piping and controls, factory assembled, tested, packaged, and charged ready for operation.
- B. Chiller will be installed in an indoor location and shall be capable of operating in room temperatures between 40°F and 104°F.
- C. Chiller shall be completely factory-packaged including evaporator, condenser, compressor, motor, control center and all interconnecting unit piping and wiring. The complete chiller assembly shall be painted to meet 500-hour salt spray test in accordance with the ASTM B117 standard.

#### **2.2 COMPRESSOR AND MOTOR**

- A. Compressors shall be 3600 rpm, direct drive, semi hermetic screw compressor, thermal protectors embedded in motor windings and with fully modulating control over the entire operating range. Each compressor shall be provided with a completely independent refrigerant circuit.
- B. Compressors shall start at minimum load. Provide microprocessor control to command compressor capacity to balance compressor capacity with cooling load.

## 2.3 EVAPORATOR AND CONDENSER

- A. The evaporator and condenser shall be built in accordance with ANSI/ASHRAE 15 Safety Code for Mechanical Refrigeration. Water boxes shall be designed for 150 psig maximum working pressure and shall be flanged and gasketed for easy removal and access to the tubes. The water boxes shall have flanged water connections for easy field chilled water and condenser water connections.
- B. Evaporator and condenser tubes shall be copper with wall thickness of not less than .035".
- C. Refrigerant circuits shall include suction and discharge service valve, liquid line shutoff valve, removable core filter drier, moisture indicating sight glass, and electronic expansion valves.
- D. Factory insulation will be 3/4" closed cell flexible insulation with a minimum thermal conductivity of 0.26(BTU/HR-Ft<sup>2</sup>-°F/in) maximum at 75°F mean temperature. Cover all low temperature surfaces to include the evaporator and water boxes, suction elbow, and motor cooling lines.
- E. Water-cooled, electrically operated, rotary chillers shall meet or exceed ASHRAE 90.1 (current edition) [or IECC (current edition)] Performance Requirements:

≥150 but < 300 tons, Min Efficiency = 0.660 FL & 0.540 IPLV

## 2.4 REFRIGERANT RELIEF

- A. The chiller (regardless of refrigerant used) shall be provided with a spring-loaded, reseating type relief valve which shall protect the machine from refrigerant losses. A rupture disk may be provided upstream of the relief valve; however, if a rupture disk is provided, it shall be of the non-fragmenting type. The relief system shall be ASME-certified and conform to the latest edition of ANSI B9.1 "Safety Code for Mechanical Refrigeration" and shall comply with ASHRAE 15, current edition.

## 2.5 CONTROLS

- A. The chiller shall be controlled by a standalone microprocessor-based control panel. Microprocessor controls shall be housed in a water tight enclosure, factory mounted and wired, providing all control functions including start up and shut down, leaving chilled water control, electronic expansion valve modulation, condenser fan sequencing, antirecycle logic, automatic lead/lag starting and load limiting. Controls shall provide shutdown for low refrigerant temperature, high condensing temperature and motor overload. Auto restart after power failure shall be provided.
- B. Safeties: The chiller control panel shall monitor such safeties as motor starting and running, time between compressor/motor starts, low chilled water temperature, high condenser refrigerant pressure, low evaporator refrigerant pressure, evaporator and condenser water flows, low oil flow, and proper operation of unit controls and sensors.
- C. Provide gauges for evaporator and condenser pressure for each refrigerant circuit.

- D. The chiller control panel is to be provided with a starts counter and running time meter for each compressor. Multiple compressor units shall have automatic lead-lag function to equalize compressor run-time.
- E. The front of the chiller control panel shall be capable of displaying the following:
1. Entering and leaving evaporator water temperature
  2. Entering and leaving condenser water temperature
  3. Chilled water setpoint
  4. Electrical current limit setpoint
  5. Chiller operating mode
  6. Chiller diagnostic codes
  7. Flow switch status
  8. Evaporator/condenser pump status
  9. Active remote control
  10. Evaporator pressure
  11. Discharge oil pressures, condenser
  12. Economizer pressures per refrigerant circuit
  13. Economizer temperature and superheat
  14. Subcooler liquid temperature and superheat
  15. Compressor discharge temperature and superheat, motor
  16. Temperatures, evaporator temperature, per refrigerant circuit
  17. Compressor speed
  18. Condenser level control valve
  19. Economizer superheat
  20. Economizer feed valve percentage open
  21. Evaporator/condenser heater status
  22. Oil pump status
  23. Compressor number of starts
  24. Run time
  25. Operating hours
  26. Evaporator and condenser heater status
  27. History data for last ten shutdown faults
  28. History data for last 20 normal (non-fault) shutdowns.
- F. Manufacturer shall provide any controls not listed above, necessary for automatic chiller operation.
- G. Predictive Control Points: Unit controls shall avoid safety shutdown when operating outside design conditions by optimizing the chiller controls and cooling load output to stay online and avoid safety limits being reached. The system shall monitor the following parameters and maintain the maximum cooling output possible without shutdown of the equipment: motor current, evaporator pressure, condenser pressure, discharge pressure, starter internal ambient temperature, and starter baseplate temperature.
- H. The chiller control panel shall provide evaporator freeze protection and low limit control. This control shall be used to avoid low evaporator refrigerant temperature trip outs during critical periods of chiller operation.
1. Control System Interface: DDC type and shall provide the following, as a minimum:
    - a. Export system operating data.
    - b. Accept setpoint adjustments for chilled water setpoint and demand limit.
    - c. RS-232 communication: BACNet MS/TP is the default communication protocol unless otherwise noted.

- d. Field commissioning assistance by manufacturer's technician.

## **2.6 STARTERS**

- A. Motor Starters: Motor starters shall be Variable Frequency Drive type with zero electrical inrush current. Wye-Delta, Solid State, and Across the Line type starters will not be acceptable.
- B. Power Factor: Chiller must maintain a displacement power factor of 95% at all load conditions. Power factor correction capacitors will not be acceptable as they do not maintain the corrected power factor at all load condition.

## **2.7 POWER WIRING**

- A. Power wiring shall include all circuits to terminal blocks, fuses, circuit breakers, contractors and relays prewired to a single power source. Service voltage shall be 460v/three phase.

## **2.8 MANUFACTURERS**

- A. Chillers shall be York or pre-approved equal by Trane or Carrier.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Provide for connection to electrical service.
- C. Arrange piping for easy dismantling to permit tube cleaning.
- D. Provide vibration isolating elastomeric isolators for field installation.
- E. Provide piping from chiller relief valve outdoors. Size as recommended by manufacturer.

### **3.2 DELIVERY AND HANDLING**

- A. Unit shall ship in one piece and shall require installer to provide the evaporator and condenser inlet and outlet pipe connections.
- B. Unit shall be delivered to job site fully assembled with all interconnecting refrigerant piping and internal wiring ready for field installation and charged with refrigerant and oil by the Manufacturer.
- C. Provide protective covering over vulnerable components for unit protection during shipment. Fit all nozzles and open ends with plastic enclosures.

**3.3 MANUFACTURER'S FIELD SERVICES**

- A. Manufacturer shall furnish a factory trained service engineer, without additional charge, to start the unit. Representatives shall provide leak testing, evacuation, dehydration, and charging of the unit as required. Chiller manufacturer shall maintain service capabilities no more than 100 miles from the jobsite.
- B. A start-up log shall be furnished by the manufacturer to document the chiller's start-up date and shall be signed by the Owner or his authorized representative prior to commissioning the chillers.

**END OF SECTION 236426**

**SECTION 26 05 00**  
**COMMON WORK RESULTS FOR ELECTRICAL**

**PART 1 - GENERAL****1.1 SCOPE**

- A. This section applies to all Sections of Division 26.
- B. The general provisions of the contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this section and in all sections of this Division.

**1.2 WORK INCLUDED**

- A. Provide all labor, tools, and materials required for a complete and fully operational installation, as described on the drawings or in the specification.
- B. The work shall be installed in conformance with NEC Section 110-12, Mechanical Execution of Work, and NECA 1-2006, Standard Practices for Good Workmanship in Electrical Construction (ANSI).

**1.3 WORK NOT INCLUDED UNDER DIVISION 26**

- A. The following items of work are specified under other divisions of the specification:
  - 1. Temporary service for construction.
  - 2. Electric motors.
  - 3. Control and interlock wiring for work furnished under other divisions, except where specifically required under this division.
  - 4. Access panels in walls or ceilings.
  - 5. Field finish painting, except for field painting of electrical material with paint supplied by the manufacturer of the material.
  - 6. Starters for certain items of equipment are furnished under other divisions for installation under this division.
- B. Refer to other sections of this division for work required in connection with the above items.

**1.4 DEFINITIONS**

- A. "Provide": furnish and install, complete and ready for operation.
- B. "Install": receive, mount, and connect, complete and ready for operation.
- C. "Wiring": wires and cables installed with all required raceways, connectors, and fittings.
- D. "Concealed": not exposed to view; embedded in masonry or other construction; in furred spaces or above suspended ceilings; below grade.
- E. "Exposed": not concealed; not embedded or installed underground; under raised floors; inside trenches, tunnels, basements, inside built-up HVAC equipment, crawl spaces, and accessible attics.
- F. "The Drawings": that portion of the contract drawings annotated as electrical.
- G. "Furnish": Supply, deliver to job site, protect and store.

**1.5 ABBREVIATIONS**

- A. The abbreviations used on the drawings and in the specification are defined as follows:
  - 1. "AC": Alternating Current
  - 2. "AFF": Height above Finished Floor
  - 3. "AIC": Ampere Interrupting Capacity
  - 4. "AICR": Ampere Interrupting Current Rating
  - 5. "AHJ": Authority Having Jurisdiction
  - 6. "NEC": National Electrical Code
  - 7. "NIC": Not in the Contract
  - 8. "NF" or "N/F": Non-fused
  - 9. "30A/2P": Example of a circuit designation for a 30 Amp 2-Pole fused switch or a 30 Amp 2-Pole circuit breaker or device.
  - 10. "FBO": Furnished by Others

11. "EC": Electrical Contractor
12. "EX": Existing to Remain
13. "EXR": Existing Relocated - new location indicated on the drawings.
14. "HP": Horsepower
15. "kVA": Kilovolt Ampere
16. "kW": Kilowatt
17. "MCC": Motor Control Center
18. "MLO": Main Lugs Only
19. "NTS": Not to Scale
20. "WP": Weatherproof

## 1.6 CODES, RULES, AND REGULATIONS

- A. Comply with the following:
  1. Local codes enforced by the local inspection authority.
  2. The edition of the National Electrical Code being enforced for this project by the local inspection authority.
  3. All applicable laws and ordinances.
  4. The rules and regulations of electric utility company serving the project applicable to the installation of service and metering equipment.
  5. The rules and regulations of the telephone company serving the project applicable to the work required for routing telephone service into the facility.
- B. Give all necessary notices, obtain all required permits, and pay all inspection and other fees imposed by Authorities Having Jurisdiction over the work.

## 1.7 STANDARDS

- A. International Building Code (IBC) - 2018 Edition with Georgia Amendments (Georgia State Minimum Standard Building Code).
- B. International Fire Code (IFC) - 2018 Edition with Georgia State Amendments (Chapter 120-3-3 - Rules and Regulations for the State Minimum Fire Safety Standards).
- C. International Energy Conservation Code (IECC) - 2015 Edition with Georgia Supplements and Amendments.
- D. American with Disabilities Act (ADA) with Georgia Amendments Chapter (120-3-20) - Georgia Accessibility Code for Buildings and Facilities).
- E. ASHRAE - American Society of Heating, Refrigerating and Air Conditioning (ASHRAE - 90.1).
- F. Illumination Engineering Society (IES) - 10th Edition, Reference and Application Handbook.
- G. NFPA® - National Fire Protection Association®
  1. NFPA 101: Life Safety Code (LSC) - 2018 Edition with Georgia Amendments.
  2. NFPA 70: National Electrical Code (NEC) - 2020 Edition (No Georgia Amendments).
  3. NFPA 72: National Fire Alarm and Signaling Code - 2019 Edition with 2020 Georgia Amendments.
- H. IEC - International Electrotechnical Commission
- I. IESNA - Illumination Engineering Society of North America
- J. ASTM - American Society for Testing and Materials
- K. ANSI - American National Standards Institute
- L. IEEE® - Institute of Electrical and Electronic Engineers, Inc.®
- M. NEMA® - National Electrical Manufacturers Association®
- N. CEA - Insulated Cable Engineers Association
- O. UL® - Underwriters Laboratories, Inc.®
- P. TIA/EIA - Telecommunications Industry Association/Electronic Industries Alliance
- Q. State of Georgia - Chapter 120-3-3: Rules and Regulations issued by The Safety Fire Commissioner.
- R. Comply with the latest editions of standards applicable to the work.



**1.8 MATERIALS**

- A. All material shall be new and shall comply with the indicated standards.
- B. All material shall be UL labeled or UL listed, except where the material is of a type not included in the UL listing service, in which case the material shall comply with other applicable industry standards and the contractor shall provide any examinations or certifications required by the local inspection authority in lieu of UL listing.
- C. All material shall be of a suitable type and rating for the intended use and shall be installed in conformance with the instructions and recommendations of the manufacturer.

**1.9 DRAWINGS**

- A. The drawings are schematic in nature and do not indicate all the required details of the work. All materials customarily considered to be a part of the electrical work and normally required for a complete and operational installation, shall be provided without additional cost to the Owner.
- B. Refer also to the drawings of all other Divisions to coordinate the electrical installation.
- C. Equipment of other Divisions is shown schematically on the electrical drawings. Examine the drawings of the Division providing the equipment before roughing in the connections for it. Connect the equipment where actually installed, including wiring through any line voltage controllers, without any additional cost to the Owner.
- D. Prior to roughing in circuits for equipment furnished by other trades, and prior to releasing for manufacture, panelboards, starters or motor control centers feeding such equipment, coordinate the electrical provisions being planned with the trade providing the equipment and submit any conflicts in writing.
- E. At the direction of the Architect, the location of any electrical outlet, luminaire, or other equipment, may be relocated to a location within 10 feet of the location shown on the drawings at no additional cost to the Owner provided such relocation is made prior to the installation of the outlet, luminaire or equipment being relocated.

**1.10 SUBMITTALS**

- A. Submit shop drawings in the manner and form described elsewhere in the contract.
- B. Submittals are required for material as noted in other sections of this Division.
- C. Check shop drawings prior to submission and provide date and signature of checker on each item. Note all corrections. Note any requested deviation from the drawings or specification, or if none, then so indicate. The Architect shall return documents without any review, where submitted without prior review by the Contractor.
- D. Review of submittals will be only for general conformance with the design concept indicated on the Drawings and in the Specification and for general compliance with the information given in the Contract Documents. Review will be made only of information clearly and specifically indicated in the submittal, and does not imply the acceptability of details, which are not so described in the submittal. Approval of a specific item shall not include approval of an assembly of which the item is a component. Contractor is responsible for: dimensions to be confirmed and correlated at the jobsite; information that pertains solely to the fabrication processes or to the means, methods, techniques, sequences and procedures of construction; coordination of the work of all trades; and performing all work in a satisfactory manner.
- E. Review of the submittal documents by the Architect does not relieve the Contractor of the responsibility to comply with all requirements of the Contract Documents.

**1.11 PROJECT CLOSEOUT**

- A. Furnish Closeout Documents in the manner and form described elsewhere in the Contract Documents.
- B. Closeout Documents shall include the following:
  - 1. Final shop drawings.
  - 2. As-built drawings including redlined as-built field layout and installation drawings.
  - 3. Operation and Maintenance Manuals.
  - 4. Receipts from the Owner stating that he has received satisfactory operational demonstrations and instruction for electrical systems as specified in other Sections.

5. Signed receipts from the Owner for spare parts and materials that are specified to be furnished.
6. Written warranty.
7. All required certifications, including certificate of inspection approval from the code-enforcing Authority.
8. All required test reports (include in Operations and Maintenance Manual).

#### **1.12 AS-BUILT DRAWINGS**

- A. Provide as-built drawings in the manner and form described elsewhere in the Contract Documents.
- B. As-built drawings shall be maintained at the jobsite and shall be available for review during construction.
- C. As-built drawings shall be kept up-to-date and current during the course of construction of the work.
- D. Record the final arrangement of the work and exact locations of the work as installed.
- E. Provide photographs of buried grounding work prior to backfill of trenches.

#### **1.13 OPERATION AND MAINTENCE MANUALS**

- A. Provide a minimum of (3) copies of Operation and Maintenance Manuals in the manner and form described elsewhere in the Contract Documents. Manuals shall be typewritten, indexed, tabbed, and loose leaf bound in heavy duty 3-ring binders.
- B. Manuals shall include, as a minimum, the following:
  1. Operating instructions customized to this specific project
  2. Maintenance instructions
  3. Parts list
  4. Descriptive literature
  5. Location, telephone number and contact information of contractors, distributors, dealers and authorized service agents.
  6. Test reports and certifications.
  7. Record copies of all shop or submittal drawings and data
  8. Copies of all software on diskette or compact disk, licensed to the Owner.
- C. Maintenance instructions and parts lists shall include the most detailed and advanced publications available from the equipment manufacturer.
- D. Demonstrate the operation of the equipment to the Owner, including instruction in its use and operation. Provide instruction by manufacturers' representatives where specified in other Sections.
- E. Provide Operation and Maintenance Manuals for equipment and systems as specifically described within the Sections of Division 26 - Electrical and Division 28 - Electronic Safety and Security, Fire Detection and Alarm.

#### **1.14 SPARE PARTS**

- A. Furnish spare parts as specified by the sections in Divisions 26 and 28.
- B. Turn over spare parts to Owner designated project representative. Store on site as directed by the Owner. Obtain written receipt detailing specific spare parts turned over and submit this document along with the contract closeout documents.
- C. Replace at no cost to the Owner, any spare parts used from the Owner inventory of stock prior to Material Completion or where used for warranty related repairs.

#### **1.15 GENERAL TESTING**

- A. Test all parts of the work to verify compliance with the Drawings and Specification.
- B. Verify correct tightness of all mechanical and electrical connections.
- C. Verify integrity of all wiring systems to assure suitable continuity, absence of unintentional grounds, and integrity of required grounds.

- D. Perform any required special factory or field-testing as specified in the other Sections of this Division. Provide all wiring, instruments, labor and personnel, required to complete these tests.
- E. Where other requirements of this Division require testing in the presence of the Architect, provide at least seven (7) business days advance written notice of such testing to the Architect.
- F. Where other requirements of this Division require submission of written records of tests and test results, accumulate and submit all such reports and include as a separate section in the operations and maintenance manuals described elsewhere in this section.

**END OF SECTION**

**SECTION 26 05 01**  
**BASIC MATERIALS AND METHODS**

**PART 1 - GENERAL****1.1 GENERAL**

- A. This section covers items of work required by more than one section of Division 26 - Electrical.
- B. Refer to other Divisions for requirements pertaining to:
  - 1. Cutting and repairing
  - 2. Field painting
  - 3. Equipment furnished under other Divisions and installed under this Division

**PART 2 - PRODUCTS****2.1 CONCRETE INSERTS**

- A. Manufacturers:
  - 1. B-Line.
  - 2. Grinnell.
  - 3. Hohmann & Barnard.
  - 4. Kindorf.
  - 5. Unistrut.

**2.2 DRILLED ANCHORS**

- A. Manufacturers:
  - 1. Grinnell.
  - 2. Hilti.
  - 3. Rawl.
  - 4. Red-Head.
- B. All metal, heavy duty, non-caulking, expansion bolt anchor equivalent to Rawl #9650 Series.
- C. Minimum size used shall be ¼" machine thread.

**2.3 METAL FRAMING CHANNEL**

- A. Manufacturers:
  - 1. B-Line.
  - 2. Kindorf.
  - 3. Power-Strut.
  - 4. Super-Strut.
  - 5. Unistrut.
- B. 1-5/8" x 1-5/8", 12 Gauge.
- C. Use appropriate fittings of same manufacturer.

**2.4 NAMEPLATES**

- A. Provide engraved plastic equipment nameplates for all new feeder breakers and disconnects
- B. A circuit nameplate indicating circuit number and the equipment served shall be provided for each feeder in service switchboard and each branch device in power distribution panels.
- C. Distribution equipment nameplates shall state equipment designation, ampere rating, voltage and phase, and "Fed From (Name)".
- D. Nameplates for individually mounted starters, VFD's and safety switches shall state load served, circuit number, voltage and phase.

**2.5 FIREPROOFING**

- A. Manufacturers:
  - 1. 3-M
  - 2. Dow Corning
  - 3. Hilti
  - 4. Nelson

- B. All fireproofing materials shall be the product of one manufacturer and shall be U.L. listed for the type of application where applied.
- C. Provide caulk, expanding foam, putty, rigid boards, tape and packing as required by the U.L. listing for the type of penetration being fireproofed.
- D. Fireproofing of sleeves, cable trays, troughs, and nipples to be used for low voltage cables shall be indefinitely non-hardening and removable with common hand tools.
- E. Fireproofing for penetrations of floor slabs shall also be waterproof for standing water in a non-fire condition.

### **PART 3 - EXECUTION**

#### **3.1 SUPPORTS**

- A. All work shall be supported from structural elements of the building, except ceiling mounted equipment such as light fixtures, detectors, remote lamps, which shall be supported from ceiling support members independent of ceiling tiles.
- B. Size and spacing of supports shall be determined by the load to be supported such that the working load of supports will not exceed a safety factor of 4:1.
- C. Spacing intervals of supports shall in no case exceed intervals required by applicable codes.
- D. Plastic anchors, non-removable drive-in type expansion anchors and power actuated tool installed anchors are not acceptable.
- E. Work under this division shall not be supported from piping, ducts, or work of other trades, unless specifically noted on the drawings or with the written permission of the architect.
- F. Drilled anchors in sides of concrete joists shall be at least 3" from bottom of joist in the vertical plane.
- G. Provide drilled expansion bolt anchors to support all material mounted on masonry construction.
- H. All hardware, nuts, bolts, channel, braces, etc., used on exterior of building shall be galvanized.
- I. Rod supports shall be constructed of minimum 3/8" nominal continuously threaded rod of a continuous length. Use of rod couplings to extend the length of hanger rod shall not be allowed.
- J. Work installed under Division 26 supported from or attached to structural steel members shall not be welded to steel member but shall be attached by clamping a device manufactured specifically for this purpose.
- K. Floor mounted equipment shall be anchored to supporting concrete pad with expansion anchors, minimum 1/2" nominal stud size.
- L. Framework required to support electrical equipment shall be constructed of 1 1/2" x 1 1/2" steel framing channel bolted together with fittings provided by the framing channel manufacturer.

#### **3.2 EQUIPMENT OF OTHER TRADES**

- A. Provide all power wiring and connections for all electrically operated equipment. Power wiring includes wiring through any line voltage control devices, such as thermostats and manual starters.
- B. Phase connections of motors shall provide proper motor shaft rotation.

#### **3.3 EQUIPMENT CONNECTIONS**

- A. Connections to motors, transformers, duct heaters and other vibrating equipment shall be made with a short length of flexible conduit, minimum 18", installed in a manner to permit movement of equipment.
- B. For floor-mounted equipment, which is fed overhead and not located adjacent to a wall or column, provide a rigid conduit standpipe from floor to ceiling with a floor flange. Provide appropriate cast conduit "tee" fitting in standpipe for connection of equipment.

#### **3.4 FIREPROOFING**

- A. All penetrations of fire rated walls, slabs, partitions, and ceilings shall be fireproofed with a U.L. listed system that will maintain the original fire rating of the penetrated structure.

**END OF SECTION**

**SECTION 26 05 02  
EXISTING CONDITIONS**

**PART 1 - GENERAL**

**1.1 EXISTING CONDITIONS**

- A. Prior to removal of existing work, and prior to the installation of conflicting new work, give written notice to the Architect where unforeseen existing conditions are discovered that affect the indicated work.

**1.2 ELECTRICAL REMOVAL**

- A. Unless otherwise indicated on the drawings, wire, conduit, and hanging materials being removed shall become the property of the Contractor and shall be removed from the jobsite as directed elsewhere in the Specification.
- B. Coordinate with other divisions of work and disconnect power feeds to motors, heaters, or other electrically operated equipment, as required for the demolition work of others.

**1.3 CONTINUITY OF SERVICE**

- A. Maintain continuity of service to equipment not scheduled for removal or relocation.

**END OF SECTION**

**SECTION 26 05 19**  
**LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES**

**PART 1 - GENERAL****1.1 SCOPE**

- A. This section covers:
1. Building Wire
  2. Wiring Connectors and Connections.

**1.2 QUALITY ASSURANCE**

- A. All wire and cable shall be delivered to the jobsite in original unbroken packages, cartons or reels, with the manufacturer's name, UL label, and characteristics of the product plainly visible.
- B. Wire or cable with defective or damaged insulation or jackets shall not be installed. Where damage, such as cuts, gouges, or slices, is discovered in the insulation or jacket while being installed, the damaged wire or cable shall be removed, and replaced. Field taping or other repair of damaged wire or cable is not acceptable.

**PART 2 - PRODUCTS****2.1 BUILDING WIRE**

- A. Conductors:
1. Material: 600V copper, 98% conductivity.
  2. Construction:
    - a. AWG 10 and AWG 12: solid or stranded.
    - b. AWG 8 and larger: stranded unless otherwise detailed on the drawings.
    - c. AWG 14 and smaller: stranded (control use only).
- B. Insulation:
1. Type THWN/THHN-2, dual-rated.
  2. Type XHHW: for underground secondary service entrance.
  3. Type SIS: for control wiring inside switchboards
- C. Voltage Rating: 600V.
- D. Color Coding:
1. Unless contrary to requirements of local codes, the following color code shall apply:

		120/208V	277/480v
	Phase A	black	brown
	Phase B	red	orange
	Phase C	blue	yellow
	Neutral	white	gray
	Ground	green	green

2. Color-coding of branch circuit neutral conductors: Where multiple branch circuit conductors of different phases, each with an associated neutral conductor, are installed within the same conduit, provide color coding of each neutral to match the associated phase conductor.
  3. If local codes require other than these color codes to be used, the local codes shall be complied with.
  4. Color code shall be indicated by insulation color (phase, neutral, and ground conductors).
    - a. Color coded tapes shall not be permitted.
- E. Accepted Manufacturers:
1. Belden
  2. Encore
  3. General Cable
  4. Piirelli
  5. Rome
  6. Southwire
  7. American Insulated Wire Corp



8. All wire shall be manufactured in the USA.

## 2.2 600 VOLT ACCESSORIES

- A. Conduit wedges: 0-Z/Gedney Type "S"
- B. Terminations, power connections, splices, taps:
  1. Splices: Compression type, copper, insulated with heat shrink sleeves.
  2. Taps #8 and larger: Compression type copper or copper alloy with snap-on insulation cover designed for the specific tap. Insulation displacement type fittings are not acceptable.
  3. Taps #10 and #12: twist-on insulated spring type connectors (i.e., Buchanan B-4) or squeeze-on insulated connector (i.e. 3M #560)
  4. Terminations: feeder cable to bus bar: copper or copper alloy compression lug, two bolt hole tongue if mounting space allows.
  5. Terminations: feeder cable to device or other condition where compression lugs mechanically will not fit: copper alloy mechanical lug, T&B "Locktite" series.
  6. Manufacturers:
    - a. Burndy
    - b. 0-Z/Gedney
    - c. T&B
    - d. Illsco
    - e. Square D
    - f. Panduit
    - g. Buchanan
    - h. 3M
    - i. Ideal
- C. Terminations: Control Conductors:
  1. Compression Lug: insulated, T & B "StaKonâ" or equal
  2. Terminal Strip: barrier style, screw type, suitable for wire size and voltage applied.
- D. All conductor connections/terminations for /span>
- E. Wire Lubricants:
  1. Lubricant used shall be certified by conductor manufacturer to be satisfactory for use with the specific conductor insulation.
  2. Approved material:
    - a. Ideal "Yellow 77"
    - b. Ideal "Yellow 77 Plus"
    - c. 3M wire pulling lubricant
- F. Wire markers: Permanent, machine printed, self-laminating vinyl, T & B Type "WSC", Burndy Type "XC".
- G. Feeder Identification Labels: Engraved black color laminated plate attached to conductors with nylon tie, or T & B TY-553M marked with WT-163M-1 pen.

## PART 3 - EXECUTION

### 3.1 SIZES, QUANTITIES, TYPES

- A. Building Wire:
  1. AWG 12 minimum.
  2. 120 Volt circuits with homerun length over 75 feet shall have AWG 10 minimum homerun conductors.
  3. 277 Volt circuits with homerun length over 150 feet shall have AWG 10 minimum homerun conductors.
  4. Combining a maximum of 3 branch circuits into a single conduit is permissible where conduits is sized according to NEC requirements and conductor derating is applied.
  5. Type THHN/THWN-2 shall be used for all branch circuits, AWG 12 through AWG 8.
  6. Conductors larger than AWG 8 installed above grade shall be Type THHN-2 or THWN. Where installed in conduit run below grade, shall be type THWN or XHHW.

7. Where branch circuit conductors enter the wiring compartment of lighting fixtures, the insulation used on that segment of the branch circuit shall be UL listed for application at the temperature that will be encountered in the fixture.
  8. General-purpose control conductors: AWG 14 minimum, stranded, protected by control circuit overcurrent protection rated not greater than or set at the rated ampacity of the conductor.
- B. Flexible Cords:
1. AWG 16 minimum
  2. Rated for the applied voltage and load
  3. Contain full size ground conductor

### 3.2 INSTALLATION

- A. Building Wire:
1. Conductors shall not be pulled in an ambient temperature lower than 15° F.
  2. Adequate wire lubricants shall be used to minimize pulling tension.
  3. Conductors shall not be bent, either manually or with bending tools, in a manner that puts excessive stress on insulation or causes it to buckle. Avoid bending to a radius less than manufacturers recommended minimum. Conductors with visibly damaged insulation shall be replaced at no additional cost to the Owner.
  4. Conductors installed in vertical raceways shall be supported by wedge fittings attached to the conduit on intervals as prescribed by code. Provide suitable sized pull box enclosures as required to contain the support wedges.
  5. All terminations of feeder conductors not made directly on device terminals shall be made with compression lugs installed in accordance with the manufacturer's instructions and with a compression tool approved for the terminator used.
  6. Feeder conductors shall be individually identified at each end and at all intermediate pull boxes and other accessible locations with feeder designation, source, load, voltage, and phase.
  7. General-purpose control conductors and all special systems conductors shall be identified on each end with a unique number or designation. This identification shall be recorded on the contractor's as-built drawings.
- B. Flexible Cords: Shall be installed with cord grip and strain-relief connectors.

### 3.3 TESTS

- A. Cable Test:
1. Megger test all feeders.
  2. Megger test of all feeders shall be accomplished before energizing circuits. Test shall be phase to phase and phase to ground.
  3. Submit a written tabulation of the results of each test to the Owner's representative for review. Replace any cable with installed insulation resistance of less than accepted industry standards.
- B. Replacement of Conductors
1. Replace conductors, determined by testing as not acceptable, without additional cost to the Owner.

**END OF SECTION**

**SECTION 26 05 26**  
**GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS**

**PART 1 - GENERAL****1.1 DESCRIPTION**

- A. Grounding System: Grounding of electrical equipment and raceways.
- B. Miscellaneous grounding, installation of separate ground bus bars and miscellaneous bonding.

**PART 2 - PRODUCTS****2.1 BUILDING GROUNDING SYSTEM**

- A. Raceways for separate ground conductors:
  - 1. Underground: Type PVC, Schedule 40 conduit.
  - 2. All other locations: Aluminum conduit or IMC with bond bushing at each termination.
- B. Conductors:
  - 1. 98% conductivity copper, solid or stranded, sizes and types as indicated on the drawings.
  - 2. In general, main and buried ground conductors shall be bare copper, AWG 3/0, seven-strand.
- C. Connections:
  - 1. Underground or exterior connections shall be exothermic weld between conductors, and between conductors and ground rods.
  - 2. In locations where conductor connects to main structural steel components, exothermic welds shall be used. For connections to light-gauge metals or in other locations where a lug must be used, a 2-hole lug shall be exothermic welded to the grounding conductor.
  - 3. Lugs shall be 2-bolt tongue, compression type.
  - 4. Compression Splices and Taps: Tin plated copper.
  - 5. Exothermic welds: Cadweld, Thermaweld or Ultraweld.
  - 6. Solid conductor to equipment or bus: Exothermic weld lug bolted to equipment.
  - 7. Flexible copper grounding and bonding jumpers: 0-Z/Gedney Type "FB" series, or Burndy Type "B" Series, rated 190 AMPS, length as required for each application.
- D. Non-Oxide Compound:
  - 1. "NO OXID A" compound as manufactured by Sanchem Chemical Company, Chicago Illinois.

**PART 3 - EXECUTION****3.1 EQUIPMENT GROUNDING CONDUCTORS**

- A. Separate Grounding Conductor: All branch circuits and feeders operating at higher than 50 volts to ground shall have an insulated equipment ground conductor, green color, sized in accordance with the National Electrical Code.
- B. Raceway Grounds: Other circuits shall utilize the raceway as the equipment ground conductor except where noted otherwise.
- C. Single grounding conductors, or RNC conduits containing single ground conductors, shall not be totally encircled by ferrous metal. Use nylon bolts in pipe hangers or in Unistrut conduit straps.
- D. Provide specified "non-oxide" compound between mating surfaces on all equipment bonding connections where mechanical connections are utilized in lieu of exothermic welds.
- E. Ground conductors shall be installed using long radius bends, minimum 12" radius, and shall maintain a downward or horizontal direction. U-bends or tight radius bends less than 90 degrees are not acceptable.
- F. Bond connections to equipment shall utilize exothermic weld lugs, 2-bolt tongue type, attached using machine screw thread type bolts where exothermic welds cannot, or should not, be utilized.
- G. All motors driven by VSD's (VFD's) shall have shaft grounding rings and shall be grounded to their source ground with no more than 25 ohms in resistance measurement.

- H. Provide combination "Do Not Disconnect" and "Destination" tags at all interior bonding and grounding connections. Tags shall be green plastic laminate with white letters. Letters shall be minimum ¼" high. Attach all tags using Nylon cable Ty-raps.

**END OF SECTION**

**SECTION 26 05 29**  
**HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS**

**PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Support and attachment requirements and components for equipment, conduit, cable, boxes, and other electrical work.

**1.2 RELATED REQUIREMENTS**

- A. Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems.

**1.3 REFERENCE STANDARDS**

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware 2016a.
- C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel 2019.
- D. MFMA-4 - Metal Framing Standards Publication 2004.
- E. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.
- F. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

**1.4 ADMINISTRATIVE REQUIREMENTS**

- A. Coordination:
  - 1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
  - 2. Coordinate the work with other trades to provide additional framing and materials required for installation.
  - 3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
  - 4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
  - 5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
  - 1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 03 30 00.

**1.5 QUALITY ASSURANCE**

- A. Comply with NFPA 70.
- B. Comply with applicable building code.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

**1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

**PART 2 PRODUCTS****2.1 SUPPORT AND ATTACHMENT COMPONENTS**

- A. General Requirements:
  - 1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
  - 2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.

3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of 3. Include consideration for vibration, equipment operation, and shock loads where applicable.
  4. Do not use products for applications other than as permitted by NFPA 70 and product listing.
  5. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
  6. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
    - a. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
    - b. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Components for Vibration Isolation and/or Seismic Controls: Comply with Section 26 05 48.
- C. Conduit and Cable Supports: Straps, clamps, etc. suitable for the conduit or cable to be supported.
1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
  2. Conduit Clamps: Bolted type unless otherwise indicated.
  3. Manufacturers:
    - a. Cooper Crouse-Hinds, a division of Eaton Corporation : [www.cooperindustries.com/#sle](http://www.cooperindustries.com/#sle).
    - b. Erico International Corporation: [www.erico.com/#sle](http://www.erico.com/#sle).
    - c. HoldRite, a brand of Reliance Worldwide Corporation: [www.holdrite.com/#sle](http://www.holdrite.com/#sle).
    - d. O-Z/Gedney, a brand of Emerson Electric Co: [www.emerson.com/#sle](http://www.emerson.com/#sle).
    - e. Thomas & Betts Corporation: [www.tnb.com/#sle](http://www.tnb.com/#sle).
- D. Outlet Box Supports: Hangers, brackets, etc. suitable for the boxes to be supported.
1. Manufacturers:
    - a. Cooper Crouse-Hinds, a division of Eaton Corporation : [www.cooperindustries.com/#sle](http://www.cooperindustries.com/#sle).
    - b. Erico International Corporation: [www.erico.com/#sle](http://www.erico.com/#sle).
    - c. HoldRite, a brand of Reliance Worldwide Corporation: [www.holdrite.com/#sle](http://www.holdrite.com/#sle).
    - d. O-Z/Gedney, a brand of Emerson Electric Co: [www.emerson.com/#sle](http://www.emerson.com/#sle).
    - e. Thomas & Betts Corporation: [www.tnb.com/#sle](http://www.tnb.com/#sle).
- E. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
1. Comply with MFMA-4.
  2. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch.
  3. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height.
  4. Manufacturers:
    - a. Cooper B-Line, a division of Eaton Corporation: [www.cooperindustries.com/#sle](http://www.cooperindustries.com/#sle).
    - b. Thomas & Betts Corporation: [www.tnb.com/#sle](http://www.tnb.com/#sle).
    - c. Unistrut, a brand of Atkore International Inc: [www.unistrut.com/#sle](http://www.unistrut.com/#sle).
- F. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
1. Minimum Size, Unless Otherwise Indicated or Required:
    - a. Equipment Supports: 1/2 inch diameter.
    - b. Busway Supports: 1/2 inch diameter.
    - c. Single Conduit: 3/8 inch diameter.
    - d. Trapeze Support for Multiple Conduits: 1/2 inch diameter.
    - e. Outlet Boxes: 1/4 inch diameter.
    - f. Luminaires: 1/4 inch diameter.
- G. Anchors and Fasteners:
1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
  2. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.

3. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
4. Hollow Masonry: Use toggle bolts.
5. Hollow Stud Walls: Use toggle bolts.
6. Steel: Use beam clamps, machine bolts, or welded threaded studs.
7. Sheet Metal: Use sheet metal screws.
8. Wood: Use wood screws.
9. Plastic and lead anchors are not permitted.
10. Powder-actuated fasteners are not permitted.
11. Hammer-driven anchors and fasteners are not permitted.
12. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
  - a. Comply with MFMA-4.
  - b. Channel Material: Use galvanized steel.
  - c. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch minimum base metal thickness.
  - d. Manufacturer: Same as manufacturer of metal channel (strut) framing system.
13. Post-Installed Concrete and Masonry Anchors: Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.
14. Manufacturers - Mechanical Anchors:
  - a. Hilti, Inc: [www.us.hilti.com/#sle](http://www.us.hilti.com/#sle).
  - b. ITW Red Head, a division of Illinois Tool Works, Inc: [www.itwredhead.com/#sle](http://www.itwredhead.com/#sle).
  - c. Powers Fasteners, Inc: [www.powers.com/#sle](http://www.powers.com/#sle).
  - d. Simpson Strong-Tie Company Inc: [www.strongtie.com/#sle](http://www.strongtie.com/#sle).

### **PART 3 EXECUTION**

#### **3.1 EXAMINATION**

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive support and attachment components.
- C. Verify that conditions are satisfactory for installation prior to starting work.

#### **3.2 INSTALLATION**

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.
- D. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- E. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
- F. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
- G. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- H. Provide required vibration isolation and/or seismic controls in accordance with Section 26 05 48.
- I. Equipment Support and Attachment:
  1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
  2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls.
  3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
  4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

- J. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.
- K. Secure fasteners according to manufacturer's recommended torque settings.
- L. Remove temporary supports.

### **3.3 FIELD QUALITY CONTROL**

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Inspect support and attachment components for damage and defects.
- C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- D. Correct deficiencies and replace damaged or defective support and attachment components.

**END OF SECTION**



**SECTION 26 05 33.13**  
**CONDUIT FOR ELECTRICAL SYSTEMS**

**PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Galvanized steel rigid metal conduit (RMC).
- B. Galvanized steel intermediate metal conduit (IMC).
- C. Flexible metal conduit (FMC).
- D. Liquid tight flexible metal conduit (LFMC).
- E. Galvanized steel electrical metallic tubing (EMT).
- F. Section 07 84 00 - Firestopping.
- G. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- H. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- I. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- J. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC) 2020.
- K. ANSI C80.3 - American National Standard for Electrical Metallic Tubing -- Steel (EMT-S) 2020.
- L. ANSI C80.6 - American National Standard for Electrical Intermediate Metal Conduit 2018.
- M. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.
- N. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT) 2013.
- O. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable 2014.
- P. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- Q. UL 1 - Flexible Metal Conduit Current Edition, Including All Revisions.
- R. UL 6 - Electrical Rigid Metal Conduit-Steel Current Edition, Including All Revisions.
- S. UL 360 - Liquid-Tight Flexible Metal Conduit Current Edition, Including All Revisions.
- T. UL 514B - Conduit, Tubing, and Cable Fittings Current Edition, Including All Revisions.
- U. UL 797 - Electrical Metallic Tubing-Steel Current Edition, Including All Revisions.
- V. UL 1203 - Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations Current Edition, Including All Revisions.
- W. UL 1242 - Electrical Intermediate Metal Conduit-Steel Current Edition, Including All Revisions.
- X. UL 2419 - Outline of Investigation for Electrically Conductive Corrosion Resistant Compounds Current Edition, Including All Revisions.

**1.2 ADMINISTRATIVE REQUIREMENTS**

- A. Coordination:
  - 1. Coordinate minimum sizes of conduits with actual type and quantity of conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
  - 2. Coordinate arrangement of conduits with structural members, ductwork, piping, equipment, and other potential conflicts.
  - 3. Verify exact conduit termination locations required for boxes, enclosures, and equipment.
  - 4. Coordinate work to provide roof penetrations that preserve integrity of roofing system and do not void roof warranty.
  - 5. Notify Architect of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
  - 1. Do not begin installation of conductors and cables until installation of conduit between termination points is complete.

### 1.3 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittals procedures.
- B. Project Record Documents: Record actual routing for conduits installed underground and conduits embedded within concrete slabs.

### 1.4 QUALITY ASSURANCE

- A. Product Listing Organization Qualifications: Organization recognized by OSHA as Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.

## PART 2 PRODUCTS

### 2.1 CONDUIT APPLICATIONS

- A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70, manufacturer's instructions, and product listing.
- B. Unless otherwise indicated and where not otherwise restricted, use conduit types indicated for specified applications. Where more than one listed application applies, comply with most restrictive requirements. Where conduit type for particular application is not specified, use galvanized steel rigid metal conduit.
- C. Concealed Within Masonry Walls: Use galvanized steel rigid metal conduit (RMC) or galvanized steel electrical metallic tubing (EMT).
- D. Concealed Within Hollow Stud Walls: Use galvanized steel rigid metal conduit (RMC) or galvanized steel electrical metallic tubing (EMT).
- E. Concealed Above Accessible Ceilings: Use galvanized steel rigid metal conduit (RMC) or galvanized steel electrical metallic tubing (EMT).
- F. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit (RMC) or galvanized steel electrical metallic tubing (EMT).
- G. Exposed, Interior, Not Subject to Physical Damage: Use galvanized steel intermediate metal conduit (IMC) or galvanized steel electrical metallic tubing (EMT).
- H. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit (RMC).
  - 1. Locations subject to physical damage include, but are not limited to:
    - a. Where exposed below 8 feet, except within electrical and communication rooms or closets.
- I. Flexible Connections to Vibrating Equipment:
  - 1. Dry Locations: Use flexible metal conduit (FMC).
  - 2. Damp, Wet, or Corrosive Locations: Use liquid tight flexible metal conduit (LFMC).
  - 3. Maximum Length: 6 feet unless otherwise indicated.
  - 4. Vibrating equipment includes, but is not limited to:
    - a. Transformers.
    - b. Motors.
- J. Fished in Existing Walls, Where Necessary: Use flexible metal conduit (FMC) or galvanized steel electrical metallic tubing (EMT).

### 2.2 CONDUIT - GENERAL REQUIREMENTS

- A. Comply with NFPA 70.
- B. Existing Work: Where existing conduits are indicated to be reused, they may be reused only where they comply with specified requirements, are free from corrosion, and integrity is verified by pulling mandrel through them.
- C. Provide conduit, fittings, supports, and accessories required for complete raceway system.
- D. Provide products listed, classified, and labeled as suitable for purpose intended.
- E. Minimum Conduit Size, Unless Otherwise Indicated:

1. Branch Circuits: 3/4-inch trade size.
  2. Branch Circuit Homeruns: 3/4-inch trade size.
  3. Control Circuits: 3/4-inch trade size.
  4. Flexible Connections to Luminaires: 3/8-inch trade size.
- F. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

### 2.3 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Manufacturers:
1. Allied Tube & Conduit, a division of Atkore International: [www.alliedeg.com/#sle](http://www.alliedeg.com/#sle).
  2. Nucor Tubular Products: [www.nucortubular.com/#sle](http://www.nucortubular.com/#sle).
  3. Western Tube, a division of Zekelman Industries: [www.westerntube.com/#sle](http://www.westerntube.com/#sle).
  4. Wheatland Tube, a division of Zekelman Industries: [www.wheatland.com/#sle](http://www.wheatland.com/#sle).
- B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.
- C. Fittings:
1. Manufacturers:
    - a. ABB; T&B: [www.electrification.us.abb.com/#sle](http://www.electrification.us.abb.com/#sle).
    - b. Allied Tube & Conduit, a division of Atkore International: [www.alliedeg.us/#sle](http://www.alliedeg.us/#sle).
    - c. Bridgeport Fittings Inc: [www.bptfittings.com/#sle](http://www.bptfittings.com/#sle).
    - d. Emerson Electric Co; O-Z/Gedney: [www.emerson.com/#sle](http://www.emerson.com/#sle).
  2. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 6.
  3. Hazardous/Classified Locations: Use fittings listed and labeled as complying with UL 1203 for classification of installed location.
  4. Material: Use steel or malleable iron.
  5. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

### 2.4 GALVANIZED STEEL INTERMEDIATE METAL CONDUIT (IMC)

- A. Manufacturers:
1. Allied Tube & Conduit, a division of Atkore International: [www.alliedeg.com/#sle](http://www.alliedeg.com/#sle).
  2. Nucor Tubular Products: [www.nucortubular.com/#sle](http://www.nucortubular.com/#sle).
  3. Western Tube, a division of Zekelman Industries: [www.westerntube.com/#sle](http://www.westerntube.com/#sle).
  4. Wheatland Tube, a division of Zekelman Industries: [www.wheatland.com/#sle](http://www.wheatland.com/#sle).
- B. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.
- C. Fittings:
1. Manufacturers:
    - a. ABB; T&B: [www.electrification.us.abb.com/#sle](http://www.electrification.us.abb.com/#sle).
    - b. Allied Tube & Conduit, a division of Atkore International: [www.alliedeg.us/#sle](http://www.alliedeg.us/#sle).
    - c. Bridgeport Fittings, LLC: [www.bptfittings.com/#sle](http://www.bptfittings.com/#sle).
    - d. Emerson Electric Co; O-Z/Gedney: [www.emerson.com/#sle](http://www.emerson.com/#sle).
  2. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 1242.
  3. Material: Use steel or malleable iron.
  4. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

### 2.5 FLEXIBLE METAL CONDUIT (FMC)

- A. Manufacturers:
1. AFC Cable Systems, a division of Atkore International: [www.afcweb.com/#sle](http://www.afcweb.com/#sle).
  2. Electri-Flex Company: [www.electriflex.com/#sle](http://www.electriflex.com/#sle).
  3. International Metal Hose: [www.metalhose.com/#sle](http://www.metalhose.com/#sle).
- B. Description: NFPA 70, Type FMC standard-wall steel flexible metal conduit listed and labeled as complying with UL 1 and listed for use in classified firestop systems.

- C. Fittings:
  - 1. Manufacturers:
    - a. ABB; T&B: [www.electrification.us.abb.com/#sle](http://www.electrification.us.abb.com/#sle).
    - b. Bridgeport Fittings, LLC: [www.bptfittings.com/#sle](http://www.bptfittings.com/#sle).
    - c. Emerson Electric Co; O-Z/Gedney: [www.emerson.com/#sle](http://www.emerson.com/#sle).
  - 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
  - 3. Material: Use steel or malleable iron.

## 2.6 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

- A. Manufacturers:
  - 1. AFC Cable Systems, a division of Atkore International: [www.afcweb.com/#sle](http://www.afcweb.com/#sle).
  - 2. Electri-Flex Company: [www.electriflex.com/#sle](http://www.electriflex.com/#sle).
  - 3. International Metal Hose: [www.metalhose.com/#sle](http://www.metalhose.com/#sle).
- B. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.
- C. Fittings:
  - 1. Manufacturers:
    - a. ABB; T&B: [www.electrification.us.abb.com/#sle](http://www.electrification.us.abb.com/#sle).
    - b. Bridgeport Fittings, LLC: [www.bptfittings.com/#sle](http://www.bptfittings.com/#sle).
    - c. Emerson Electric Co; O-Z/Gedney: [www.emerson.com/#sle](http://www.emerson.com/#sle).
  - 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
  - 3. Material: Use steel or malleable iron.

## 2.7 GALVANIZED STEEL ELECTRICAL METALLIC TUBING (EMT)

- A. Manufacturers:
  - 1. Allied Tube & Conduit, a division of Atkore International: [www.alliedeg.com/#sle](http://www.alliedeg.com/#sle).
  - 2. Nucor Tubular Products: [www.nucortubular/#sle](http://www.nucortubular/#sle).
  - 3. Western Tube, a division of Zekelman Industries: [www.westerntube.com/#sle](http://www.westerntube.com/#sle).
  - 4. Wheatland Tube, a division of Zekelman Industries: [www.wheatland.com/#sle](http://www.wheatland.com/#sle).
- B. Description: NFPA 70, Type EMT galvanized steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.
- C. Fittings:
  - 1. Manufacturers:
    - a. ABB; T&B: [www.electrification.us.abb.com/#sle](http://www.electrification.us.abb.com/#sle).
    - b. Allied Tube & Conduit, a division of Atkore International: [www.alliedeg.us/#sle](http://www.alliedeg.us/#sle).
    - c. Bridgeport Fittings, LLC: [www.bptfittings.com/#sle](http://www.bptfittings.com/#sle).
    - d. Emerson Electric Co; O-Z/Gedney: [www.emerson.com/#sle](http://www.emerson.com/#sle).
  - 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
  - 3. Material: Use steel or malleable iron.
  - 4. Connectors and Couplings: Use compression/gland type.
    - a. Do not use indenter type connectors and couplings.

## 2.8 ACCESSORIES

- A. Corrosion Protection Tape: PVC-based, minimum thickness of 20 mil, 0.020 inch.
- B. Conduit Joint Compound: Corrosion-resistant, electrically conductive compound listed as complying with UL 2419; suitable for use with conduit to be installed.
- C. Pull Strings: Use nylon or polyester tape with average breaking strength of not less than 1,250 lbf.
- D. Sealing Systems for Concrete Penetrations:
  - 1. Sleeves: Provide water stop ring or cement coating that bonds to concrete to prevent water infiltration.
  - 2. Rate for minimum of 40 psig; suitable for sealing around conduits to be installed.

- E. Sealing Systems for Roof Penetrations: Premanufactured components and accessories as required to preserve integrity of roofing system and maintain roof warranty; suitable for conduits and roofing system to be installed; designed to accommodate existing penetrations where applicable.
- F. Flashing Panels for Exterior Wall Penetrations: Premanufactured components and accessories as required to preserve integrity of building envelope; suitable for conduits and facade materials to be installed.
- G. Firestop Sleeves: Listed; provide as required to preserve fire resistance rating of building elements.

## **PART 3 EXECUTION**

### **3.1 EXAMINATION**

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive conduits.
- C. Verify that conditions are satisfactory for installation prior to starting work.

### **3.2 INSTALLATION**

- A. Install products in accordance with manufacturer's instructions.
- B. Install conduit in accordance with NECA 1.
- C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.
- D. Install intermediate metal conduit (IMC) in accordance with NECA 101.
- E. Conduit Routing:
  - 1. Unless dimensioned, conduit routing indicated is diagrammatic.
  - 2. When conduit destination is indicated without specific routing, determine exact routing required.
  - 3. Conceal conduits unless specifically indicated to be exposed.
  - 4. Conduits in the following areas may be exposed, unless otherwise indicated:
    - a. Electrical rooms.
    - b. Mechanical equipment rooms.
    - c. Within joists in areas with no ceiling.
  - 5. Unless otherwise approved, do not route exposed conduits:
    - a. Across floors.
    - b. Across top of parapet walls.
    - c. Across building exterior surfaces.
  - 6. Arrange conduit to maintain adequate headroom, clearances, and access.
  - 7. Arrange conduit to provide no more than equivalent of four 90-degree bends between pull points.
  - 8. Arrange conduit to provide no more than 150 feet between pull points.
  - 9. Route conduits above water and drain piping where possible.
  - 10. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
  - 11. Maintain minimum clearance of 6 inches between conduits and piping for other systems.
  - 12. Maintain minimum clearance of 12 inches between conduits and hot surfaces. This includes, but is not limited to:
    - a. Heaters.
    - b. Hot water piping.
    - c. Flues.
  - 13. Group parallel conduits in same area on common rack.
- F. Conduit Support:
  - 1. Secure and support conduits in accordance with NFPA 70 using suitable supports and methods approved by authorities having jurisdiction; see Section 26 05 29.
  - 2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

3. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
  4. Use conduit strap to support single surface-mounted conduit.
    - a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.
  5. Use metal channel/strut with accessory conduit clamps to support multiple parallel surface-mounted conduits.
  6. Use conduit clamp to support single conduit from beam clamp or threaded rod.
  7. Use trapeze hangers assembled from threaded rods and metal channel/strut with accessory conduit clamps to support multiple parallel suspended conduits.
  8. Use nonpenetrating rooftop supports to support conduits routed across rooftops, where approved.
  9. Use of spring steel conduit clips for support of conduits is not permitted.
  10. Use of wire for support of conduits is not permitted.
- G. Connections and Terminations:
1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
  2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
  3. Use suitable adapters where required to transition from one type of conduit to another.
  4. Provide drip loops for liquid tight flexible conduit connections to prevent drainage of liquid into connectors.
  5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
  6. Where spare conduits stub up through concrete floors and are not terminated in box or enclosure, provide threaded couplings equipped with threaded plugs set flush with finished floor.
  7. Provide insulating bushings, insulated throats, or listed metal fittings with smooth, rounded edges at conduit terminations to protect conductors.
  8. Secure joints and connections to provide mechanical strength and electrical continuity.
- H. Penetrations:
1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
  2. Make penetrations perpendicular to surfaces unless otherwise indicated.
  3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
  4. Conceal bends for conduit risers emerging above ground.
  5. Provide suitable sealing system where conduits penetrate exterior wall below grade.
  6. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
  7. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty.
  8. Install firestopping to preserve fire resistance rating of partitions and other elements; see Section 07 84 00.
- I. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
  2. Where conduits are subject to earth movement by settlement or frost.
- J. Conduit Sealing:
1. Use foam conduit sealant to prevent entry of moisture and gases. This includes, but is not limited to:

2. Where conduits cross barriers between areas of potential substantial temperature differential, use foam conduit sealant at accessible point near penetration to prevent condensation. This includes, but is not limited to:
  - a. Where conduits pass from outdoors into conditioned interior spaces.
  - b. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
- K. Provide pull string in each empty conduit and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches at each end.
- L. Provide grounding and bonding; see Section 26 05 26.
- M. Identify conduits; see Section 26 05 53.

### **3.3 FIELD QUALITY CONTROL**

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- C. Correct deficiencies and replace damaged or defective conduits.

### **3.4 CLEANING**

- A. Clean interior of conduits to remove moisture and foreign matter.

### **3.5 PROTECTION**

- A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

**END OF SECTION**

**SECTION 26 05 33.16**  
**BOXES FOR ELECTRICAL SYSTEMS**

**PART 1 GENERAL**

**1.1 SECTION INCLUDES**

- A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.
- B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.
- C. Boxes and enclosures for integrated power, data, and audio/video.
- D. Boxes for hazardous (classified) locations.
- E. Floor boxes.
- F. Underground boxes/enclosures.
- G. Section 03 30 00 - Cast-in-Place Concrete.
- H. Section 08 31 00 - Access Doors and Panels: Panels for maintaining access to concealed boxes.
- I. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- J. Section 26 05 33.13 - Conduit for Electrical Systems:
  - 1. Conduit bodies and other fittings.
  - 2. Additional requirements for locating boxes to limit conduit length and/or number of bends between pulling points.
- K. Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems.
- L. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- M. Section 26 27 26 - Wiring Devices:
  - 1. Wall plates.
  - 2. Floor box service fittings.
  - 3. Additional requirements for locating boxes for wiring devices.
- N. Section 27 10 00 - Structured Cabling: Additional requirements for communications systems outlet boxes.
- O. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.
- P. NECA 130 - Standard for Installing and Maintaining Wiring Devices 2016.
- Q. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.
- R. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable 2014.
- S. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports 2013 (Reaffirmed 2020).
- T. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports 2013 (Reaffirmed 2020).
- U. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- V. SCTE 77 - Specifications for Underground Enclosure Integrity 2017.
- W. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations Current Edition, Including All Revisions.
- X. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations Current Edition, Including All Revisions.
- Y. UL 508A - Industrial Control Panels Current Edition, Including All Revisions.
- Z. UL 514A - Metallic Outlet Boxes Current Edition, Including All Revisions.



- AA. UL 514C - Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers Current Edition, Including All Revisions.

## 1.2 ADMINISTRATIVE REQUIREMENTS

### A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.
6. Coordinate the work with other trades to preserve insulation integrity.
7. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated.
8. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

## 1.3 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for floor boxes and underground boxes/enclosures.
- C. Project Record Documents: Record actual locations for pull boxes, floor boxes, and underground boxes/enclosures.
- D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
1. See Section 01 60 00 - Product Requirements, for additional provisions.
  2. Keys for Lockable Enclosures: Two of each different key.

## 1.4 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

## 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

## PART 2 PRODUCTS

### 2.1 BOXES

#### A. General Requirements:

1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
3. Provide products listed, classified, and labeled as suitable for the purpose intended.
4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
5. Provide grounding terminals within boxes where equipment grounding conductors terminate.

#### B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:

1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.

2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
  3. Use cast iron boxes or cast aluminum boxes where exposed galvanized steel rigid metal conduit or exposed intermediate metal conduit (IMC) is used.
  4. Use nonmetallic boxes where exposed rigid PVC conduit is used.
  5. Use suitable concrete type boxes where flush-mounted in concrete.
  6. Use suitable masonry type boxes where flush-mounted in masonry walls.
  7. Use raised covers suitable for the type of wall construction and device configuration where required.
  8. Use shallow boxes where required by the type of wall construction.
  9. Do not use "through-wall" boxes designed for access from both sides of wall.
  10. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
  11. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
  12. Nonmetallic Boxes: Comply with NEMA OS 2, and list and label as complying with UL 514C.
  13. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
  14. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes unless specifically indicated or permitted.
  15. Minimum Box Size, Unless Otherwise Indicated:
    - a. Wiring Devices: 4 inch square by 2-1/8 inch deep (100 by 54 mm) trade size.
    - b. Ceiling Outlets: 4 inch octagonal or square by 2-1/8 inch deep (100 by 54 mm) trade size.
  16. Wall Plates: Comply with Section 26 27 26.
  17. Manufacturers:
    - a. Cooper Crouse-Hinds, a division of Eaton Corporation  
: [www.cooperindustries.com/#sle](http://www.cooperindustries.com/#sle).
    - b. Hubbell Incorporated; Bell Products: [www.hubbell-rtb.com/#sle](http://www.hubbell-rtb.com/#sle).
    - c. Hubbell Incorporated; RACO Products: [www.hubbell-rtb.com/#sle](http://www.hubbell-rtb.com/#sle).
    - d. O-Z/Gedney, a brand of Emerson Electric Co: [www.emerson.com/#sle](http://www.emerson.com/#sle).
    - e. Thomas & Betts Corporation: [www.tnb.com/#sle](http://www.tnb.com/#sle).
- C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:
1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
  2. NEMA 250 Environment Type, Unless Otherwise Indicated:
    - a. Indoor Clean, Dry Locations: Type 1, painted steel.
    - b. Outdoor Locations: Type 3R, painted steel.
  3. Junction and Pull Boxes Larger Than 100 cubic inches:
    - a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.
    - b. Boxes 6 square feet and Larger: Provide sectionalized screw-cover or hinged-cover enclosures.
  4. Finish for Painted Steel Enclosures: Manufacturer's standard grey unless otherwise indicated.
  5. Manufacturers:
    - a. Cooper B-Line, a division of Eaton Corporation: [www.cooperindustries.com/#sle](http://www.cooperindustries.com/#sle).
    - b. Hoffman, a brand of Pentair Technical Products: [www.hoffmanonline.com/#sle](http://www.hoffmanonline.com/#sle).
    - c. Hubbell Incorporated; Wiegmann Products: [www.hubbell-wiegmann.com/#sle](http://www.hubbell-wiegmann.com/#sle).
- D. Boxes and Enclosures for Integrated Power, Data, and Audio/Video: Size and configuration as indicated or as required with partitions to separate services; field-connected gangable boxes may be used.
1. Manufacturers:
    - a. Chief, a brand of Legrand: [www.legrandav.com](http://www.legrandav.com)
    - b. Hubbell Incorporated: [www.hubbell.com/#sle](http://www.hubbell.com/#sle).

- c. FSR: [www.fsrinc.com](http://www.fsrinc.com)
- E. Floor Boxes:
  1. Description: Floor boxes compatible with floor box service fittings provided in accordance with Section 26 27 26; with partitions to separate multiple services; furnished with all components, adapters, and trims required for complete installation.
  2. Use cast iron floor boxes within slab on grade.
  3. Use sheet-steel or cast-iron floor boxes within slab above grade.
  4. Metallic Floor Boxes: Fully adjustable (with integral means for leveling adjustment prior to and after concrete pour).
  5. Manufacturer: Same as manufacturer of floor box service fittings.

## **PART 3 EXECUTION**

### **3.1 EXAMINATION**

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive boxes.
- C. Verify that conditions are satisfactory for installation prior to starting work.

### **3.2 INSTALLATION**

- A. Install products in accordance with manufacturer's instructions.
- B. Install boxes in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide separate boxes for emergency power and normal power systems.
- E. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.
- F. Flush-mount boxes in finished areas unless specifically indicated to be surface-mounted.
- G. Unless otherwise indicated, boxes may be surface-mounted where exposed conduits are indicated or permitted.
- H. Box Locations:
  1. Locate boxes to be accessible. Provide access panels in accordance with Section 08 31 00 as required where approved by the Architect.
  2. Unless dimensioned, box locations indicated are approximate.
  3. Locate boxes so that wall plates do not span different building finishes.
  4. Locate boxes so that wall plates do not cross masonry joints.
  5. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.
  6. Do not install flush-mounted boxes on opposite sides of walls back-to-back. Provide minimum 6 inches horizontal separation unless otherwise indicated.
  7. Acoustic-Rated Walls: Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches horizontal separation.
  8. Fire Resistance Rated Walls: Install flush-mounted boxes such that the required fire resistance will not be reduced.
    - a. Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches separation where wall is constructed with individual noncommunicating stud cavities or protect both boxes with listed putty pads.
    - b. Do not install flush-mounted boxes with area larger than 16 square inches or such that the total aggregate area of openings exceeds 100 square inches for any 100 square feet of wall area.
  9. Locate junction and pull boxes as indicated, as required to facilitate installation of conductors, and to limit conduit length and/or number of bends between pulling points in accordance with Section 26 05 33.13.
  10. Locate junction and pull boxes in the following areas, unless otherwise indicated or approved by the Architect:

- a. Concealed above accessible suspended ceilings.
  - b. Within joists in areas with no ceiling.
  - c. Electrical rooms.
  - d. Mechanical equipment rooms.
- I. Box Supports:
1. Secure and support boxes in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
  2. Provide required seismic controls in accordance with Section 26 05 48.
  3. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.
  4. Installation Above Suspended Ceilings: Do not provide support from ceiling grid or ceiling support system.
- J. Install boxes plumb and level.
- K. Flush-Mounted Boxes:
1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.
  2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.
  3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.
- L. Install boxes as required to preserve insulation integrity.
- M. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- N. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.
- O. Close unused box openings.
- P. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.
- Q. Provide grounding and bonding in accordance with Section 26 05 26.
- R. Identify boxes in accordance with Section 26 05 53.

### 3.3 CLEANING

- A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

### 3.4 PROTECTION

- A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

**END OF SECTION**

**SECTION 26 05 63**  
**IDENTIFICATION FOR ELECTRICAL SYSTEMS**

**PART 1 - GENERAL****1.1 SCOPE**

- A. Identification nameplates and labels.
- B. Wire and cable identification markers.
- C. Conduit identification markers

**1.2 SUBMITTALS**

- A. Product Data: Provide catalog data for nameplates, labels, and markers.
- B. Manufacturer's application conditions and limitations of use including instructions for storage, handling, protection, examination, preparation, and installation of product.

**PART 2 - PRODUCTS****2.1 NAMEPLATES AND LABELS**

- A. Engraved three-layer laminated plastic nameplate with minimum 1/4" height letters.
- B. Equipment connected to non-essential supply (commercial power only): Black letters on white background.
- C. Locations:
  - 1. Main Service and Distribution over-current devices.
  - 2. Disconnect switches.
- D. Labels:
  - 1. Locations required:
    - a. All motors.
    - b. All field equipment fed from 120/208 V power source.
    - c. All field equipment such as motors, control stations, etc.
- E. Provide engraved plastic equipment nameplates for all new panelboards, disconnects, and transformers.
- F. Provide engraved plastic equipment nameplates for all new panelboards - include voltage, phase, feeder conduit/conductor size, origin of feeder connection and calculated AIC.
- G. Nameplate wording shall be coordinated with final equipment identification nomenclature and approved by the owners' designated representative prior to installation.
- H. Letter Size:
  - 1. 1/4 inch letters: Identify individual equipment, and loads.
  - 2. 1/2 inch letters: Identify major electrical equipment and panelboards.

**2.2 WIRE AND CABLE MARKERS**

- A. Description: Non-ferrous identify tag or shrink type label.
- B. Locations: Each cable feeder, power circuit, and conductor in vaults, manholes, gutters, pull boxes, starters, outlet and junction boxes, control panels, panelboards, switchboards, etc., and each load connection.
- C. Legend: Each tag or label shall be typewritten with description listed below.
  - 1. Power and Lighting Circuits: Branch circuit or feeder number indicated on drawings.
  - 2. Control Circuits: Control wire number indicated on schematic and interconnection diagrams.

**2.3 CONDUIT MARKERS**

- A. Location: Furnish vinyl markers for each 2.00" or larger conduit longer than 6 feet for power circuits.
- B. Spacing: Adjacent to each termination at equipment and pull boxes and intermittently at 20 feet on center.
- C. Color: Use the following color-coding:

1. White color and black stencil, voltage in 1/2" black letters. At the source end, also indicate the load served in 1/2" black letters. At the load end, also indicate the circuit identification in 1/2" black letters. At intermediate points, also identify both the circuit identification and load in 1/2" black letters.

### **PART 3 - EXECUTION**

#### **3.1 PREPARATION**

- A. Degrease and clean surfaces to receive nameplates and labels.

#### **3.2 INSTALLATION**

- A. Install nameplate and label parallel to equipment lines.
- B. Secure nameplate to equipment front using screws.
- C. Secure nameplate to inside surface of door on panelboards that are recessed in finished wall locations.
- D. Install conduit markers per Section 2.
- E. Stencil conduit markers or use adhesive letters or order pre-labeled. Handwritten entries that are neat and legible and not smeared are acceptable. Any conduit markers that that are determined not to be neat, legible, and free from smears shall be replaced to the satisfaction of the Architect.
- F. For other conductor color-coding, see Section 26 0519 - Low-Voltage Electrical Power Conductors And Cables.

**END OF SECTION**

**SECTION 26 05 73**  
**OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY**

**PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Short Circuit Study.
- B. Coordination Study and Analysis.

**1.2 SCOPE**

- A. Provide an overcurrent protective device current coordination study in a computer-generated format for the added chiller breaker.
- B. From the primary of the service transformer down through the last branch circuit breaker of new equipment installed under this project.
- C. Compute short-circuit currents.

**1.3 QUALITY ASSURANCE**

- A. The Study shall be prepared by a Registered Professional Electrical Engineer experienced in studies of this type and shall bear the PE's seal and signature.
- B. Study shall conform to current ANSI/IEEE standards.

**1.4 SUBMITTALS**

- A. Submit prior to release of distribution system equipment for manufacture.
- B. Description and version of software program used, including database type libraries.
- C. One Line Diagram identifying equipment, busses, and protective devices.
- D. Textual description of coordination obtained and compromises selected.
- E. Tabulation of all adjustable device settings.
- F. Time-current curve plots graphically illustrating protective device ratings and characteristics including:
  - 1. Utility protective device.
  - 2. Secondary main protective device.
  - 3. Each device through, and including, the main and largest branch circuit device in the most downstream panel.
  - 4. Transformer inrush and damage limits.
  - 5. Device long-time pick-up and delay, short-time pick-up and delay, instantaneous, ground fault pick-up and delay.
  - 6. Motor-starting curve.
- G. Submit final As-Built version of Study minimum 60 days prior to final review of electrical system.

**PART 2 - PRODUCTS****PART 3 - EXECUTION****3.1 SETTINGS**

- A. Submit report showing final adjusted settings of all new protective devices.
- B. Set all protective devices for new equipment in accordance with the study.

**END OF SECTION**

**SECTION 26 05 83  
WIRING CONNECTIONS****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Electrical connections to equipment.

**1.2 RELATED REQUIREMENTS****1.3 REFERENCE STANDARDS**

- A. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

**1.4 ADMINISTRATIVE REQUIREMENTS**

- A. Coordination:
  - 1. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
  - 2. Determine connection locations and requirements.
- B. Sequencing:
  - 1. Install rough-in of electrical connections before installation of equipment is required.
  - 2. Make electrical connections before required start-up of equipment.

**1.5 QUALITY ASSURANCE**

- A. Comply with requirements of NFPA 70.
- B. Products: Listed, classified, and labeled as suitable for the purpose intended.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

**PART 2 PRODUCTS****2.1 EQUIPMENT CONNECTIONS**

- A. Refer to drawings.:

**PART 3 EXECUTION****3.1 EXAMINATION**

- A. Verify that equipment is ready for electrical connection, wiring, and energization.

**3.2 ELECTRICAL CONNECTIONS**

- A. Make electrical connections in accordance with equipment manufacturer's instructions.
- B. Make conduit connections to equipment using flexible conduit. Use liquid tight flexible conduit with watertight connectors in damp or wet locations.
- C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.
- D. Provide receptacle outlet to accommodate connection with attachment plug.
- E. Provide cord and cap where field-supplied attachment plug is required.
- F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
- G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.
- H. Install terminal block jumpers to complete equipment wiring requirements.
- I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

**END OF SECTION**



**SECTION 26 24 05  
DISTRIBUTION EQUIPMENT TESTING**

**PART 1 - GENERAL****1.1 DISTRIBUTION EQUIPMENT TESTING**

- A. All costs incurred for testing shall be included under Division 26.
- B. Description of Tests:
  - 1. Preliminary Inspections and Tests: Visual inspections of electrical equipment, wire checks of factory wiring, and any other preliminary work required to prevent delays during performance of electrical acceptance tests.
  - 2. Electrical Acceptance Tests: Those inspections and tests required to show that the workmanship, methods, inspections, and materials used in erection and installation of the electrical equipment conforms to accepted engineering practices, IEEE, ICEA and NEMA Standards, the National Electrical Code, National Electric Testing Association (NETA) specifications, and manufacturer's instructions, and to determine that the equipment involved may be energized for operational use.
  - 3. Operating Tests: Tests performed on electrical equipment, installed under other sections, to show that the electrical equipment will perform the functions for which it was designed.
  - 4. Final Acceptance: Final acceptance of electrical equipment will depend on equipment integrity as determined by the electrical acceptance test and depend on complete operational tests.
- C. Test and calibrate all new circuit breakers furnished under this contract and "spare" breakers scheduled to be placed into service, prior to acceptance of the building. This requirement shall apply to breakers rated 100 amp and larger.
- D. Tests shall be conducted per NETA recommendations and in accordance with NETA ATS Standard Practices
- E. In general, tests shall include the following:
  - 1. Determine proper operation of circuit breaker trip devices.
  - 2. Determine trip ratings or settings are correctly adjusted.
  - 3. Determine control and interlock devices perform as specified.
  - 4. Determine electrical resistance across contact surfaces in switches, circuit breakers and busway are acceptable.
  - 5. Torque all bolted connections.
  - 6. Determine bus bars are properly braced as specified.
- F. Contractor shall advise in writing as to when the distribution equipment will be tested so that the Owner may be present to witness this test. At least one week's notice of this test shall be given.
- G. These tests shall not alter the contractor's guarantee of the equipment. All work and materials found to be in non-compliance shall be replaced and re-tested by the contractor without additional cost to the Owner.
- H. Provide test results to Owner and Cx prior to on-site Functional Testing.
- I. Provide (3) copies of bound test reports, bound and included in the closeout documentation.

**END OF SECTION**

**SECTION 26 24 06  
NEW OVERCURRENT DEVICES IN EXISTING EQUIPMENT**

**PART 1 - GENERAL****1.1 SCOPE**

- A. This section covers the installation of new short-circuit over-current protective devices in existing equipment.

**1.2 DESCRIPTION OF WORK**

- A. Provide new over-current protective devices, hardware and associated components as required for a complete installation in existing switchboards and panelboards as indicated on the plans.

**PART 2 - PRODUCTS****2.1 AVAILABILITY OF DEVICES**

- A. Where a device is obsolete and the manufacturer does not offer an equivalent replacement device, provide written notice to the Architect.
- B. New device voltage and fault current interrupting ratings (SCCR) shall equal, or exceed, existing device ratings unless otherwise noted elsewhere in the specification or on the drawings.

**2.2 HARDWARE**

- A. Bus bars, draw-out and plug-in assemblies, connectors, adapters, lugs, and other hardware shall be of the same type and manufacture as existing equipment.
- B. New closure panels and doors shall match existing equipment.

**2.3 BREAKERS**

- A. Switchboard Distribution Circuit Breakers
  1. Solid State electronic trip, adjustable LSI. Provide with indicating ammeter.
  2. Rated for 100% continuous load to match existing distribution breakers.
  3. UL listed as type HACR for air conditioning equipment branch circuits.

**PART 3 - EXECUTION****3.1 EXTEND, MODIFY, BRACE AND INSTALL ALL NEW BUSING TO MATCH EXISTING BUSING.**

- A. All hardware, doors, panels and closure plates shall be mounted in alignment with existing equipment.
- B. Provide engraved nameplates on all new circuits in switchboards and in power distribution panelboards.
- C. Provide new typewritten directory in branch circuit lighting and receptacle panelboards where circuits have been modified under this scope of work.
- D. Adjust circuit breaker trip and time delay settings to values indicated in Coordination Study.

**END OF SECTION**

