

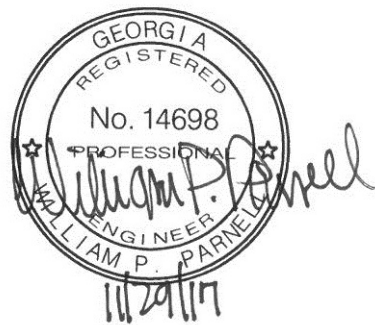
# PROJECT MANUAL

DIVISION 0 – DIVISION 28 SPECIFICATIONS

November 2017

SAVANNAH-CHATHAM COUNTY  
PUBLIC SCHOOL SYSTEM

## Johnson High School HVAC REPLACEMENT



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**Johnson High School  
HVAC Replacement**

November 29, 2017

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**CONSTRUCTION CONTRACT**  
**BETWEEN CONTRACTOR AND OWNER**

**TO BE USED WITH**  
**DESIGN PROFESSIONAL (ARCHITECTURAL) CONTRACT**  
**APPROVED BY THE BOARD OF PUBLIC EDUCATION FOR THE CITY OF SAVANNAH AND THE**  
**COUNTY OF CHATHAM**

To be provided under separate cover by owner.

SECTION 01 10 00 – SUMMARY OF WORK

PART 1 - GENERAL

- A. This Section includes the following:
  - 1.1 Work under other contracts
  - 1.2 Owner's occupancy requirements
  - 1.3 Work restrictions
- B. Stipulation Regarding Specifications:

All provisions in these Sections 01 26 00, 01 29 00, 01 31 00, 01 32 00, 01 33 00, 01 40 00, 01 50 00, 01 60 00, 01 73 00, 01 73 29, 01 74 19, 01 77 00, 01 78 23, and 01 78 39 are in addition to the provisions in the CONSTRUCTION CONTRACT BETWEEN CONTRACTOR AND OWNER. No provisions in these Specifications shall be construed to negate or diminish any requirements in the Construction Contract, but shall be applicable in addition to those requirements.
- C. Use of Existing Building(s): As applicable, maintain existing building(s) in a weather tight condition throughout construction period. Repair damage caused by construction operations. Protect building and its occupants during construction period.

1.1 WORK UNDER OTHER CONTRACTS

The Owner reserves the right to perform construction or operations related to the project with separate Contractors on the site per Article 1.3.6 of the Construction Contract. The following separate Contracts have been awarded and the Contractor shall coordinate construction operations as required, or directed, by the Owner:

1.2 OWNER'S OCCUPANCY REQUIREMENTS

1.2.1 Owner Occupancy of Completed Areas of Construction:

Owner reserves the right to occupy and to place and install equipment in completed areas of building, before Material Completion. Such placement of equipment and partial occupancy shall not constitute acceptance of the total Work. Design Professional will prepare a Certificate of Material Completion for each specific portion of the Work to be occupied before Owner occupancy. Before partial Owner occupancy, mechanical and electrical systems shall be fully operational, and required tests and inspections shall be successfully completed. On occupancy, Owner will operate and maintain mechanical and electrical systems serving occupied portions of building.

1.3 WORK RESTRICTIONS

1.3.1 Work can be performed 24 hours per day (including Saturdays and Sundays) during the 'limited-access' period, as well as during 'open-access' period and shall be coordinated with the work areas identified below, (at no time shall contractors be allowed to work during scheduled testing hours for the students):

- a. **Limited access-period:** Contractor to refrain from disruptive work during school hours.
- b. **General Work Access:** The Contractor shall coordinate work hours with SCCPSS prior to commencement of scheduled work.
- c. Hours for Utility Shutdowns: As authorized in advance by the Design Professional, and as limited by regulations and by authorities having jurisdiction.
- d. Coordination with Campus Police: Access to school facilities during non-school hours shall be coordinated with Campus Police. Contractor shall obtain prior clearance to occupy the site or buildings by calling Campus Police dispatcher @ 912-395-5536. Contact Campus Police at end of work and ensure facilities are

secure and Alarm Systems are activated.

- 1.3.2 Tobacco Products are prohibited and not permitted on Board property.
- 1.3.3 Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated. Notify Design Professional, and Owner, not less than 72 hours in advance of proposed utility interruptions. Proceed only with Design Professional's, and Owner's, written permission and only with all written authorizations including permits that may be required by authorities having jurisdiction.

END OF SECTION 01 10 00

SECTION 01 26 00 - CONTRACT MODIFICATION PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section specifies administrative and procedural requirements for processing Contract modifications.

1.2 Requests for Information or Clarification

- A. Request for Information (RFI): The Design Professional will issue a written RFI Response to each written Contractor inquiry. Unless specifically addressed, RFIs and RFI Responses shall not involve any adjustment to the Contract Sum or the Contract Time. RFI Responses when issued, become a part of the Contract Documents, and as such must be adhered to. The effects of RFI Responses must be reflected in the Project Record Documents. Each RFI Response shall bear words addressed by the Design Professional to the Contractor: "The work shall be carried out according to the following instructions or clarifications issued in response to Request For Information #(enter RFI #), and in accordance with The Contract Documents without change in The Contract Sum or Contract Time. If you determine that this response does affect The Contract Sum or Contract Time, you shall notify The Design Professional immediately, and shall do so prior to proceeding with the work in accordance with this response. Proceeding with the work in accordance with this response without your prior notification otherwise indicates your acknowledgement that there will be no change in The Contract Sum or Contract Time."

1.3 CHANGES IN THE WORK AFFECTING COST AND/OR TIME

- A. Proposed Change Order Requests: The Design Professional (or Owner) may issue a, which is detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time, the description will include supplemental or revised Drawings and Specifications. Each PCO will be numbered and dated, and subsequent communications regarding each PCO should give reference to the PCO number and date.
  - 1. Proposal Requests are for information only. Do not consider them instructions either to stop work in progress or to execute the proposed change.
  - 2. Within time specified in PCO after receipt of Proposal Request, the Contractor shall submit a Change Order Proposal (COP), which is a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change. Each COP must give reference to the number and date of the PCO to which it is in response.
    - a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
    - b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
    - c. Pricing of Changes shall be in accordance with Articles 3.2.9 and 3.2.10 of the Construction Contract.

- d. If affected, the Contractor's Construction Schedule shall be updated to indicate the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. This updated schedule shall be submitted with the COP. Use available total float before requesting an extension of the Contract Time. By omission of an updated Schedule as a part of a COP, the Contractor shall and does establish that the Schedule is not affected by the subject change. Any COP that proposes to affect Contract Time may be considered non-responsive if it does not include an updated Schedule
  
- A. All change proposals shall include complete break-out and support documentation, including unit descriptions, unit quantities, unit costs (labor, material, other), burdens and mark-ups. Portions of work that are to be deleted as a part of an overall change description shall be clearly reflected in the break-out; abbreviated descriptions which reflect only the net effects of reduced work scopes combined with increased work scopes will not be accepted. The Design Professional and Owner shall have full discretion in determining what measure of breakout and support is adequate and acceptable. No extension of Contract Time will be allowed for Construction delays attributable to the failure on the part of the Contractor to provide properly prepared and supported change proposals.
  
- B. Proposal and change request forms: Use forms that are acceptable to the Design Professional and Owner. If the Design Professional or Owner deems it necessary, the Contractor shall be required and shall agree to submit change proposals on forms provided by the Design Professional or Owner.
  
- B. Do not reflect any Change Order in the Schedule of Values or Application for Payment Continuation without an approved Change Order. The Design Professional or Owner shall have full discretion in establishing the manner in which Change Orders are added to the Schedule of Values and Continuation Sheets.

#### 1.4 ALLOWANCE

- A. Allowance Adjustment: All charges against an Allowance shall be made in the form of a CO resulting from PCO or RFI, shall be managed as any CO, and shall be invoiced against the Allowance line item in the Application for Payment. At Project completion, any unused balance in each allowance will be returned to the Owner by deductive CO.
  
- B. Submit claims for increased costs because of a change in scope or nature of the allowance described in the Contract Documents Submit claims within 14 days of receipt of the Change Order authorizing work to proceed. Owner will reject claims submitted later than 14 days after such authorization per Article 5.2.2 of the Contract.
  - 1. Do not include Contractor's or subcontractor's indirect expense in the Change Order cost amount unless it is clearly shown that the nature or extent of work has changed from what could have been foreseen from information in the Contract Documents.
  - 2. No change to Contractor's indirect expense is permitted for selection of higher- or lower-priced materials or systems of the same scope and nature as originally indicated.

#### 1.5 CHANGE ORDER PROCEDURES

- A. The Design Professional shall immediately upon receipt review each Proposed Change Order (PCO) for its technical and monetary merits. The Design Professional will not forward to the



Owner any advice or recommendation for any PCO that does not meet all requirements per Article 3.2.4 of the Contract Documents, but shall instead return it to the Contractor with specific instructions as to what must be done in order to rectify the problems with PCO. The Design Professional will provide written advice to the Owner regarding his opinion of each PCO, which will include a recommendation.

- B. Upon Owner's approval of a Proposed Change Order (PCO), Design Professional will issue a Change Order for approval by the Owner.

1.6 FORCE ACCOUNT CHANGE ORDER

- A. Force Account: Force Account work shall be undertaken only after receipt of an Approved Change Order, stating a maximum dollar amount (Stipulated Maximum Sum) beyond which no change work may be undertaken subject to amendment, for funding all costs of the Change Order as prescribed in Article 3.2.7.3 of the Contract.

- B. Documentation: The Contractor shall maintain detailed records on a time and material basis of work required by the Force Account Change Order.

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

1.7 TRACKING, COORDINATION and MANAGEMENT of CLARIFICATIONS and CHANGES

- A. Some clarifications and changes will go thru a process whereby they are assigned tracking numbers as more than one of the type documents defined in the articles above and in other Sections of these Specifications (i.e. RFIs, etc.). All documents created which pertain to the same subject shall make clear reference to other previous or concurrent documents on the subject.

- 1. The Contractor shall establish and maintain current a single Log which tracks all these type documents. The form and content of this log is subject to Design Professional and Owner approval, and may if sufficient be used to meet other stipulated tracking log requirements.

1.8 DELAYS AND EXTENSIONS OF TIME DUE TO WEATHER

- A. Delays caused by weather are non-compensable, and will be processed in accordance with Article 3.3.7.2 of the Contract.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 26 00

SECTION 01 29 00 - PAYMENT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

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

1.2 SCHEDULE OF VALUES

- A. Coordination: Coordinate preparation of the Schedule of Values with preparation of Contractor's Construction Schedule.
  - 1. The Design Professional and Owner shall have full discretion in establishing the measure and depth of breakout that is required to be reflected in the Schedule of Values. Additionally, the Design Professional and Owner shall have full discretion in establishing the manner in which Change Orders are added to the Schedule of Values.
  - 2. Correlate line items in the Schedule of Values with other required administrative forms and schedules, including Application for Payment forms with Continuation Sheets Submittals Schedule and Contractor's Construction Schedule.
  - 3. Submit the Schedule of Values to Design Professional and Owner at earliest possible date but no later than 14 days after the issuance of the first Proceed Order. The Schedule of Values must precede and be approved by the Design Professional and Owner prior to the initial Application for Payment.
  - 4. Sub-schedules: Where the Work is separated into phases requiring separately phased payments, provide sub schedules showing values correlated with each phase of payment.
- B. Format and Content: The Schedule of Values shall be in a format similar to AIA Document G703. Use the Project Manual table of contents as a guide to establish line items for the Schedule of Values. Provide at least one line item for each Specification Section.
  - 1. Submit draft of Application for Payment Continuation Sheets.
  - 2. The approved Schedule of Values shall be used in the Continuation Sheets of all Applications for Payment, and shall not be altered except by the addition of approved Change Orders. Alterations to the approved line items in an Application for Payment without prior agreement will result in the return of the Application for Payment to the Contractor, for correction.
  - 3. The total of the items in the Schedule of Values shall equal the Contract Sum.
  - 4. Allowances: Provide a separate line item in the Schedule of Values for each allowance. Use information indicated in the Contract Documents to determine quantities.
  - 5. Schedule Updating: Resubmit the Schedule of Values at least 10 days before the next Applications for Payment when Change Orders result in a change in the Contract Sum.

1.3 APPLICATIONS FOR PAYMENT

- A. Each Application for Payment shall be consistent with previous applications and payments as

certified by Design Professional and paid by Owner.

- B. Payment Application Times: Progress payments shall be submitted to Design Professional no later than the last day of the month. The period covered by each Application for Payment is one month (minimum), ending on the last date of the application.
- D. Payment Application Forms: Use forms provided in the Construction Contract.
- E. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. Design Professional will return incomplete applications without action.
  - 1. Entries shall match data on the Schedule of Values and Contractor's Construction Schedule. Use updated schedules if approved revisions were made. No changes shall be made to the Schedule of Values and Continuation Sheets without the prior approval of the Design Professional and Owner.
  - 2. Include amounts of Change Orders approved before last day of construction period covered by application. Add Change Orders to the Schedule of Values and Continuation Sheets in a manner that accurately reflects the manner in which they are authorized and issued.
  - 3. On the Application form, include in the "work completed" columns (previous and current) only the value of work that has actually been completed. The value of the current inventory of stored materials shall be accurately reflected in the "stored materials" column. When stored materials which have been previously invoiced remain stored at the time of subsequent Applications, their value shall remain in the "stored materials" column; only when previously-stored materials are incorporated into the work shall their value be shifted into the "current work completed" column. The inaccurate inclusion of the value of Stored Materials within the value of Work Completed will result in the return of the Application for payment with no action. There will be no exceptions.
  - 4. All Stored Materials for which payment is requested must be supported by sufficient documentation including invoices. If there remains stored a value of materials for which an invoice was presented with a previous Application for Payment, a copy of the same invoice shall be presented. When applicable, these material support invoices should bear notations to reflect the diminishing volume and hence value of the stored materials.
  - 5. Applications for Payment which reflect an incorrect or unapproved retainage rate or amount will be returned without action.
  - 6. The Design Professional will not mark, edit, or correct Applications for Payment in order to recommend them for payment. Applications which require corrections will be returned to the Contractor for the needed corrections.
  - 7. The Contractor may if he wishes submit a draft of each Application for Payment in advance of the actual Application, for the advance cursory review and informal approval of the Design Professional. Any such review and informal approval by the Design Professional shall not guarantee the formal review action by the Design Professional of the actual Application for Payment.
- F. Transmittal: Submit 4 signed and notarized original copies of each Application for Payment to Design Professional by a method ensuring receipt within 24 hours. One copy shall include waivers of lien and similar attachments if required.
- G. Waivers of Mechanic's Lien: If required by the Owner or Design Professional, with each

Application for Payment, submit waivers of mechanic's lien from every entity who is lawfully entitled to file a mechanic's lien arising out of the Contract and related to the Work covered by the payment.

1. Submit partial waivers on each item for amount requested in previous application, after deduction for retainage, on each item.
2. When an application shows completion of an item, submit final or full waivers.
3. Owner and Design Professional reserve the right to designate which entities involved in the Work must submit waivers.
4. Waiver Forms: Submit waivers of lien on forms, executed in a manner acceptable to Owner and in conformance with Georgia Law.

H. All Applications for Payment involve additional required actions and submittals. Any Application for Payment submitted without compliance with these additional requirements will be returned without action.

1. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:
  - a. List of subcontractors and suppliers.
  - b. Schedule of Values.
  - c. Contractor's Construction Schedule (preliminary if not final).
  - d. Submittals Schedule and Log (preliminary if not final).
  - e. All submittals and approvals of all items that require approval prior to commencement of work for which payment is sought.
  - f. List of Contractor's staff assignments.
  - g. List of Contractor's principal consultants.
  - h. Copies of building permits.
  - i. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.
  - j. Initial progress report.
  - k. Report of preconstruction conference.
  - l. Certificates of insurance and insurance policies.
  - m. Performance and Payment Bonds.
2. Periodic Applications for Payment: Administrative actions and submittals that must precede or coincide with submittal of each Periodic Application for Payment include the following:
  - a. Contractor's updated construction schedule, or a written statement that the most recent previous updated schedule remains accurate within 5%, which statement shall be subject to the concurrence of the Design Professional.
  - b. Updated current Submittals Schedule and Log.
  - c. Updated current RFI, PCO and CO Logs.
  - d. All actual submittals and approvals of all items that require approval prior to commencement of work for which payment is sought.
  - e. Daily Construction Reports for the period covered by the Application.
  - f. Minutes of all Meetings held during the period covered by the Application.
  - g. Local and/or MFBE Monthly Report Forms provided in the Bidding Documents

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3. Application for Payment at Material Completion and Final Payment:

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 29 00

SECTION 01 31 00 - PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
  - 1. Safety.
  - 2. Coordination Drawings.
  - 3. Project meetings.
  - 4. Requests for Interpretation (or Information) (RFIs).
- B. See Division 01 Section "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.

1.2 SAFETY

- A. Safety is the responsibility of solely the Contractor in accordance with Section 1-General, Part 4-Protection of Persons and Property of the contract.
- B. The Contractor shall have in effect at all times an active Safety Plan, and the Design Professional may in the course of and as a prerequisite to approving Applications for Payment, request to see evidence that this required Safety Plan is in place and fully in effect.

1.3 DEFINITIONS

- A. Request For Information (RFI): Request from Contractor seeking interpretation or clarification of the Contract Documents.
- B. Design Professional's Supplemental Instruction (DSI): A supplemental instruction from the Design Professional. DSIs will commonly be issued when the Design Professional (as opposed to the Contractor) recognizes the need to provide interpretation or clarification, or to make a change in the Work which will not change the Contract Sum or Time. See Section 01 26 00, "Contract Modification Procedures" for additional information.

1.4 COORDINATION

- A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections that depend on each other for proper installation, connection, and operation.
  - 1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
  - 2. Coordinate installation of different components with other contractors to ensure maximum accessibility for required maintenance, service, and repair.
  - 3. Make adequate provisions to accommodate items scheduled for later installation.

4. Where availability of space is limited, coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair of all components, including mechanical and electrical.
- B. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
  1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.
- C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and activities of other contractors to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
  1. Preparation of Contractor's Construction Schedule.
  2. Preparation of the Schedule of Values.
  3. Installation and removal of temporary facilities and controls.
  4. Pre-construction conference.
  5. Delivery and processing of submittals.
  6. Progress meetings.
  7. Pre-installation conferences.
  8. Project closeout activities.
  9. Startup and adjustment of systems.
  10. Project closeout activities.
- D. Electronic Communications: It will be acceptable and in most cases preferable that communications regarding the project be sent and received electronically, by email and email attachment. Exceptions would include Applications for Payment and executed Change Order Documents, and Notices of Claims or Disputes.

## 1.5 SUBMITTALS

- A. Coordination Drawings: Prepare Coordination Drawings if limited space availability necessitates maximum utilization of space for efficient installation of different components or if coordination is required for installation of products and materials fabricated by separate entities.
  1. Content: Project-specific information, drawn accurately to scale. Do not base Coordination Drawings on reproductions of the Contract Documents or standard printed data. Include the following information, as applicable:
    - a. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
    - b. Indicate dimensions shown on the Contract Drawings and make specific note of dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Design Professional for resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
  2. Sheet Size: At least 8-1/2 by 11 inches but no larger than 30 by 40 inches.
  3. Number of Copies: Submit two opaque copies of each submittal. Design Professional will return one copy.
  4. Refer to individual Sections for Coordination Drawing requirements for Work in those Sections.

1.6 PROJECT MEETINGS

- A. General: Schedule and conduct meetings and conferences at Project site, unless otherwise indicated.
1. The Contractor shall be responsible to facilitate and schedule all required meetings, including meeting agendas and reports of meeting minutes.
  2. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Design Professional of scheduled meeting dates and times.
  2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
  3. Minutes: Record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Design Professional, within three days of the meeting.
- B. Preconstruction Conference: Schedule a preconstruction conference before starting construction, at a time convenient to Owner and Design Professional, but no later than 14 days after execution of the Agreement. Hold the conference at Project site or another convenient location. Conduct the meeting to review responsibilities and personnel assignments.
1. Attendees: Authorized representatives of Owner, Design Professional, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
  2. Agenda: Discuss items of significance that could affect progress, including the following:
    - a. Safety.
    - b. Tentative construction schedule.
    - c. Phasing.
    - d. Critical work sequencing and long-lead items.
    - e. Designation of key personnel and their duties.
    - f. Procedures for processing field decisions and Change Orders.
    - g. Procedures for RFIs.
    - h. Procedures for testing and inspecting.
    - i. Procedures for processing Applications for Payment.
    - j. Distribution of the Contract Documents.
    - k. Submittal procedures.
    - l. Preparation of Record Documents.
    - m. Use of the premises, coordination with Campus Police, and utility outage process.
    - n. Work restrictions.
    - o. Owner's occupancy requirements.
    - p. Responsibility for temporary facilities and controls.
    - q. Construction waste management and recycling.
    - r. Parking availability.
    - s. Office, work, and storage areas.
    - t. Equipment deliveries and priorities.
    - u. First aid.
    - v. Security.
    - w. Progress cleaning.
    - x. Working hours.
  3. Minutes: Record and distribute meeting minutes to all attendees as well as to those not in



attendance who should receive the meeting minutes.

- C. Pre-installation Conferences: Conduct a reinstallation conference at Project site before each construction activity that requires coordination with other construction. Hold reinstallation conferences for construction activities determined by either the Contractor or the Design Professional to require such a conference. Indications within these Specifications as to which construction activities require pre-installation conferences shall not be construed to set a limit.
1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Design Professional of scheduled meeting dates.
  2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
    - a. The Contract Documents.
    - b. Options.
    - c. Related RFIs.
    - d. Related Change Orders.
    - e. Purchases.
    - f. Deliveries.
    - g. Submittals.
    - h. Review of mockups.
    - i. Possible conflicts.
    - j. Compatibility problems.
    - k. Time schedules.
    - l. Weather limitations.
    - m. Manufacturer's written recommendations.
    - n. Warranty requirements.
    - o. Compatibility of materials.
    - p. Acceptability of substrates.
    - q. Temporary facilities and controls.
    - r. Space and access limitations.
    - s. Regulations of authorities having jurisdiction.
    - t. Testing and inspecting requirements.
    - u. Installation procedures.
    - v. Coordination with other work.
    - w. Required performance results.
    - x. Protection of adjacent work.
    - y. Protection of construction and personnel.
  3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
  4. Reporting: Distribute minutes of the meeting to each party present and to parties who should have been present.
  5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.
- D. Progress Meetings: Conduct progress meetings at weekly intervals. Coordinate dates of meetings with preparation of payment requests.

1. Attendees: In addition to representatives of Owner and Design Professional, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
2. Agenda: First, address all safety issues. Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
  - a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's Construction Schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time. Review schedule for next period.
  - b. Review present and future needs of each entity present, including the following:
    - 1) Interface requirements.
    - 2) Sequence of operations.
    - 3) Status of submittals.
    - 4) Deliveries.
    - 5) Off-site fabrication.
    - 6) Access.
    - 7) Site utilization.
    - 8) Temporary facilities and controls and utility outage requirements.
    - 9) Work hours.
    - 10) Hazards and risks.
    - 11) Progress cleaning.
    - 12) Quality and work standards.
    - 13) Status of correction of deficient items.
    - 14) Field observations.
    - 15) RFIs.
    - 16) Status of proposal requests.
    - 17) Pending changes.
    - 18) Status of Change Orders.
    - 19) Pending claims and disputes.
    - 20) Documentation of information for payment requests.
3. Minutes: Record the meeting minutes.
4. Reporting: Distribute minutes of the meeting to each party present and to parties who should have been present.
  - a. Schedule Updating: Revise Contractor's Construction Schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

#### 1.7 REQUESTS FOR INTERPRETATION (RFIs)

- A. Procedure: Immediately on discovery of the need for interpretation of the Contract Documents, and if not possible to request interpretation at Project meeting, prepare and submit an RFI in the form specified.
  1. RFIs shall originate with Contractor. RFIs submitted by entities other than Contractor

- will be returned with no response.
2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.
- B. Content of the RFI: Include a detailed, legible description of item needing interpretation and the following:
1. Project name.
  2. Date.
  3. Name of Contractor.
  4. Name of Design Professional.
  5. RFI number, numbered sequentially.
  6. Specification Section number and title and related paragraphs, as appropriate.
  7. Drawing number and detail references, as appropriate.
  8. Field dimensions and conditions, as appropriate.
  9. Contractor's suggested solution(s). If Contractor's solution(s) impact the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
  10. Contractor's signature.
  11. Attachments: Include drawings, descriptions, measurements, photos, Product Data, Shop Drawings, and other information necessary to fully describe items needing interpretation. Give clear reference to all attachments on the face of the RFI.
- C. RFI Format: Use RFI forms that are acceptable to the Design Professional and Owner.
1. Identify each page of attachments with the RFI number and sequential page number.
- D. Design Professional's Action: Design Professional will review each RFI, determine action required, and provide an RFI Response as soon as possible, but in no case later than two business days after receipt. RFIs received after 1:00 p.m. will be considered as received the following working day.
1. The following RFIs may be returned without action:
    - a. Requests for approval of submittals.
    - b. Requests for approval of substitutions.
    - c. Requests for information that is already indicated in the Contract Documents.
    - d. Requests for adjustments in the Contract Time or the Contract Sum.
    - e. Requests for interpretation of Design Professional's actions on submittals.
    - f. Incomplete RFIs or RFIs with numerous errors, mistakes or other flaws.
  2. Design Professional's action may include a requirement that additional information be provided, in which case Design Professional's time for response will start again.
  3. Design Professional's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Division 01 Section "Contract Modification Procedures."
    - a. If Contractor believes the Design Professional's response to an RFI warrants change in the Contract Time or the Contract Sum, notify Design Professional in writing within seven days of receipt of the RFI response and submit a Proposed Change Order. Do not proceed with any additional cost work item until receipt of an approved Change Order.
- E. On receipt of Design Professional's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Design Professional within seven days if Contractor disagrees with response.

- F. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly. Include the following:
1. Project name.
  2. Name and address of Contractor.
  3. Name and address of Design Professional.
  4. RFI number including RFIs that were dropped and not submitted.
  5. RFI description.
  6. Date the RFI was submitted.
  7. Date Design Professional's response was received.
  8. Identification of any related Design Professional's Supplemental Instruction (DSI), Request for Proposal (RFP), Proposed Change Order (PCO), Bulletin Drawing (BD), and executed Change Order (CO), as appropriate.

1.8 TRACKING, COORDINATION and MANAGEMENT of CLARIFICATIONS and CHANGES

- A. Some clarifications and changes will go thru a process whereby they are assigned tracking numbers as more than one of the type documents defined in the articles above and in other Sections of these Specifications. All documents created which pertain to the same subject shall make clear reference to other previous or concurrent documents on the subject.
1. The Contractor shall establish and maintain current a single Log which tracks all these documents. The form and content of this log is subject to Design Professional and Owner approval, and may if sufficient be used to meet other stipulated tracking log requirements.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 31 00

SECTION 013200 - CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:
  - 1. Contractor's Construction Schedule.
  - 2. Submittals Schedule.
  - 3. Daily construction reports.
  - 4. Field condition reports.
- B. See Division 01 Section "Payment Procedures" for submitting the Schedule of Values.
- C. See Division 01 Section "Photographic Documentation" for submitting construction photographs.

1.2 DEFINITIONS

- A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a construction schedule consume time and resources.
  - 1. Critical activities are activities on the critical path. They must start and finish on the planned early start and finish times.
  - 2. Predecessor Activity: An activity that precedes another activity in the network.
  - 3. Successor Activity: An activity that follows another activity in the network.
- B. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Project.
- C. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.
- D. Float: The measure of leeway in starting and completing an activity.
  - 1. Float time belongs to Owner.
- E. Fragment: A partial or fragmentary network that breaks down activities into smaller activities for greater detail.
- F. Major Area: A story of construction, a separate building, or a similar significant construction element. See Section 01100, "Summary."

1.3 SUBMITTALS

- A. Submittals Schedule {Article 2.2.3; Submittals}: Submit three copies of schedule within 60 days of the effective date of the contract. Arrange the following information in a tabular format:

1. Scheduled date for first submittal.
2. Specification Section number and title.
3. Submittal category (action or informational).
4. Name of subcontractor.
5. Description of the Work covered.
6. Scheduled date for Design Professional's final release or approval.

- A. Contractor's Construction Schedule :{ Article 2.1.5; Construction Progress Schedule} Submit two copies of initial schedule, large enough to show entire schedule for entire construction period.
- B. CPM Reports: Concurrent with CPM schedule, submit two copies of each of the following computer-generated reports. Format for each activity in reports shall contain activity number, activity description, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float in calendar days.
1. Activity Report: List of all activities sorted by activity number and then early start date, or actual start date if known.
  2. Logic Report: List of preceding and succeeding activities for all activities, sorted in ascending order by activity number and then early start date, or actual start date if known.
  3. Total Float Report: List of all activities sorted in ascending order of total float.
- C. Daily Construction Reports: Submit one copy of daily construction reports, accompanied by corresponding photographs, at weekly intervals.
- D. Field Condition Reports: Submit immediately at time of discovery of differing or noteworthy conditions.

#### 1.4 COORDINATION

- A. Coordinate preparation and processing of schedules and reports with performance of construction activities and with scheduling and reporting of separate contractors.
- B. Coordinate Contractor's Construction Schedule with the Schedule of Values, list of subcontracts, Submittals Schedule, progress reports, payment requests, and other required schedules and reports.
1. Secure time commitments for performing critical elements of the Work from parties involved.
  2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

### PART 2 - PRODUCTS

#### 2.1 SUBMITTALS SCHEDULE

- A. Comply with all requirements, including those of Section 013300, "Submittal Procedures," and coordinate submittal requirements with the project schedule requirements.

#### 2.2 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

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- A. Time Frame: Extend schedule from date established for the Proceed Order to date of Final Completion.
  - 1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.
  
- B. Activities: Treat each story or separate area as a separate numbered activity for each principal element of the Work. Comply with the following:
  - 1. Activity Duration: Define activities so no activity is longer than 21 days, unless specifically allowed by Design Professional.
  - 2. Procurement Activities: Include procurement process activities for the following long lead items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
  - 3. Submittal Review Time: Include review and resubmittal times indicated in Division 01 Section "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's Construction Schedule with Submittals Schedule.
  - 4. Startup and Testing Time: Include not less than 21 days for startup and testing.
  - 5. Material Completion: Indicate completion in advance of date established for Material Completion, and allow time for Design Professional's administrative procedures necessary for certification of Material Completion.
  
- C. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.
  - 1. Phasing: Arrange list of activities on schedule by phase.
  - 2. Work by Owner: Include a separate activity for each portion of the Work performed by Owner.
  - 3. Work Restrictions: Show the effect of the following items on the schedule:
    - a. Use of premises restrictions.
    - b. Seasonal variations.
    - c. Environmental control.
  - 4. Work Stages: Indicate important stages of construction for each major portion of the Work.
  
- D. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Proceed Order, Material Completion, and Final Completion, and the following interim milestones, including for applicable parts as established in Section 01100, "Summary":
  - 1. All scheduled pre-installation conferences
  - 2. Dry-in, roof
  - 3. Dry-in, walls
  - 4. Permanent power
  - 5. Start-up dates for primary systems and equipment
  - 6. Interim commissioning dates for systems and equipment which are relied upon by other systems or equipment
  - 7. Permanent lighting
  - 8. Moderation and control of interior climate
  - 9. Milestone dates relating to Furniture, Fixtures, and Equipment
  - 10. Certificate of Occupancy (delivered to Design Professional)
  
- E. Contract Modifications: For each proposed contract modification and concurrent with its

submission, prepare a time-impact analysis using fragments to demonstrate the effect of the proposed change on the overall project schedule.

- F. **Schedule Updating:** Concurrent with making revisions to schedule, prepare tabulated reports showing the following:
1. Identification of activities that have changed.
  2. Changes in early and late start dates.
  3. Changes in early and late finish dates.
  4. Changes in activity durations in workdays.
  5. Changes in the critical path.
  6. Changes in total float or slack time.
  7. Changes in the Contract Time.

## 2.4 REPORTS

- A. **Daily Construction Reports:** Prepare a daily construction report recording the following information concerning events at Project site, to include:
1. List of subcontractors at Project site, including the approximate man-power presence for each subcontractor.
  2. Equipment at Project site.
  3. Material deliveries.
  4. High and low temperatures and general weather conditions.
  5. Accidents and unusual events.
  6. Stoppages, delays, shortages, and losses.
  7. Meter readings and similar recordings.
  8. Orders and requests of authorities having jurisdiction.
  9. Services connected and disconnected.
  10. Equipment or system tests and startups.
- B. **Field Condition Reports:** Immediately on discovery of a difference between field conditions and the Contract Documents, prepare and submit a detailed report. Submit with an RFI. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

## PART 3 - EXECUTION

### 3.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

- A. **Contractor's Construction Schedule Updating:** At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.
1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
  2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
  3. As the Work progresses, indicate Actual Completion percentage for each activity.



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- B. Distribution: Distribute copies of approved schedule to Design Professional, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.
1. Post copies in Project meeting rooms and temporary field offices.
  2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

END OF SECTION 01 32 00

SECTION 01 33 00 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for submitting all project submittals, including product data, product certificates, manufacturer certificates, test reports, shop drawings, color and finish selection information, samples, and other submittals.
- B. See also all other Divisions and Sections for additional submittal information as required by the Design Professional.

1.2 SUBMITTAL TYPES / DEFINITIONS

- A. Each submittal must be identified according to the following submittal types:
  - 1. Informational Submittal: Submittal item that is made for the purpose of supplying required information or information which demonstrate compliance with project requirements. While an Informational Submittal does not require the Design Professional's or Consultant's responsive action, it may be rejected for not complying with requirements, in which case the item would be required to be re-submitted. Also, in certain instances, corrective work may be required as the result of a rejected Informational Submittal.
  - 2. Action Submittal: Submittal item that is made for the purpose of supplying required information or information which demonstrate compliance with project requirements, and which does require the Design Professional's or Consultant's responsive action. Except as directed or indicated otherwise, an Action Submittal shall be submitted and approved prior to the commencement of the work to which it pertains.
  - 3. Administrative Submittal: Submittal item that is required as a part of general project management and administration. Most or all Administrative Submittals will be Informational Submittals.
  - 4. Technical Submittal: Submittal item that pertains to a particular aspect of the actual work. Most Technical Submittals will be Action Submittals, although some will instead be informational submittals.
  - 5. Periodic Submittal: Submittal item that is required during the course of construction (such as manufacturing or installation reports). Most or all Periodic Submittals will be Informational Submittals.
  - 6. Job-End Submittal: Submittal item that is required as a part of project close-out, operation and maintenance information, warranties, record documents, demonstration and training, or special requirements associated with Material and Final Completion. Do not submit Job-End Submittals with Technical Submittals. Most or all Job-End Submittals will be Informational Submittals.
  - 7. Component Submittal: Submittal (more accurately, transmittal) of actual components, such as extra materials, tools, parts that are specified to be required. While a Component Submittal does not require the Design Professional's or Consultant's responsive action, it may be rejected for not complying with requirements, in which case the item would be required to be re-submitted. Also, corrective work may be required as the result of a rejected Informational Submittal.
- B. Do not transmit or bind different type submittals together when such would encumber proper handling or action by the Design Professional; for instance, do not bind Informational Submittals together with Action Submittals.

1.3 SUBMITTAL PROCEDURES

- A. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
  2. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
    - a. Design Professional may withhold action on a submittal requiring coordination with other submittals until related submittals are received. Failure on the part of the Design Professional to notify the Contractor that action on a submittal is pending related submittals shall not be cause for an extension in the Contract Time.
- B. Submittals Schedule/Log: Maintain and periodically submit a Schedule/Log of Submittals. Coordinate submittal and action dates with the Project Schedule, allowing adequate time {14 calendar days minimum} for review and action by the Design Professional, re-submittal, re-review and action, field measuring, ordering, manufacturing, fabrication, and delivery.
1. Include for each line entry in the Submittal Schedule/Log columns to indicate no less than the following information:
    - a. Number
    - b. Section Article Number
    - c. Subject or Description
    - d. Content
    - e. Type Product
    - f. Type
    - g. Date, scheduled
    - h. Date, actual
    - i. Review Action Date, scheduled (for Action Submittals)
    - j. Review Action Date, actual (for Action Submittals)
    - k. Review Action
  2. Coordinate Submittals Schedule with list of subcontracts, the Schedule of Values, and Contractor's Construction Schedule.
  3. Submit current updated Submittal Schedule / Logs no less frequently than monthly and more frequently when required by the Design Professional.
- C. Identification / Transmittal of Submittals: Use the Project "Submittal Cover / Transmittal Sheet" form, which follows this Section, to transmit ALL submittal items, without exception. Complete all information on the form, entering "NA" in blanks that are not applicable. For Action Submittals, attach a fully completed copy of the "Project Submittal Cover / Transmittal Sheet" to the front of each and every copy of each and every submittal. A partially editable electronic copy of the "Project Submittal Cover / Transmittal Sheet" will be made available to the Contractor upon request. Submittals that are not properly and correctly identified will be returned with no action, a re-submittal will be required, and attributable delays will not be considered as cause for an extension in Contract Time.
- D. Processing Time: Allow enough time {14 calendar days minimum} for submittal review, including time for re-submittals, as follows. Time for review shall commence on Design Professional's receipt of submittal. No extension of the Contract Time will be authorized

because of failure to transmit submittals enough in advance of the Work to permit processing, including re-submittals.

1. Initial Review: Allow 14 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Design Professional will advise Contractor when a submittal being processed must be delayed for coordination.
  2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
  3. Re-submittal Review: Allow 14 days for review of each re-submittal.
- E. Deviations: Highlight, encircle, or otherwise specifically identify deviations from the Contract Documents on submittals.
- F. Additional Copies: Unless additional copies are required for final submittal, and unless Design Professional observes noncompliance with provisions in the Contract Documents, initial submittal may serve as final submittal.
1. All copies including additional copies submitted for maintenance manuals less three will not be marked with action taken and will be returned.
- G. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
1. Note date and content of previous submittal.
  2. Note date and content of revision in label or title block and clearly indicate extent of revision.
  3. Resubmit submittals until they are returned with a review stamp and note by either the Design Professional or his Consultant that does not indicate the requirement that they be resubmitted.
  4. The Design Professional shall be responsible for an initial and one subsequent review of the submittal. The Contractor shall be liable for additional cost of subsequent reviews due to non-compliance.
- H. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, and installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
- I. Use for Construction: Use only final submittals with mark indicating a review stamp and note by either the Design Professional or his Consultant that does not indicate the requirement that they be resubmitted.
- J. All submittals shall be made in a manner that will accommodate the progress of construction. No extension of Contract Time will be issued for construction delays caused by untimely submittals. All Action Submittals and all other submittals that are deemed relevant to the progress of the Work shall be provided according to the approved Submittals Schedule, and all such submittals shall be provided no later than within 60 days of commencement of work or other notice to provide submittals, or within 15% of the project schedule, whichever time period is shortest.
- K. If at the time of an Application for Payment, the provision of submittals is behind schedule, based on the current approved Submittal Schedule, the Contractor may not be allowed to request funds for General Conditions, which, if requested, will cause the Application to be returned without action.

- L. If the Agreement allows for the reduction of retainage, this reduction shall not be approved or allowed until all Action Submittals and all other submittals that are deemed relevant to the progress of the Work have been approved.

#### 1.4 CONTRACTOR'S USE OF DESIGN PROFESSIONAL'S CAD FILES

- A. General: At Contractor's written request, copies of Design Professional's electronic drawing files may be provided on a limited basis to Contractor for Contractor's use in connection with Project, subject to the following conditions:
  - 1. The Design Professional assumes no liability for reliance upon these documents instead of actual physical measurements or examination of actual field conditions. The Design Professional's drawings are copyrighted and may not be used for any purposes other than for the construction of this building at this time and place.
  - 2. Each request must include specific information about the intended use of the electronic drawings, and the type electronic drawing file sought, and a list of the specific drawing sheets sought. These will be provided in response to each request at the sole discretion of the Design Professional.

### PART 2 - PRODUCTS

#### 2.1 ACTION SUBMITTALS

- A. General: Prepare and submit Action Submittals required by individual Specification Sections.
  - 1. Except as approved by the Design Professional, submit all Action Submittals required by each Section at one time. Bind and consolidate these to the greatest extent possible, taking care however that each individual submittal requirement is included.
- B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
  - 1. If information must be specially prepared for submittal because standard printed data are not suitable for use, submit as Shop Drawings, not as Product Data.
  - 2. Mark each copy of each submittal to show which products and options are applicable.
  - 3. Include the following information, as applicable:
    - a. Manufacturer's written recommendations.
    - b. Manufacturer's product specifications.
    - c. Manufacturer's installation instructions.
    - d. Manufacturer's catalog cuts.
    - e. Wiring diagrams showing factory-installed wiring.
    - f. Printed performance curves.
    - g. Operational range diagrams.
    - h. Compliance with specified referenced standards.
    - i. Testing by recognized testing agency.
  - 4. Number of Copies: Submit copies of Product Data in a quantity to meet Contractor's requirements, considering that the Design Professional will retain three copies. Mark up and retain one returned copy as a Project Record Document.
- C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data, unless submittal of Design Professional's electronic Drawings is otherwise permitted.
  - 1. Preparation: Fully illustrate requirements in the Contract Documents. Include the

- following information, as applicable:
- a. Dimensions.
  - b. Identification of products.
  - c. Fabrication and installation drawings.
  - d. Roughing-in and setting diagrams.
  - e. Wiring diagrams showing field-installed wiring, including power, signal, and control wiring.
  - f. Shopwork manufacturing instructions.
  - g. Templates and patterns.
  - h. Schedules.
  - i. Notation of coordination requirements.
  - j. Notation of dimensions established by field measurement.
  - k. Relationship to adjoining construction clearly indicated.
  - l. Seal and signature of professional engineer if specified.
  - m. Wiring Diagrams: Differentiate between manufacturer-installed and field-installed wiring.
2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches but no larger than 30 by 40 inches.
  3. Number of Copies: Submit copies in a quantity to meet Contractor's requirements, considering that the Design Professional will retain three copies.
- D. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.
1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
  2. Identification: Attach label on unexposed side of Samples that includes the following:
    - a. Generic description of Sample.
    - b. Product name and name of manufacturer.
    - c. Sample source.
    - d. Number and title of appropriate Specification Section.
  3. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
  4. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.
    - a. Number of Samples: Submit no fewer than five full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Design Professional will retain three and will return the remaining submittal(s) with options selected.
  5. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
    - a. Number of Samples: Submit no fewer than four sets of Samples. Design Professional will retain three Sample sets; remainder will be returned. Mark up and retain one returned Sample set as a Project Record Sample.

- E. Product Schedule or List: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location.
  - 1. Number of Copies: Submit copies of product schedule or list in a quantity to meet Contractor's requirements, considering that the Design Professional will retain three copies.
- F. Applications for Payment: Comply with requirements specified in Division 01 Section "Payment Procedures."
- G. Schedule of Values: Comply with requirements specified in Division 01 Section "Payment Procedures."
- I. List of Subcontractors and Suppliers, including Local and/or MWBE participants: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include company names, addresses, contacts, phone numbers, fax numbers, and email addresses.
  - 1. Number of Copies: Submit no fewer than four copies of list, unless otherwise indicated.
  - 2. Local and/or MWBE Monthly Report: Submit with Monthly Payment Application on Forms specified in the original solicitation documents.

## 2.2 INFORMATIONAL SUBMITTALS

- A. General: Prepare and submit Informational Submittals required by other Specification Sections.
  - 1. Number of Copies: Submit three copies of each submittal, unless otherwise indicated. Design Professional will not return copies.
  - 2. Certificates and Certifications: Provide a notarized statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
  - 3. Test and Inspection Reports: Comply with requirements specified in Division 01 Section "Quality Requirements." Instruct all testing and reporting agents to forward copies of all documents directly to the Design Professional.
- B. Coordination Drawings: Comply with requirements specified in Division 01 Section "Project Management and Coordination."
- C. Contractor's Construction Schedule: Comply with requirements specified in Division 01 Section "Construction Progress Documentation."
- D. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, names and addresses of Design Professionals and owners, and other information specified.
- E. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification (WPS) and Procedure Qualification Record (PQR) on AWS forms. Include names of firms and personnel certified.
- F. Installer Certificates: Prepare written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.

- G. **Manufacturer Certificates:** Prepare written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
- H. **Product Certificates:** Prepare written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
- I. **Material Certificates:** Prepare written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
- J. **Material Test Reports:** Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
- K. **Product Test Reports:** Prepare written reports indicating current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
- L. **Research/Evaluation Reports:** Prepare written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project.
- M. **Preconstruction Test Reports:** Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
- N. **Compatibility Test Reports:** Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.
- O. **Field Test Reports:** Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
- P. **Maintenance Data:** Prepare written and graphic instructions and procedures for operation and normal maintenance of products and equipment. Comply with requirements specified in Division 01 Section "Operation and Maintenance Data."
- Q. **Design Data:** Prepare written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.
- R. **Manufacturer's Instructions:** Prepare written or published information that documents manufacturer's recommendations, guidelines, and procedures for installing or operating a product or equipment. Include name of product and name, address, and telephone number of manufacturer.



- S. **Manufacturer's Field Reports:** Prepare written information documenting factory-authorized service representative's tests and inspections. Include the following, as applicable:
  - 1. Statement on condition of substrates and their acceptability for installation of product.
  - 2. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
  - 3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
- T. **Insurance Certificates and Bonds:** Prepare written information indicating current status of insurance or bonding coverage. Include name of entity covered by insurance or bond, limits of coverage, amounts of deductibles, if any, and term of the coverage.
- U. **Construction Photographs:** Comply with requirements specified in Division 01 Section "Photographic Documentation."
- V. **Material Safety Data Sheets (MSDSs):** Submit information directly to Owner; do not submit to Design Professional.
  - 1. Design Professional will not review submittals that include MSDSs and will return them for re-submittal.

### 2.3 DELEGATED DESIGN

- A. **Performance and Design Criteria:** Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
  - 1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Design Professional.
- B. **Delegated-Design Submittal:** In addition to Shop Drawings, Product Data, and other required submittals, submit copies of a statement, in a count no fewer than that of the shop drawing or other type submittal to which it is in relation, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.
  - 1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

## PART 3 - EXECUTION

### 3.1 CONTRACTOR'S REVIEW

All submittals shall be reviewed and approved by the Contractor prior to submittal to the Design professional. Submittals that are not fully and properly reviewed by the Contractor will be returned with no action, and a re-submittal will be required, and attributable delays will not be considered as cause for an extension in Contract Time. Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions.

### 3.2 DESIGN PROFESSIONAL'S ACTION

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- A. General: Design Professional will not review submittals that do not bear Contractor's approval stamp and will return them without action.
- B. Action Submittals: Design Professional will review each submittal, make marks to indicate corrections or modifications required, and return it. Design Professional will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action taken.
- C. Informational Submittals: Design Professional will review each submittal and will not return it, or will return it if it does not comply with requirements.
- D. Partial submittals are not acceptable, will be considered non-compliant, and will be returned without review.
  - 1. Should the Contractor proceed with the Work without the required full review of complete submittals, he does so at his sole risk. In any event and at any time it is determined that a missing portion of a submittal is needed in order to ensure compliance with the Contract Documents; the Contractor shall immediately submit the missing portion. No increase in the Contract Amount or the Contract Time will be allowed, nor will any variations from the requirements of the Contract Documents be allowed as a result of the failure on the part of the Contractor to provide complete submittals, or as a result of the failure of the Design Professional to garner complete submittals from the Contractor.
- E. Submittals not required by the Contract Documents may not be reviewed and may be discarded.
- F. In no case shall any review action or comments on the part of the Design Professional or his Consultants be construed to authorize compensable extra Work or an increase in Contract Amount or Contract Time.

END OF SECTION 01 33 00

SECTION 01 50 00 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes requirements for temporary utilities, support facilities, and security and protection facilities.
- A. See Division 01 Section "Execution" for progress cleaning requirements.
- B. See Divisions 02 through 33 Sections for temporary heat, ventilation, and humidity requirements for products in those Sections.
- C. Failure on the part of the Contractor to establish and maintain all required on-site communication and clerical provisions may be cited as cause to return Applications for Payment without action.

1.2 DEFINITIONS

- A. Permanent Enclosure: As determined by Design Professional, permanent or temporary roofing is complete, insulated, and weather-tight; exterior walls are insulated and weather-tight; and all openings are closed with permanent construction or substantial temporary closures.

1.3 USE CHARGES

- A. General: Cost or use charges for temporary facilities shall be included in the Contract Sum. Allow other entities to use temporary services and facilities without cost, including, but not limited to, Owner's construction forces, Design Professional, testing agencies, and authorities having jurisdiction.

1.4 SUBMITTALS

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

1.5 QUALITY ASSURANCE

- A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.
- B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

1.6 PROJECT CONDITIONS

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

**PART 2 - PRODUCTS**

**2.1 MATERIALS**

- A. Pavement: Comply with Division 02 pavement Sections.
- B. Chain-Link Fencing: Minimum 2-inch, 0.148-inch thick, galvanized steel, chain-link fabric fencing; minimum 6 feet high with galvanized steel pipe posts; minimum 2-3/8-inch OD line posts and 2-7/8-inch OD corner and pull posts, with 1-5/8-inch OD top rails and galvanized barbed-wire top strand.
- C. Portable Chain-Link Fencing: Minimum 2-inch, 9-gage, galvanized steel, chain-link fabric fencing; minimum 6 feet high with galvanized steel pipe posts; minimum 2-3/8-inch OD line posts and 2-7/8-inch OD corner and pull posts, with 1-5/8-inch OD top and bottom rails. Provide concrete or galvanized steel bases for supporting posts.
- D. Lumber and Plywood: Comply with requirements in Division 06 Section "Rough Carpentry."
- E. Gypsum Board: Minimum 1/2 inch thick by 48 inches wide by maximum available lengths; regular-type panels with tapered edges. Comply with ASTM C 36/C 36M.
- F. Insulation: Unfaced mineral-fiber blanket, manufactured from glass, slag wool, or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.
- G. Provide and maintain during the Construction period one (1) project sign as specified by the Owner. The maintenance and upkeep of the sign shall be the responsibility of the Contractor.

**2.2 TEMPORARY FACILITIES**

- A. Field Offices, General: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading. Provide unit(s) of adequate size to serve needs of project, including jobsite progress meetings.
- B. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.

**2.3 EQUIPMENT**

- A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.
- B. HVAC Equipment: Unless Owner authorizes use of permanent HVAC system; provide climate control units with individual space thermostatic control.
  - 1. Heating Units: Listed and labeled for type of fuel being consumed, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
  - 2. Permanent HVAC System: If Owner authorizes use of permanent HVAC system for temporary use during construction, provide filter with MERV of 8 at each return air grille in system and remove at end of construction.

**PART 3 – EXECUTION**

3.1 INSTALLATION, GENERAL

- A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work, and to limit site disturbance as required to attain LEED-NC Credit SS 5.1, and as specified in Division 01 Section "Summary." Relocate and modify facilities as required by progress of the Work.
- B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.2 TEMPORARY UTILITY INSTALLATION

- A. General: Install temporary service or connect to existing service.
  - 1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.
- B. Sewers and Drainage: Provide temporary utilities to remove effluent lawfully.
  - 1. Connect temporary sewers to municipal system as directed by authorities having jurisdiction.
- C. Water Service: Install water service and distribution piping in sizes and pressures adequate for construction.
- D. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.
- E. Heating and Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.
- F. Ventilation and Humidity Control: Provide temporary ventilation required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce ambient condition required and minimize energy consumption.
- G. Electric Power Service: Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations.
  - 1. Install electric power service overhead, or underground, as conditions required.
- H. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.
  - 1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.
- I. Telephone Service: Provide temporary telephone service in common-use facilities for use by all construction personnel. Install one telephone line(s) for each field office.

1. At each telephone, post a list of important telephone numbers including police and fire departments, Contractor's home office, Design Professional's office, principal subcontractors' field and home offices.
  3. Provide superintendent with cellular telephone for use when away from field office.
- J. Electronic Equipment: In field office, provide and maintain a computer with on-line capability and electronic mail. Provide and maintain also a printer which can be used to print communications and bulletin drawings.

### 3.3 SUPPORT FACILITIES INSTALLATION

- A. General: Comply with the following:
1. Provide noncombustible construction for offices, shops, and sheds located within construction area or within 30 feet of building lines. Comply with NFPA 241.
  2. Maintain support facilities until near Material Completion. Remove before Material Completion. Personnel remaining after Material Completion will be permitted to use permanent facilities, under conditions acceptable to Owner.
- B. Temporary Roads and Paved Areas: Construct and maintain temporary roads and paved areas adequate for construction operations. Locate temporary roads and paved areas within construction limits indicated on Drawings.
1. Provide dust-control treatment that is nonpolluting and non-tracking. Reapply treatment as required to minimize dust.
- C. Traffic Controls: Comply with requirements of authorities having jurisdiction.
1. Protect existing site improvements to remain including curbs, pavement, and utilities.
  2. Maintain access for fire-fighting equipment and access to fire hydrants.
- D. Parking: Provide temporary parking areas for construction personnel.
- E. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.
1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties nor endanger permanent Work or temporary facilities.
  2. Remove snow and ice as required to minimize accumulations.
- F. Project Identification and Temporary Signs: Provide Project identification and other signs as a part of Allowance No. Four. Install signs where indicated to inform public and individuals seeking entrance to Project. Unauthorized signs are not permitted.
1. Provide temporary, directional signs for construction personnel and visitors.
  2. Maintain and touchup signs so they are legible at all times.
- G. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction. Comply with Division 01 Section "Execution" for progress cleaning requirements.
- H. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.
1. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.

- I. Temporary Elevator Use: Refer to Division 14 Sections for temporary use of new elevators.
- J. Temporary Stairs: Until permanent stairs are available, provide temporary stairs where ladders are not adequate.
- K. Temporary Use of Permanent Stairs: Cover finished permanent stairs with protective covering of plywood or similar material so finishes will be undamaged at time of acceptance.

#### 3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction in ways and by methods that comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.
- B. Temporary Erosion and Sedimentation Control: Provide measures to prevent soil erosion and discharge of soil-bearing water runoff and airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction.
- C. Storm water Control: Comply with authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of storm water from heavy rains.
- D. Tree and Plant Protection: Install temporary fencing located as indicated or outside the drip line of trees to protect vegetation from damage from construction operations. Protect tree root systems from damage, flooding, and erosion.
- E. Pest Control: Engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals so Project will be free of pests and their residues at Material Completion. Obtain extended warranty for Owner. Perform control operations lawfully, using environmentally safe materials.
- F. Site Enclosure Fence: Before construction operations begin, furnish and install site enclosure fence in a manner that will prevent people and animals from easily entering site except by entrance gates.
  - 1. Extent of Fence: As required to enclose entire Project site or portion determined sufficient to accommodate construction operations.
  - 2. Maintain security by limiting number of keys and restricting distribution to authorized personnel. Provide Owner and Design Professional with one set of keys.
- G. Security Enclosure and Lockup: Install substantial temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security.
- H. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.
- I. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weather tight enclosure for building exterior.

1. Where heating or cooling is needed and permanent enclosure is not complete, insulate temporary enclosures.
- K. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241.
1. Prohibit smoking and use of all tobacco products on SCCPSS property
  2. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of authorities having jurisdiction.
  3. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.
  4. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign stating that hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

### 3.5 OPERATION, TERMINATION, AND REMOVAL

- A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.
- B. Maintenance: Maintain facilities in good operating condition until removal.
1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.
- C. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Material Completion.
- D. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Material Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
1. Materials and facilities that constitute temporary facilities are property of Contractor. Owner reserves the right to take possession of Project identification signs.
  2. At Material Completion, clean and renovate permanent facilities used during construction period. Comply with final cleaning requirements specified in Division 01 Section "Closeout Procedures."

END OF SECTION 01 50 00



SECTION 01 60 00 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; product substitutions; and comparable products.
- B. See Division 01 Section "Closeout Procedures" for submitting warranties for Contract closeout.
- C. See Divisions 02 through 33 Sections for specific requirements for warranties on products and installations specified to be warranted.

1.2 DEFINITIONS

- A. Products: Items purchased for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
  - 1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.
  - 2. New Products: Items that have not previously been incorporated into another project or facility, except that products consisting of recycled-content materials are allowed, unless explicitly stated otherwise. Products salvaged or recycled from other projects are not considered new products.
  - 3. Comparable Product: Product that is demonstrated and approved through submittal process, or where indicated as a product substitution, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor. It may be in certain instances, but is not necessarily the intent of product Specifications to limit the use of product manufacturers and model numbers to those listed by name. As a minimum, all requirements of the Specifications must be met, including but not limited to in regard to appearance, function, quality, durability, and source reliability. Actions and approvals regarding products and product substitutions will occur in a manner that suits and is in the best interest of the Owner.
- C. Basis-of-Design Product Specification: Where a specific manufacturer's product is named and accompanied by the words "basis of design," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of other named manufacturers.

1.3 SUBMITTALS

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

1. Substitution Request Form: Use CSI Form 13.1A.
  2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
    - a. Statement indicating why specified material or product cannot be provided, or an explanation why Contractor wishes to provide an alternate material or product.
    - b. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.
    - c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
    - d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
    - e. Samples, where applicable or requested.
    - f. List of similar installations for completed projects with project names and addresses and names and addresses of Design Professionals and owners.
    - g. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
    - h. Research/evaluation reports evidencing compliance with building code in effect for Project, from a model code organization acceptable to authorities having jurisdiction.
    - i. Detailed comparison of Contractor's Construction Schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating lack of availability or delays in delivery.
    - j. Cost information, including a proposal of change, if any, in the Contract Sum.
    - k. Contractor's certification that proposed substitution complies with requirements in the Contract Documents and is appropriate for applications indicated.
    - l. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results, or because of adverse unforeseen conditions or expenses resulting from the substitution.
  3. Design Professional's Action: If necessary, Design Professional will request additional information or documentation for evaluation within 7 days of receipt of a request for substitution. Design Professional will notify Contractor of acceptance or rejection of proposed substitution within 15 days of receipt of request, or 7 days of receipt of additional information or documentation, whichever is later.
    - a. Form of Acceptance: Change Order.
    - b. Use product specified if Design Professional cannot make a decision on use of a proposed substitution within time allocated.
- B. Comparable Product Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
1. Design Professional's Action: If necessary, Design Professional will request additional information or documentation for evaluation within one week of receipt of a comparable product request. Design Professional will notify Contractor of approval or rejection of proposed comparable product request within 15 days of receipt of request, or 7 days of receipt of additional information or documentation, whichever is later.

- a. Form of Approval: As specified in Division 01 Section "Submittal Procedures."
  - b. Use product specified if Design Professional cannot make a decision on use of a comparable product request within time allocated.
- C. Basis-of-Design Product Specification Submittal: Comply with requirements in Division 01 Section "Submittal Procedures." Show compliance with requirements.
- 1.4 QUALITY ASSURANCE
- A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project; product selected shall be compatible with products previously selected, even if previously selected products were also options.
- 1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING
- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft. Comply with manufacturer's written instructions.
- B. Delivery and Handling:
- 1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
  - 2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
  - 3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
  - 4. Inspect products on delivery to ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected.
- C. Storage:
- 1. Store products to allow for inspection and measurement of quantity or counting of units.
  - 2. Store materials in a manner that will not endanger Project structure.
  - 3. Store products that are subject to damage by the elements, under cover in a weather tight enclosure above ground, with ventilation adequate to prevent condensation.
  - 4. Store cementations products and materials on elevated platforms.
  - 5. Store foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
  - 6. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
  - 7. Protect stored products from damage and liquids from freezing.
- 1.6 PRODUCT WARRANTIES
- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
- 1. Manufacturer's Warranty: Preprinted written warranty published by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
  - 2. Special Warranty: Written warranty required by or incorporated into the Contract

Documents, either to extend time limit provided by manufacturer's warranty or to provide more rights for Owner.

- B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution. Submit a draft for approval before final execution.
  - 1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
  - 2. Specified Form: When specified forms are included with the Specifications, prepare a written document using appropriate form properly executed.
  - 3. Refer to Divisions 2 through 16 Sections for specific content requirements and particular requirements for submitting special warranties.
- C. All warranties that are normally available from manufacturers, vendors, Subcontractors, etc. shall be provided to the Owner, even if these warranties are not specifically called for in the Contract Documents.
- D. Submittal Time: Comply with requirements in Division 01 Section "Closeout Procedures."

## PART 2 - PRODUCTS

### 2.1 PRODUCT SELECTION PROCEDURES

- A. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged and, unless otherwise indicated, that are new at time of installation.
  - 1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
  - 2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
  - 3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
  - 4. Where products are accompanied by the term "as selected," Design Professional will make selection.
  - 5. Where products are accompanied by the term "match sample," sample to be matched is Design Professional's.
  - 6. Descriptive, performance, and reference standard requirements in the Specifications establish "salient characteristics" of products.
- B. Product Selection Procedures:
  - 1. Product: Where Specifications name a single product and manufacturer, provide the named product that complies with requirements.
  - 2. Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements.
  - 3. Available Products: Where Specifications include a list of names of both products and manufacturers, provide one of the products listed, or an unnamed product, that complies with requirements, as determined by the Design Professional. Comply with provisions in Part 2 "Comparable Products" Article for consideration of an unnamed product.
  - 4. Available Manufacturers: Where Specifications include a list of manufacturers, provide a product by one of the manufacturers listed, or an unnamed manufacturer, that complies with requirements, as determined by the Design Professional. Comply with provisions in Part 2 "Comparable Products" Article for consideration of an unnamed product.
  - 5. Product Options: Where Specifications indicate that sizes, profiles, and dimensional

- requirements on Drawings are based on a specific product or system, provide the specified product or system. Comply with provisions in Part 2 "Product Substitutions" Article for consideration of an unnamed product or system.
6. Basis-of-Design Product: Where Specifications name a product and include a list of manufacturers, provide the specified product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with provisions in Part 2 "Comparable Products" Article for consideration of an unnamed product by the other named manufacturers.
  7. Visual Matching Specification: Where Specifications require matching an established Sample, select a product that complies with requirements and matches Design Professional's sample. Design Professional's decision will be final on whether a proposed product matches.
    - a. If no product available within specified category matches and complies with other specified requirements, comply with provisions in Part 2 "Product Substitutions" Article for proposal of product.
  8. Visual Selection Specification: Where Specifications include the phrase "as selected from manufacturer's colors, patterns, and textures" or a similar phrase, select a product that complies with other specified requirements.
    - a. Standard Range: Where Specifications include the phrase "standard range of colors, patterns, textures" or similar phrase, Design Professional will select color, pattern, density, or texture from manufacturer's product line that does not include premium items.
    - b. Full Range: Where Specifications include the phrase "full range of colors, patterns, textures" or similar phrase, Design Professional will select color, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

## 2.2 PRODUCT SUBSTITUTIONS

- A. Timing: Design Professional will consider requests for substitution if received within 5 days after the Proceed Order. Requests received after that time may be considered or rejected at the discretion of the Design Professional.
- B. Conditions: Design Professional will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Design Professional will return requests without action, except to record noncompliance with these requirements:
  1. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Design Professional for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
  2. Requested substitution does not require extensive revisions to the Contract Documents.
  3. Requested substitution is consistent with the Contract Documents and will produce indicated results.
  4. Substitution request is fully documented and properly submitted.
  5. Requested substitution will not adversely affect Contractor's Construction Schedule.
  6. Requested substitution has received necessary approvals of authorities having jurisdiction.
  7. Requested substitution is compatible with other portions of the Work.

8. Requested substitution has been coordinated with other portions of the Work.
  9. Requested substitution provides specified warranty.
- C. Should, subsequent to the approval or implementation of a substitution, there occur a discovery of an unforeseen circumstance or condition that is attributable to the substitution, the Contractor shall be responsible to bear any additional costs or to return to the Owner any cost savings resulting from the discovery.

### 2.3 COMPARABLE PRODUCTS

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

### PART 3 - EXECUTION (Not Used)

END OF SECTION 01 60 00

SECTION 01 73 00 - EXECUTION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes general procedural requirements governing execution of the Work including, but not limited to, the following:
  - 1. Construction layout.
  - 2. Field engineering and surveying.
  - 3. General installation of products.
  - 4. Progress cleaning.
  - 5. Starting and adjusting.
  - 6. Protection of installed construction.
  - 7. Correction of the Work.
- B. See Division 01 Section "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, and final cleaning.

1.2 SUBMITTALS

- A. Certificates: Submit certificate signed by land surveyor certifying that location and elevation of improvements comply with requirements.
- B. Landfill Receipts: Submit copy of receipts issued by a landfill facility, licensed to accept hazardous materials, for hazardous waste disposal, if any.

1.3 QUALITY ASSURANCE

- A. Land Surveyor Qualifications: A professional land surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing land-surveying services of the kind indicated.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Existing Conditions: The existence and location of site improvements, utilities, and other construction indicated as existing are not guaranteed. Before beginning work, investigate and verify the existence and location of mechanical and electrical systems and other construction affecting the Work.
  - 1. Before construction, verify the location and points of connection of utility services.
- B. Existing Utilities: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities and other construction affecting the Work.
  - 1. Before construction, verify the location and invert elevation at points of connection of

- sanitary sewer, storm sewer, and water-service piping; and underground electrical services.
- 2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.
- C. Acceptance of Conditions: Examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
  - 1. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
  - 2. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
  - 3. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
  - 4. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

### 3.2 PREPARATION

- A. Existing Utility Information: Furnish information to local utility that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents, submit a request for information to Design Professional. Include a detailed description of problem encountered, together with recommendations for changing the Contract Documents.

### 3.3 CONSTRUCTION LAYOUT

- A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify Design Professional promptly.
- B. General: Engage a land surveyor to lay out the Work using accepted surveying practices.
  - 1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
  - 2. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
  - 3. Inform installers of lines and levels to which they must comply.
  - 4. Check the location, level and plumb, of every major element as the Work progresses.
  - 5. Notify Design Professional when deviations from required lines and levels exceed



- allowable tolerances.
- 6. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.
- C. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and invert elevations.
- D. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.
- E. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Design Professional.

### 3.4 FIELD ENGINEERING

- A. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.
- B. Benchmarks: Establish and maintain a minimum of four permanent benchmarks on Project site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.
  - 1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.
- C. Certified Survey: On completion of foundation walls, major site improvements, and other work requiring field-engineering services, prepare a certified survey showing dimensions, locations, angles, and elevations of construction and sitework.
- D. Final Property Survey: Prepare a final property survey showing significant features (real property) for Project. Include on the survey a certification, signed by land surveyor, that principal metes, bounds, lines, and levels of Project are accurately positioned as shown on the survey.
  - 1. Recording: At Material Completion, have the final property survey recorded by or with authorities having jurisdiction as the official "property survey."

### 3.5 INSTALLATION

- A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
  - 1. Make vertical work plumb and make horizontal work level.
  - 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
  - 3. Conceal pipes, ducts, and wiring in finished areas, unless otherwise indicated.
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.

- C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Material Completion.
- D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
- E. Tools and Equipment: Do not use tools or equipment that produces harmful noise levels.
- F. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.
- G. Anchors and Fasteners: Provide anchors and fasteners as required to anchor each component securely in place, accurately located and aligned with other portions of the Work.
  - 1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Design Professional.
  - 2. Allow for building movement, including thermal expansion and contraction.
  - 3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- H. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.
- I. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

### 3.6 PROGRESS CLEANING

- A. General: Clean Project site and work areas daily, including common areas. Coordinate progress cleaning for joint-use areas where more than one installer has worked. Enforce requirements strictly. Dispose of materials lawfully.
  - 1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
  - 2. Do not hold materials more than 7 days during normal weather or 3 days if the temperature is expected to rise above 80 deg F.
  - 3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
- B. Site: Maintain Project site free of waste materials and debris.
- C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.
  - 1. Remove liquid spills promptly.
  - 2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
- D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials

specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.

- E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.
- F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Material Completion.
- G. Waste Disposal: Burying or burning waste materials on-site will not be permitted. Washing waste materials down sewers or into waterways will not be permitted.
- H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Material Completion.
- I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
- J. Limiting Exposures: Supervise construction operations to assure that no part of the construction completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

### 3.7 STARTING AND ADJUSTING

- A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- B. Adjust operating components for proper operation without binding. Adjust equipment for proper operation.
- C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Manufacturer's Field Service: If a factory-authorized service representative is required to inspect field-assembled components and equipment installation, comply with qualification requirements in Division 01 Section "Quality Requirements."

### 3.8 PROTECTION OF INSTALLED CONSTRUCTION

- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Material Completion.
- B. Comply with manufacturer's written instructions for temperature and relative humidity.

### 3.9 CORRECTION OF THE WORK

- A. Repair or remove and replace defective construction. Restore damaged substrates and finishes. Comply with requirements in Division 01 Section "Cutting and Patching."
  - 1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.

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- B. Restore permanent facilities used during construction to their specified condition.
- C. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.
- D. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.
- E. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

END OF SECTION 01 73 00

SECTION 01 77 00 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
  - 1. Inspection procedures.
  - 2. Warranties.
  - 3. Final cleaning.
- B. See Division 01 Section "Payment Procedures" for requirements for Applications for Payment for Material and Final Completion.
- C. See Division 01 Section "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
- D. See Division 01 Section "Operation and Maintenance Data" for operation and maintenance manual requirements.
- E. See Divisions 02 through 33 Sections, including but not limited to Section 15 01 60, "Mechanical Work Closeout," for specific closeout and special cleaning requirements for the Work in those Sections.

1.2 MATERIAL COMPLETION

- A. Preliminary Procedures: Before requesting inspection for determining date of Material Completion, complete the following. List items below that are incomplete in request.
  - 1. Prepare a list of items to be completed and corrected (punch list), the value of items on the list, and reasons why the Work is not complete.
  - 2. Advise Owner of pending insurance changeover requirements.
  - 3. Submit specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
  - 4. Obtain and submit releases permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
  - 5. Prepare and submit Project Record Documents, operation and maintenance manuals, Final Completion construction photographs, damage or settlement surveys, property surveys, and similar final record information.
  - 6. Deliver tools, spare parts, extra materials, and similar items to location designated by Owner. Label with manufacturer's name and model number where applicable.
  - 7. Make final changeover of permanent locks and deliver keys to Owner. Transmit keys with a detailed accounting of the keys transmitted, and garner the receipt signature of an authorized representative of the Owner. Advise Owner's personnel of changeover in security provisions.
  - 8. Complete startup testing of systems.
  - 9. Submit test/adjust/balance records.
  - 10. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
  - 11. Advise Owner of changeover in heat and other utilities.
  - 12. Submit changeover information related to Owner's occupancy, use, operation, and

- maintenance.
13. Complete final cleaning requirements, including touchup painting.
  14. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.
- B. Inspection: Submit a written request for inspection for Material Completion. On receipt of this written request, Design Professional will either proceed with inspection or notify Contractor of unfulfilled requirements. Design Professional will prepare the Certificate of Material Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Design Professional, that must be completed or corrected before certificate will be issued.
1. Re-inspection: Request re-inspection when the Work identified in previous inspections as incomplete is completed or corrected.
  2. Results of completed inspection will form the basis of requirements for Final Completion.

### 1.3 FINAL COMPLETION

- A. Preliminary Procedures: Before requesting final inspection for determining date of Final Completion, complete the following:
1. Submit a final Application for Payment according to Division 01 Section "Payment Procedures."
  2. Submit certified copy of Design Professional's Material Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Design Professional. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
  3. Submit evidence of final, continuing insurance coverage complying with insurance requirements.
  4. Submit pest-control final inspection report and warranty.
  5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training DVDs.
- B. Inspection: Submit a written request for final inspection for acceptance. On receipt of this written request, Design Professional will either proceed with inspection or notify Contractor of unfulfilled requirements. Design Professional will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.
1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

### 1.4 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

- A. Preparation: Submit three copies of list. Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction. Use CSI Form 14.1A.
1. Organize list of spaces in sequential order, starting with the site, then the building exterior then proceeding to the building interior, from lowest floor to highest floor.
  2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.

1.5 WARRANTIES

- A. Submittal Time: Submit written warranties on request of Design Professional for designated portions of the Work where commencement of warranties other than date of Material Completion is indicated.
- B. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.
  - 1. Bind warranties and bonds in heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.
  - 2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
  - 3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.
  - 4. Provide all warranties available from product and system manufacturers, regardless of whether each warranty is specifically called for in these Specifications.
- B. Provide additional copies of each warranty to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 MATERIALS

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

PART 3 - EXECUTION

3.1 FINAL CLEANING

- A. General: Provide final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.
- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
  - 1. Complete the following cleaning operations before requesting inspection for certification of Material Completion for entire Project or for a portion of Project:
    - a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
    - b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
    - c. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.

- d. Remove tools, construction equipment, machinery, and surplus material from Project site.
  - e. Remove snow and ice to provide safe access to building.
  - f. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
  - g. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
  - h. Sweep concrete floors broom clean in unoccupied spaces.
  - i. Vacuum carpet and similar soft surfaces, removing debris and excess nap; shampoo if visible soil or stains remain.
  - j. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.
  - k. Remove labels that are not permanent.
  - l. Touch up and otherwise repair and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration.
    - 1) Do not paint over "UL" and similar labels, including mechanical and electrical nameplates.
  - m. Wipe surfaces of mechanical and electrical equipment, elevator equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
  - n. Replace parts subject to unusual operating conditions.
  - o. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
  - p. Replace disposable air filters and clean permanent air filters and clean exposed surfaces of diffusers, registers, and grills.
  - q. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs, and those noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.
  - r. Leave Project clean and ready for occupancy.
- C. Pest Control: Engage an experienced, licensed exterminator to make a final inspection and rid Project of rodents, insects, and other pests. Prepare a report.
- D. Comply with safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on Owner's property. Do not discharge volatile, harmful, or dangerous materials into drainage systems. Remove waste materials from Project site and dispose of lawfully.

END OF SECTION 01 77 00



SECTION 01 78 23 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following per Article 6.4.1; Final Documents, of the Contract.
  - 1. Emergency procedure manuals.
  - 2. Operation manuals for systems, subsystems, and equipment.
  - 3. Maintenance manuals for the care and maintenance of products, materials, and finishes systems and equipment.
- B. See Divisions 02 through 33 Sections for specific operation and maintenance manual requirements for the Work in those Sections.

1.2 SUBMITTALS

- A. Manual: Submit one copy of each manual in final form at least 15 days before final inspection. Design Professional will return copy with comments within 15 days after final inspection.
  - 1. Correct or modify each manual to comply with Design Professional's comments. Submit 3 copies of each corrected manual within 15 days of receipt of Design Professional's comments.

PART 2 - PRODUCTS

2.1 MANUALS, GENERAL

- A. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain a title page, table of contents, and manual contents.
- B. Title Page: Enclose title page in transparent plastic sleeve. Include the following information:
  - 1. Subject matter included in manual.
  - 2. Name and address of Project.
  - 3. Name and address of Owner.
  - 4. Date of submittal.
  - 5. Name, address, and telephone number of Contractor.
  - 6. Name and address of Design Professional.
  - 7. Cross-reference to related systems in other operation and maintenance manuals.
- C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
- D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
  - 1. Binders: Heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.

- a. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents. Indicate volume number for multiple-volume sets.
2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software diskettes for computerized electronic equipment.
4. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
  - a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
  - b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

## 2.2 EMERGENCY PROCEDURE MANUALS

- A. Content: Organize manual into a separate section for type of emergency, emergency instructions, and emergency procedures.
- B. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component for fire, flood, gas leak, water leak, power failure, water outage, equipment failure, and chemical release or spill.
- C. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.
- D. Emergency Procedures: Include instructions on stopping, shutdown instructions for each type of emergency, operating instructions for conditions outside normal operating limits, and required sequences for electric or electronic systems.

## 2.3 OPERATION MANUALS

- A. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and equipment descriptions, operating standards, operating procedures, operating logs, wiring and control diagrams, and license requirements.
- B. Descriptions: Include the following:
  1. Product name and model number.
  2. Manufacturer's name.
  3. Equipment identification with serial number of each component.
  4. Equipment function.
  5. Operating characteristics.
  6. Limiting conditions.
  7. Performance curves.
  8. Engineering data and tests.
  9. Complete nomenclature and number of replacement parts.

shutdown instructions; routine, normal, seasonal, and weekend operating instructions; and required sequences for electric or electronic systems.

- D. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.
- E. Piped Systems: Diagram piping as installed, and identify color-coding where required for identification.

## 2.4 PRODUCT MAINTENANCE MANUAL

- A. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.
- B. Source Information: List each product included in manual identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.
- C. Product Information: Include the following, as applicable:
  - 1. Product name and model number.
  - 2. Manufacturer's name.
  - 3. Color, pattern, and texture.
  - 4. Material and chemical composition.
  - 5. Reordering information for specially manufactured products.
- D. Maintenance Procedures: Include manufacturer's written recommendations and inspection procedures, types of cleaning agents, methods of cleaning, schedule for cleaning and maintenance, and repair instructions.
- E. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.
- F. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

## 2.5 SYSTEMS AND EQUIPMENT MAINTENANCE MANUAL

- A. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.
- B. Source Information: List each system, subsystem, and piece of equipment included in manual identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.
- C. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including maintenance instructions, drawings and diagrams for maintenance, nomenclature of parts and components, and recommended spare parts for each component part or piece of equipment:

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

### PART 3 - EXECUTION

#### 3.1 MANUAL PREPARATION

- A. Emergency Procedure Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.
- B. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.
- C. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.
- D. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
- E. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in Record Drawings to ensure correct illustration of completed installation.
  - 1. Do not use original Project Record Documents as part of operation and maintenance manuals.
- F. Comply with Division 01 Section "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

END OF SECTION 01 78 23

SECTION 01 78 39 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for Project Record Documents, including the following:
  - 1. Record Drawings.
  - 2. Record Specifications.
  - 3. Record Product Data.
  - 4. Miscellaneous Submittals
  - 4. Record Documents
- B. See Division 01 Section "Operation and Maintenance Data" for operation and maintenance manual requirements.
- C. See Divisions 02 through 32 Sections for specific requirements for Project Record Documents of the Work in those Sections.

1.2 SUBMITTALS

- A. Record Drawings: Comply with the following:
    - 1. Submit one set of full size marked-up Record Prints
    - 2. Submit one set half size prints size marked-up Record Prints.
  - B. Record Specifications: Comply with the following:
    - 1. Submit one copy of Project's Specifications, including addenda and contract modifications.
  - C. Record Product Data: Comply with the following:
    - 1. Submit one copy of each Product Data submittal.
  - D. Electronic Copies: Using the Record Drawings and Specifications provided by the Construction Professional, the Design Professional shall provide the following
    - 1. Record Drawings: Submit two copies of electronic media (disk, memory card, etc.) in "PDF" format and "DWG/CAD" format. (Submitted from design professional to SCCPSS)
      - a. Electronic File Naming to be as follows:
        - i. School letters code-Sheet number.PDF
          - 1. Example for Beach High School – Sheet A1.0:"BHS-A1.0.PDF"
    - 2. Specifications: Submit two copies of electronic media (disk, memory card, etc.) in "PDF" format and "DOC" format. (submitted from design professional to SCCPSS)
      - a. Electronic File Naming to be as follows:
        - i. School letters code-Specification number-Section Title.PDF
          - 1. Example for Beach High School – Spec. Section 04 23 13 – Brick Masonry:"BHS-04 23 13-Brick Masonry.PDF"
- E. Miscellaneous Submittals
  - 1. Submit one hard copy of any pertinent documents and one electronic copy in PDF Format

- F. Municipality Close Out Documents
  - 1. Submit as a record of submittal one hard copy of any documents required by authority having jurisdiction and one electronic copy in PDF Format.
    - a. Submit CAD file in DWG format if produced as part of this contract.

## PART 2 - PRODUCTS

### 2.1 RECORD DRAWINGS

- A. Record Prints: Maintain one set of blue- or black-line white prints of the Contract Drawings and Shop Drawings.
  - 1. Preparation: Mark Record Prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to prepare the marked-up Record Prints.
    - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
    - b. Record data as soon as possible after obtaining it. Record and check the markup before enclosing concealed installations.
  - 2. Mark the Contract Drawings or Shop Drawings, whichever is most capable of showing actual physical conditions, completely and accurately. If Shop Drawings are marked, show cross-reference on the Contract Drawings.
  - 3. Mark record sets with erasable, red-colored pencil/or PDF mark-up. Use other colors to distinguish between changes for different categories of the Work at same location.
  - 4. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
- B. Record CAD Drawings: Immediately before inspection for Certificate of Material Completion, review marked-up Record Prints with Design Professional, to assist the Design Professional in preparing a full set of corrected CAD Drawings of the Contract Drawings, as follows:
  - 1. Format: "DWG" format Autocad version 2000 or greater.
  - 2. Incorporate changes and additional information previously marked on Record Prints. Delete, redraw, and add details and notations where applicable.
  - 3. Resolve any instances of uncertainty with Design Professional.
- C. Format: Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
  - 1. Record Prints: Organize Record Prints and newly prepared Record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
  - 2. Identification: As follows:
    - a. Project name.
    - b. Date.
    - c. Designation "PROJECT RECORD DRAWINGS."
    - d. Name of Design Professional.
    - e. Name of Contractor.

### 2.2 RECORD SPECIFICATIONS

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

## 2.3 RECORD PRODUCT DATA

- A. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.
  - 1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
  - 2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
  - 3. Note related Change Orders, Record Specifications, and Record Drawings where applicable.

## 2.4 MISCELLANEOUS RECORD SUBMITTALS

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

## 1.5 MUNICIPALITY RECORD SUBMITTALS

- A. Assemble all paper documents submitted to the authority having jurisdiction. Bind or file these records with and identifying each for continued use and reference.

## PART 3 - EXECUTION

### 3.1 RECORDING AND MAINTENANCE

- A. Recording: Maintain one copy of each submittal during the construction period for Project Record Document purposes. Post changes and modifications to Project Record Documents as they occur; do not wait until the end of Project. Project Record Documents will be reviewed periodically during the course of the project, as a part of the payment authorization procedure.
- B. Maintenance of Record Documents and Samples: Store Record Documents and Samples in the field office apart from the Contract Documents used for construction. Do not use Project Record Documents for construction purposes. Maintain Record Documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to Project Record Documents for Design Professional's reference during normal working hours.

END OF SECTION 01 78 39

## SECTION 230500

### COMMON WORK RESULTS FOR HVAC

#### 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. Work Included:
  - 1. Submittals
  - 2. Electrical Requirements
  - 3. Excavation & Backfilling
  - 4. Painting
  - 5. Cleaning
  - 6. Testing

##### 1.3 SUBMITTALS

- A. The Contractor shall submit for review by the Architect data of materials and equipment to be incorporated in the work. Submittals shall be supported by descriptive material, catalogs, cuts, diagrams, performance curves, and charts published by the manufacturer to show conformance to specification and drawing requirements; model numbers alone will not be acceptable.
- B. Refer to the individual sections for identified equipment and materials for which submittals are required.
- C. Refer to the SHOP DRAWINGS, PRODUCT DATA AND SAMPLES Section for required procedures.
- D. Product Data Preparation: Product submittals shall be made by specification section. All items of a section, requiring submission, shall be submitted together at one time in a tabbed binder. If two or more sections require inter-ordination, (e.g. Air Handling Unit and Vibration Isolation or Air Handling Unit and Condensing Unit) they shall be submitted at the same time. Each individual submittal item within a binder shall be marked to show paragraph number which pertains to the item. Binders for mechanical submittals shall be color coded - Black for HVAC. Binders shall be labeled on outside with project name, contractors name, date of submission, and specification section and number. Binders shall also have a tab indicating submittal number and specification section number. If product submittals for section exceed the capacity of one binder, two or more binders shall be used. In addition to above, a notation cover shall indicate the number of binders for the section and the number of that binder (i.e., 2 of 3). Section binders shall be report cover type with solid cover and 3 metal fasteners or 3-ring type. Report cover binders shall be Duo-Tang Series L2-53558 or approved equal. Electronic submittals shall also be acceptable.
- E. Mechanical Equipment Electrical Data
  - 1. Prior to submitting data for equipment requiring electrical service, the Contractor shall verify that electrical characteristics of equipment submittals comply with electrical service provided for the specified items of equipment.



2. Upon receipt by the Contractor of reviewed submittals for equipment provided under this Division, the Contractor shall coordinate the electrical service requirements, i.e., motor horsepower and full load amps, electrical service characteristics (voltage and phase), and number of services for each item of equipment requiring electrical connections with the electrical drawings and specifications. The Contractor shall furnish to the Architect a complete typewritten list of electrical requirements for each item of equipment to be installed.

F. Items on or projecting through the ceiling shall be coordinated with other items.

#### 1.4 QUALITY ASSURANCE

A. The mechanical equipment and installation shall conform to the following codes:

1. The International Building Code 2012 Edition with Georgia Amendments.
2. The International Mechanical Code 2012 Edition with Georgia Amendments.
3. The International Energy Conservation Code, 2009 Edition with Georgia Amendments.
4. National Electrical Code, 2014 Edition with Georgia Amendments.

B. The mechanical equipment and installation shall conform to the following standards:

1. Associated Air Balance Council (AABC):
  - a. National Standard for Total System Balance.
2. National Fire Protection Association (NFPA):
  - a. Standard 70, National Electric Code.
  - b. Standard 90A, Installation of Air Conditioning and Ventilating Systems.
  - c. Standard 96, Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Establishments.
  - d. Standard 101, Code for Safety to Life from Fire in Buildings and Structures.

C. Publication Dates: Where the date of issue of a Reference Standard is not specified, comply with the Standard is effective as of Date of Contract Document.

D. Permits

1. Obtain all permits and inspections for the installation of this work and pay all charges incident thereto. Deliver to the Owner all certificates of said inspection issued by authorities having jurisdiction.

E. Workmanship and Materials

1. The workmanship and materials covered by these specifications shall conform to all ordinances and regulations of the city, county and/or other authorities having jurisdiction.

#### 1.5 OPERATION AND MAINTENANCE INSTRUCTIONS

A. Refer to Division 1 for Detail Requirements.

B. Printed Material: Provide required printed material for binding in operation and maintenance manuals.

1. Refer to the individual sections for identified equipment for which material is to be provided.
2. The Operations and Maintenance Manual shall include a section for certifications and project warranty data. Refer to individual sections for certifications. Warranties for equipment shall be included in the equipment section of the Operation and Maintenance Manual.

C. The Manuals shall be a 3 ring binder with tabs for each item listed in specifications. The manuals shall be submitted to the Architect for approval 30 days prior to instruction of Owner personnel. The manual shall include the following items:

1. Parts list
2. Lubrication requirements
3. Preventative maintenance requirements
4. Name, address, and telephone numbers for supplier of equipment.

D. Instructions of Owner personnel:

1. Before final inspection, at a time designated by the Architect, provide a competent representative to instruct Owner's designated personnel in operation, adjustment, and maintenance of products, equipment, and systems under this division of the specifications. For equipment requiring seasonal operation, perform instructions for other seasons within six months unless requested otherwise.
2. Use operation and maintenance manuals as basis of instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.
3. Prepare and insert additional data in Operation and Maintenance Manual when need for such data becomes apparent during instruction.

1.6 SPARE PARTS

- A. The Contractor shall prepare a typed written list of spare parts or equipment to be turned over to the Owner. The list shall indicate the equipment the parts are for, model numbers and quantity of parts. Refer to individual sections for the spare parts or equipment required by these specifications.

1.7 RECORD DOCUMENTS

- A. Refer to Division 1 for record documents and related submittals.

1.8 CONTRACT DRAWINGS

- A. Drawings are diagrammatic and indicate general arrangement of systems and work. Provide offsets, transitions, and fittings to coordinate the work of each trade with that of other trades, including HVAC, plumbing, fire protection, electrical, structural, and architectural.
- B. Follow drawings in laying out work and check drawings of other disciplines relating to work to verify space conditions. Do not scale drawings.
- C. Equipment layout is based on one manufacturer's product. Where equipment selected by the Contractor for use on the job differs from layout, the Contractor shall be responsible for coordinating space requirements and connection arrangements.

1.9 GUARANTY

- A. The components of the mechanical systems furnished under this division of the Specifications shall be guaranteed for a period of one year from the date of acceptance thereof, either for beneficial use or final acceptance, whichever is earlier, against defective materials, design, and workmanship. Upon receipt of notice from the Architect of failure of any part of the equipment during the guaranty period, the affected part or parts shall be replaced promptly which includes removing the defective part or parts, replacing and installing the new part or parts, at the expense of the Contractor. In addition to the one year guaranty required, each air conditioning compressor shall have an additional four year guaranty on the compressor which shall include parts only.

## **PART 2 PRODUCTS**

### **2.1 ELECTRICAL WORK**

- A. All electrical equipment furnished under this Division of these Specifications shall comply with the electrical system characteristics indicated on the electrical drawings.
- B. Motors shall be as specified in the MOTORS Section.
- C. Motor control components furnished as an integral part of the mechanical equipment shall conform to requirements of Division 26 - Electrical.
- D. For all motors furnished under this Division of these Specifications for which motor controls are not specified to be integral with the equipment, the controls shall be provided under Division 26 – Electrical.
- E. Power wiring (i.e., feeders to motors, water heaters, and electric heaters and tapes including final connection to equipment) shall be provided under Division 26 - Electrical.
- F. Control wiring (i.e. 120 volt and below) including 120 volt control power to motor operated dampers valves, and variable volume boxes shall be provided under this division unless shown on the electrical drawings. Power wiring (120V) to control panels shall be provided under Division 26. Power (120V) and control (24V) wiring to application-specific controllers and other control system components shall originate at control panels and be provided under this division.

## **PART 3 EXECUTION**

### **3.1 PAINTING**

- A. Factory painted equipment that has been scratched or marred shall be repainted to match original color.
- B. Steel equipment hangers, threaded rods, bolts, nuts, and supports and uninsulated black steel pipe exposed to sight inside the building which are not provided with a factory applied prime coat shall be cleaned of rust, grease and scale. After cleaning hangers, supports and pipe, a field-applied prime coat shall be provided. In addition, such items in finished spaces shall also be provided with two coats of finish paint in a color to match adjacent surfaces or as noted on the architectural drawings.
- C. Steel equipment hangers and supports, uninsulated black steel pipe, and black steel pipe supports exposed to sight outside the building which are not provided with factory prime coat shall be cleaned of rust, grease and scale. After cleaning hangers, supports and pipe, a field-applied prime coat and two coats of bituminous aluminum paint shall be provided. Insulated pipes outside the building shall be cleaned of rust, grease and scale, and shall be provided with a field-applied prime coat before installing insulation.

### **3.2 CLEANING AND ADJUSTING**

- A. All equipment, pipe, valves, and fittings shall be cleaned of grease, oil, paint spots, metal cuttings, sludge, and construction debris.
- B. Ducts, plenums and casings shall be cleaned of all debris and blown free of all particles of rubbish and dust before installing outlet faces.

- C. Bearings shall be lubricated as recommended by the equipment manufacturer.
- D. Temporary filters shall be provided for fans that are used during construction. Where supply, exhaust, or return fans (whether alone or part of mechanical equipment), are used, all return/exhaust inlets shall be covered with roll filter media. Media shall be taped in place to face of air inlet device or opening. At the time of starting the balancing of the air distribution system, new filters shall be installed.

### 3.3 EXCAVATION, TRENCHING AND BACKFILLING

- A. General: The Contractor shall perform all excavation to install piping herein specified. During excavation, material for backfilling shall be piled back from the banks of the trench to avoid over-loading and to prevent slides and cave-ins. All excavated materials not to be used for back filling shall be removed and disposed of by the Contractor. Grading shall be done to prevent surface water from flowing into trenches and excavations, and any water accumulating therein shall be removed by pumping. All excavation shall be made by open cut. No tunneling shall be done. Trenches shall not be cut below a plane extending at a 45 degree angle down and away from any footing.
- B. Trench Excavation. The bottom of the trenches shall be graded to provide uniform bearing and support for each section of the pipe on undisturbed soil at every point along its entire length, except for the portions of the pipe sections excavated for sealing of pipe joints. Depressions for joints shall be dug after the trench bottom has been graded. Over depths shall be backfilled with loose, granular, moist earth, tamped. Remove unstable soil that is not capable of supporting the pipe and replace with specified material for a minimum depth of 12" below invert of pipe.
- C. Backfilling. The trenches shall not be backfilled until all specified pressure tests are performed. The trenches shall be backfilled with the excavated materials approved for backfilling consisting of earth, loam, sandy clay, sand and gravel or soft shale, free from large clods of earth and stones, deposited in 6" layers and rammed until the pipe has a cover of not less than the adjacent existing ground, but not greater than 2" above existing ground. The backfilling shall be carried on simultaneously on both sides of the trench so that injurious side pressures do not occur. All trenches under pavements and all trenches within the building walls and to 5 ft. outside the building walls shall be compacted. For all trenches, the compaction of the filled trench shall be at least equal to that of the surrounding undisturbed material, except that trenches occurring in areas to be filled shall be backfilled in 6" maximum layers and each layer compacted to 95% maximum density. Settling the backfill with water will not be permitted. Reopen any trenches not meeting compaction requirements; or where settlement occurs, refill, compact, and restore the surface to the grade and compaction specified above, mounded over and smoothed off.

### 3.4 TESTING PIPE AND DUCT SYSTEMS

- A. General: Concealed piping and duct work and insulated piping and ductwork shall be tested in place before concealing or covering. Piping and ductwork located underground shall be tested before backfilling. Equipment, materials, and instruments for testing shall be furnished by the Contractor without additional cost to the Owner. System components not rated for the respective test pressure shall be isolated from the system during the test.
- B. Observation: The contractor shall notify the owner's representative 5 days prior to a scheduled test. The owner's representative, at his option, has the right to witness the test.
- C. Heating & Air Conditioning Piping System
  1. All hot water, condensate drain, loop water, condenser water, and make-up water piping shall be tested hydrostatically and proved tight at a pressure of not less than 100 psi (690 kPa) for a period of not less than 2 hours.

2. Field erected refrigerant piping shall be tested with a halide leak detector.
  3. No loss in pressure will be permitted. Leaks detected shall be repaired by tightening, rewelding joints, or replacing pipe and fittings. Caulking of joints will not be permitted.
- D. Air Distribution Systems
1. Ductwork in pressure classes less than  $\pm 3$ " W.G. shall be made airtight prior to covering or concealing to the point that no leakage can be detected by the senses of hearing or feeling at all duct joints and seams.

**END OF SECTION**

## SECTION 230513

### COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

#### 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. Work Included
  - 1. Motors (except hermetic refrigeration machine motors) for mechanical equipment.
  - 2. Variable frequency drives
- B. Description
  - 1. All motors shall be provided with equipment for which they serve as prime mover.

##### 1.3 SUBMITTALS

- A. General: All submittals shall conform to the requirements of Division 1 - GENERAL REQUIREMENTS and Section 230500 COMMON WORK RESULTS FOR HVAC.
- B. Product Data: Data shall be submitted on the following items:
  - 1. High efficiency motors, including certification of rating and power factor at full, three quarter, and half load.
  - 2. Variable frequency drives
- C. Operation and Maintenance Data: Data shall be provided on the following items:
  - 1. Variable frequency drives

##### 1.4 QUALITY ASSURANCE

- A. Standards
  - 1. Anti-Friction Bearing Manufacturers Association, Inc. (AFBMA):
    - a. Standard 9, Load Ratings and Fatigue Life for Ball Bearings
  - 2. National Electrical Manufacturer's Association (NEMA):
    - a. Publication MG - 1, Motors and Generators
  - 3. The Institute of Electrical and Electronics Engineers, Inc. (IEEE):
    - a. Standard 112, Test Procedure for Polyphase Induction Motors and Generators.
  - 4. American Society of Heating Refrigerating and Air Conditioning Engineers (ASHRAE):
    - a. Standard 90.1 - 1999 Energy Standard for Buildings Except Low Rise Residential Buildings

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Motors received and stored on the job site shall be stored in dry storage spaces, (e.g. building, a storage trailer, or shed). Under no condition shall the units be stored in such a way that metal components are in direct contact with the ground.

**PART 2 - PRODUCTS**

2.1 GENERAL

- A. Unless indicated otherwise hereinafter or on the drawings, motors shall be 1800 RPM open drip proof (ODP) type.
- B. Motors shall operate within plus or minus 10% of nameplate voltage without reduction of performance or life.
- C. Motors shall have continuous duty classification based on 40 degree C. ambient temperature. Motor service factor shall not be less than 15% unless indicated other wise herein.
- D. Motors shall be sized for the duty to be performed and shall not be operated in the service factor when the driven equipment is operating at specified capacity.
- E. Motors shall comply with NEMA MG – 1-2003, Section I, parts 1, 2, 3, 4, Section II, parts 10, 11, 12, 14.
- F. Motors operating on 120 volt systems shall be rated at 115 volts; motors operating on 208 volt system shall be rated at 200 volts; motors operating on 240 volt system shall be rated at 230 volts; motors operating on 277 volt system shall be rated at 265 volts; motors operating on 480 volt system shall be rated at 460 volts.
- G. Motor voltage and phase shall be as indicated on the Electrical drawings.
- H. Motors used with variable frequency drives shall be inverter duty designed to operate with variable frequency drives. Motors shall be approved by the variable frequency drive manufacturer and the motor manufacturer to provide quiet and stable operation over the entire speed range.

2.2 STANDARD MOTORS

- A. Fractional Horsepower Motors
  1. Fractional horsepower motors rated 3/4 HP, 1/2 HP, 1/3 HP, or 1/4 HP (550 W, 400 W, 250 W, or 200 W) shall be capacitor start type motors.
  2. Drip-proof enclosure motors shall have Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, pre-lubricated sleeve or ball bearings.
  3. Enclosed Motors shall have Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, pre-lubricated ball bearings.
- B. Integral Horsepower Motors
  1. Integral horsepower motors, i.e., one horsepower (750 W) and larger, shall be polyphase, squirrel-cage induction motors, NEMA design B, normal starting torque and low starting current unless other operational characteristics are required for the duty to be performed.

2. Integral horsepower motors 25 HP (19 kW) and larger shall be provided with thermal devices embedded in motor windings. Protection shall be static type, sensitive to both over temperature and rate of temperature rise, and shall provide motor protection from overheating due to frequent starting, overload, high ambient temperature, abnormal voltage, ventilation failure, and locked rotor.
3. Bearings shall be grease lubricated anti-friction ball bearings rated for minimum AFBMA 9, L - 10 life of 20,000 hours. Bearing housings shall be equipped with plugged provision for relubrication. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
4. Insulation shall be NEMA Class B.
5. Sound power levels shall comply with NEMA MG 1.
6. Weatherproof Epoxy treated motors shall have coated windings with rotor and starter surfaces protected with epoxy enamel; bearings shall be double shielded with waterproof non-washing grease.

C. Heaters

1. Motors for cooling tower fans shall be provided with built-in space heaters to prevent condensation. Heaters shall be for operation on 460 volts and shall be operated from interlock circuit in magnetic starter.

2.3 EXPLOSION PROOF MOTORS

- A. Motors indicated to be explosion proof shall be as specified above for standard motors. In addition, motors shall be UL approved and labeled for hazardous classification.

2.4 TOTALLY ENCLOSED MOTORS

- A. Motors indicated to be totally enclosed shall be as specified above for standard motors. In addition, motors shall have coated windings and fan cooled enclosure.

2.5 MOTOR EFFICIENCY

- A. Motors shall be standard efficiency as defined by the Energy Policy Act of 1992. All motors 5 hp and above shall be high efficiency.
- B. All general purpose motors shall have nominal full load power factor and efficiency ratings not less than those listed in Table I & II below. Data listed is for 3 phase 230/460 volts NEMA design B, Class B insulation, 40 degree C. ambient, continuous duty motor. Motors of other ratings and characteristics shall conform to their respective efficiency standards for efficiency and power factor.
- C. High efficiency motors nameplate data shall indicate rated efficiency and power factor in addition to standard nameplate data.
- D. Efficiency and power factor shall be tested in accordance with IEEE 112.



Open Drip-Proof (ODP)									
HP (kW)	1200 RPM			1800 RPM			3600 RPM		
	Power Factor %	Standard Eff. %	High Eff. %	Power Factor %	Standard Eff. %	High Eff. %	Power Factor %	Standard Eff. %	High Eff. %
1 (0.75)	72	80	82.5	84	82.5	85.5	85	N/A	77
1.5 (1.1)	73	84	86.5	85	84	86.5	85	82.5	84
2 (1.5)	75	85.5	87.5	85	84	86.5	87	84	85.5
3 (2.3)	60	87.5	88.5	86	86.5	89.5	85	84	85.5
5 (3.8)	65	88.5	89.5	87	87.5	89.5	86	85.5	86.5
7.5 (5.6)	73	90.2	90.2	86	88.5	91	88	87.5	88.5
10 (7.5)	74	90.2	91.7	85	89.5	91.7	86	88.5	89.5
15 (12)	77	91	91.7	85	91	93	89	89.5	90.2
20 (15)	78	91.7	92.4	86	91	93	89	90.2	91
25 (19)	74	92.4	93	85	91.7	93.6	92	91	91.7
30 (22)	78	93	93.6	88	92.4	94.1	91	91	91.7
40 (30)	77	93	94.1	83	93	94.1	92	91.7	92.4
50 (37)	79	93.6	94.1	85	93	94.5	89	92.4	93
60 (45)	82	93.6	94.5	88	93.6	95	91	93	93.6
75 (56)	80	94.1	94.5	88	94.1	95	88	93	93.6
100 (75)	80	94.1	95	83	94.1	95.4	88	93	93.6
125 (94)	84	94.5	95	86	94.5	95.4	91	93.6	94.1
150 (113)	83	94.5	95.4	85	95	95.8	91	93.6	94.1
200 (150)	83	94.5	95.4	85	95	95.8	90	94.5	95
Totally Enclosed Fan-Cooled (TEFC)									
HP	1200 RPM			1800 RPM			3600 RPM		
	Power Factor %	Standard Eff. %	High Eff. %	Power Factor %	Standard Eff. %	High Eff. %	Power Factor %	Standard Eff. %	High Eff. %
1 (0.75)	72	80	82.5		82.5	85.5		75.5	77
1.5 (1.1)	65	85.5	87.5	84	84	86.5	85	82.5	84
2 (1.5)	68	86.5	88.5	85	84	86.5	87	84	85.5
3 (2.3)	63	87.5	89.5	85	87.5	89.5	87	85.5	86.5
5 (3.8)	66	87.5	89.5	83	87.5	89.5	88	87.5	88.5
7.5 (5.6)	68	89.5	91	83	89.5	91.7	86	88.5	89.5
10 (7.5)	75	89.5	91	85	89.5	91.7	86	89.5	90.2
15 (12)	72	90.2	91.7	84	91	92.4	91	90.2	91
20 (15)	76	90.2	91.7	86	91	93	89	90.2	91
25 (19)	71	91.7	93	85	92.4	93.6	92	91	91.7
30 (22)	79	91.7	93	84	92.4	93.6	92	91	91.7
40 (30)	78	93	94.1	86	93	94.1	91	91.7	92.4
50 (37)	81	93	94.1	83	93	94.5	92	92.4	93
60 (45)	83	93.6	94.5	85	93.6	95	93	93	93.6
75 (56)	80	93.6	94.5	87	94.1	95.4	91	93	93.6
100 (75)	83	94.1	95	87	94.5	95.4	92	93.6	94.1
200 (150)	81	95	95.8	87	95	96.2	87	95	95.4

2.6 Variable Frequency Drives

- A. Description: NEMA ICS 2, IGBT, PWM, VFC; listed and labeled as a complete unit and arranged to provide variable speed of an NEMA MG 1, Design B, 3-phase induction motor by adjusting output voltage and frequency.
- B. Output Rating: 3-phase; 6 to 60 Hz, with voltage proportional to frequency throughout voltage range 66 Hz, with torque constant as speed changes.
- C. Unit Operating Requirements:
  - 1. Input ac voltage tolerance of 380 to 500 V, plus or minus 10 percent.
  - 2. Input frequency tolerance of 50/60 Hz, plus or minus 6 percent.
  - 3. Minimum Efficiency: 96 percent at 60 Hz, full load.
  - 4. Minimum Displacement Primary-Side Power Factor: 96 percent.
  - 5. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.
  - 6. Starting Torque: 100 percent of rated torque or as indicated.
  - 7. Speed Regulation: Plus or minus 1 percent.
- D. Isolated control interface to allow controller to follow control signal over an 11:1 speed range.
- E. Internal Adjustability Capabilities:
  - 1. Minimum Speed: 5 to 25 percent of maximum rpm.
  - 2. Maximum Speed: 80 to 100 percent of maximum rpm.
  - 3. Acceleration: 2 to a minimum of 22 seconds.
  - 4. Deceleration: 2 to a minimum of 22 seconds.
  - 5. Current Limit: 50 to a minimum of 110 percent of maximum rating.
- F. Self-Protection and Reliability Features:
  - 1. Retain one or more of first nine subparagraphs below.
  - 2. Input transient protection by means of surge suppressors.
  - 3. Undervoltage and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
  - 4. Adjustable motor overload relays capable of NEMA ICS 2 performance.
  - 5. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
  - 6. Instantaneous line-to-line and line-to-ground overcurrent trips.
  - 7. Loss-of-phase protection.
  - 8. Reverse-phase protection.
  - 9. Short-circuit protection.
  - 10. Motor overtemperature fault.
- G. Enclosures shall be NEMA 1 for indoor locations and NEMA 4X for outdoor locations.
- H. Automatic Reset/Restart: Attempts three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bidirectional autospeed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.
- I. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped.
- J. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

- K. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
  
- L. Door-mounted LED status lights shall indicate the following conditions:
  - 1. Power on.
  - 2. Run.
  - 3. Overvoltage.
  - 4. Line fault.
  - 5. Overcurrent.
  - 6. External fault.
  
- M. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual-speed-control potentiometer and elapsed time meter.
  
- N. Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:
  - 1. Output frequency (Hertz).
  - 2. Motor speed (rpm).
  - 3. Motor status (running, stop, fault).
  - 4. Motor current (amperes).
  - 5. Motor torque (percent).
  - 6. Fault or alarming status (code).
  - 7. Proportional-integral-derivative (PID) feedback signal (percent).
  - 8. DC-link voltage (volts direct current).
  - 9. Set-point frequency (Hertz).
  - 10. Motor output voltage (volts).
  
- O. Control Signal Interface:
  - 1. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.
  - 2. Remote signal inputs capable of accepting any of the following speed-setting input signals from the control system:
    - a. 0 to 10-V dc.
    - b. 0-20 or 4-20 mA.
    - c. Potentiometer using up/down digital inputs.
    - d. Fixed frequencies using digital inputs.
    - e. RS485.
    - f. Keypad display for local hand operation.
  - 3. Output signal interface with a minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:
    - a. Output frequency (Hertz).
    - b. Output current (load).
    - c. DC-link voltage (volts direct current).
    - d. Motor torque (percent).
    - e. Motor speed (rpm).
    - f. Set-point frequency (Hertz).
  - 4. Remote indication interface with a minimum of 2 dry circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
    - a. Motor running.
    - b. Set-point speed reached.
    - c. Fault and warning indication (overtemperature or overcurrent).
    - d. High- or low-speed limits reached.

- P. Communications: RS485 interface allows VFC to be used with an external system within a multidrop LAN configuration. Interface shall allow all parameter settings of VFC to be programmed via BMS control. Provide capability for VFC to retain these settings within the nonvolatile memory.
- Q. Coordinate both subparagraphs below with manufacturers selected; not all manufacturers offer all optional features below.
- R. Integral Disconnecting Means: NEMA AB 1, instantaneous-trip circuit breaker with lockable handle.
- S. Accessories:
  - 1. Devices shall be factory installed in controller enclosure unless otherwise indicated.
  - 2. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.
  - 3. Standard Displays:
    - a. Output frequency (Hertz).
    - b. Set-point frequency (Hertz).
    - c. Motor current (amperes).
    - d. DC-link voltage (volts direct current).
    - e. Motor torque (percent).
    - f. Motor speed (rpm).
    - g. Motor output voltage (volts).
- T. Variable frequency drives shall be:
  - a. ABB
  - b. Emerson
  - c. Square D
  - d. Hitachi
  - e. Toshiba

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Motors shall be installed and aligned with equipment for which they serve as prime mover.
- B. Motors located indoors shall be open drip proof unless indicated otherwise hereinafter.
- C. Motors located outdoors shall be weatherproof type unless indicated otherwise hereinafter.
- D. Motors located in wet airstreams shall be totally enclosed epoxy treated type.

**END OF SECTION**

## SECTION 230519

### METERS AND GAGES FOR HVAC PIPING

#### 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. Work Included
  - 1. Piping specialties for HVAC systems.

##### 1.3 SUBMITTALS

- A. General: All submittals shall conform to the requirements of Division 1 - GENERAL REQUIREMENTS and Section 230500 COMMON WORK RESULTS FOR HVAC.
- B. Product Data: Data shall be submitted on the following items:
  - 1. Strainers
  - 2. Pressure Reducing Valves
  - 3. Air Vents
  - 4. Dielectric Adapters
  - 5. Thermometers and Test Wells
  - 6. Pressure Gauges and Gauge Cocks
  - 7. Temperature/Pressure Test Fittings
  - 8. Expansion Tanks
  - 9. Air Separator Tank
  - 10. Temperature Relief Valve
- C. Operation and Maintenance Data: Data shall be provided on the following items:
  - 1. Pressure Reducing Valves
  - 2. Expansion Tanks

##### 1.4 QUALITY ASSURANCE

- A. Standards
  - 1. American Society of Mechanical Engineers (ASME):
    - a. Boiler and Pressure Vessel Code, Section VIII - Rules for Construction of Pressure Vessels.
  - 2. American Society for Testing and Materials (ASTM):
    - a. Standard A53, Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
    - b. Standard A74, Cast Iron Soil Pipe and Fittings.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Piping specialties received and stored on the job site shall be stored in dry storage spaces, (e.g. building, a storage trailer, or shed). Under no condition shall the units be stored in such a way that metal components are in direct contact with the ground.

**PART 2 - PRODUCTS**

2.1 STRAINERS

- A. All strainers, except those installed as integral parts of equipment, shall be the product of a single manufacturer.
- B. Y - Type Strainers:
  - 1. Strainers 2 inches (50mm) and smaller shall be iron body with screwed end connections and screwed plug in blowoff. Strainers shall be rated for 400 pounds (2760 kPa) minimum WOG. Screens for water service shall be 20 mesh monel or stainless steel. Strainers shall be:
    - a. Keckley; Style B
    - b. Metraflex; Style S
    - c. Mueller ; No. 11-FCB
    - d. Spirex Sarco; Type IT
    - e. Watts; Series 77S
- C. Strainers 2-1/2 inches (50mm) and larger shall be iron body with 125 pound (860 kPa) flanged end connections for installation between 150 pound (1035 kPa) raised face slip-on weld flanges. Strainers shall be rated for 175 pound (1205 kPa) minimum WOG. Strainers shall have blowdown connection which shall be provided with full size gate valve. Strainers shall be equipped with perforated baskets or perforated baskets lined with mesh screens. Strainer screens and baskets shall be stainless steel in accordance with the following:

Size	Service	Perforation Diameter
2-1/2", 3"	Water	.033" (0.8mm)
4", 5"	Water	1/8"(3.2mm)
6" & 8"	Water	1/8" (3.2mm)
10" & 12"	Water	1/4" (6.4mm)

- D. Strainers shall be:
  - Keckley; Style D
  - Metraflex; Series M1
  - Mueller; No. 751 to 12"(300 mm), No. 752 14" (350mm) & larger
  - Spirex Sarco; Type C1-125
  - Victaulic; Style 732/730 (Water only)
  - Watts; Series 77F-125

2.2 PRESSURE REDUCING VALVES

- A. Pressure reducing valves shall be field adjustable with outlet pressure set as specified hereinafter or as indicated on drawings.

- B. All internal parts subject to wear shall be replaceable without removing the pressure reducing valve from the piping.
- C. For Heating and Air Conditioning:
  - 1. Water pressure reducing valves, shall be diaphragm actuated type with cast iron or bronze body, 100 psig (690 kPa) (minimum) working pressure. Valves shall be set to maintain a terminal pressure of 5 psi (35 kPa) in excess of the static head on the system unless shown otherwise on the drawings. Valves shall be
    - a. Armstrong; RD Series
    - b. Bell& Gossett; B-38, B7-12
    - c. Thrush; Automatic Standard Filling Valve
    - d. Taco; No. 409 Series
    - e. Watts; N250

### 2.3 AIR VENTS

- A. Air vents at system high points shall be float type with automatic air vent outlet rated for 125 psig (861 kPa). Air vents shall be:
  - 1. Armstrong; No. 71
  - 2. Bell& Gossett; No. 87
  - 3. Hoffman; No. 78
  - 4. Taco; No. 424
  - 5. Thrush; No. 8
  - 6. Watts; Series FU4
- B. Air vents at air separators shall be high capacity float type with automatic air vent outlet rated for 125 psig (861 kPa). Air vents shall be:
  - 1. Armstrong; AAE 750
  - 2. Bell& Gossett; No. 107A
  - 3. Taco; Hy-Vents

### 2.4 DIELECTRIC ADAPTERS

- A. Dielectric adapters shall be the union type for pipes 2" (50mm) in size and smaller and flanged type for pipes 2-1/2" (12mm) in size and larger. Adapters shall have a working pressure of 250psi (1725 kPa) for union type and 175 psi (1205 kPa) for flanged type. The insulating gasket shall have an operating range of 40°F to 240°F (4.4°C to 115°C) and shall limit the galvanic corrosion to a maximum of 1% of the short circuit current.
- B. Dielectric adapters shall be:
  - 1. Capital
  - 2. Clearflow
  - 3. Crane
  - 4. Ebco
  - 5. Watts

### 2.5 THERMOMETERS AND TEST WELLS

- A. Thermometers:
  - 1. Thermometers shall be the red-reading mercury-filled adjustable angle type. Thermometers shall be adjustable to any angle through a 180° arc and shall be provided with a locking device.

2. Thermometers shall have V-cast aluminum case with baked enamel finish and 9-inch (225mm) scale. Thermometers shall be provided with separable sockets and where installed on insulated pipes, sockets shall be extension neck type to provide for 2" (50mm) thick insulation.
3. Thermometer scale range shall be:
  - a. Hot Water Heating Systems 30-300°F (0° to 150°C)
  - b. Condenser Water System 0-160°F (-20°C to 70°C)
  - c. Loop Water System 30-130°F (0°C to 50°C)
4. Thermometers shall be:
  - a. Trerice; Adjustable Angle Series Type BX
  - b. Weiss; Vari-Angle Series Type BS
  - c. Weksler; Adjust-Angle Series Type AA-5

B. Test Wells

1. Test wells shall be for use with engraved stem thermometers. Test wells shall be brass and shall be provided with cap and chain with gasket for sealing when not in use.
2. Wells installed in insulated pipes shall be extension neck type to provide for 2" (50mm) thick insulation.

C. Test wells shall be:

1. Trerice
2. Weiss
3. Weksler

## 2.6 PRESSURE GAUGE AND GAUGE COCKS

A. Pressure Gauges

1. Gauges shall be flangeless type and shall have 4-1/2 inch (110mm) dials, cast aluminum cases, stainless steel rotary gear movements, phosphor bronze bourdon tubes, forged brass rod sockets and tips, 1/2% accuracy of scale range, Plexiglas dial covers, safety blowout disc and 1/4 (6mm) inch lower connections.
2. Gauges in pump suction line shall be the compound type. Gauges in all other locations and discharge shall be the plain pressure type.
3. Range for pressure gauges shall be selected so that the normal operating point for each application falls in the approximate midpoint of the gauge range. Shop drawings shall indicate ranges.
4. Gauges shall be:
  - a. Weiss; Series PG
  - b. Trerice; No. 500X Series
  - c. Weksler; Type AA14

B. Gauge Cocks:

1. Gauge cocks shall be brass lever handle type. Gauge cocks shall be:
  - a. Weiss; Type LC
  - b. Trerice; No. 880
  - c. Weksler; Type A

## 2.7 TEMPERATURE/PRESSURE TEST FITTINGS

A. Fittings shall be the combination temperature pressure test type with brass body, self sealing EPDM gasket, threaded connections, insulation extension and cap. Temperature/Pressure Test Fittings shall be:

1. Fairfax
2. Pete's Plug
3. Sisco



4. Watts

## 2.8 PIPE SLEEVES

### A. Pipe Sleeves

1. Sleeve size shall be such as to provide an annular space of the sleeve and the passing pipe or pipe insulation.
2. Sleeve requirements and material shall be as follows:
  - a. In walls and foundations below grade: Schedule 40 galvanized steel pipe, ASTM A53.
  - b. Under foundations, footings and load supporting members: Service weight cast iron pipe, ASTM A74 or Schedule 40 galvanized steel pipe, ASTM A53, sleeve shall be two pipe sizes larger than pipe.
  - c. In concrete floors on grade: Service weight cast iron pipe, ASTM A74
  - d. In walls and partitions above grade: 20 gauge galvanized sheet steel with lock-type longitudinal seams.
  - e. In concrete floors above grade: Service weight cast iron pipe, ASTM A74 or Schedule 40 black steel pipe, ASTM A53.
  - f. In concrete roofs: Service weight cast iron or Schedule 40 black steel pipe, ASTM A74.
3. Pipes passing through foundations, footings and load supporting members shall include sleeves.
4. Pipes passing under foundations, footings and load supporting members shall include sleeves. Sleeves shall extend a minimum of 6" (150mm) beyond the bearing cone.
5. Pipe sleeves in walls, partitions and roofs and in floors on grade shall be cut flush with each surface except where clamping flanges are used. Sleeves through floors above grade shall be cut flush with the underside of the floor and shall extend 1" (25mm) above the top side of the floor. Where pipes penetrate existing slabs above grade, install a 2"(50mm) high concrete water dam around pipe.
6. Except where otherwise specified, pipes passing through concrete and masonry walls, concrete and masonry partitions, concrete floors and roofs, and fire rated gypsum board or plaster partitions shall be provided with pipe sleeves which shall be installed at the time of construction of walls, partitions, floor or roof.
7. Sleeves are not required for water and waste connections through a wall or partition to an individual fixture nor for cast-iron pipe through concrete slab on grade.
8. Sleeves shall not be installed in structural members except where specifically indicated or approved by the Architect.
9. The annular space between pipe and sleeve and between insulation and sleeve shall be sealed. Sealants shall conform to Section 079200 JOINT SEALANTS. In addition, penetrations through fire rated, walls, partitions and floors above grade shall be sealed with Firestopping in accordance to Section 078413 PENETRATION FIRESTOPPING.

## 2.9 FLOOR, WALLS AND CEILING PLATES

- A. Escutcheons for HVAC and Fire Protection systems shall be chrome plated steel plates, hinged type with set screw.
- B. Escutcheons for Plumbing systems shall be chrome plated cast brass with setscrew. Connections at plumbing fixtures shall be as specified under the plumbing fixtures.
- C. Escutcheons shall be:  
BEA-COR;  
Anvil;  
P&S;

## 2.10 EXPANSION TANKS

### A. Captive Air Expansion Tank

1. Expansion tank shall be a pre-pressurized captive air bladder type. Tank shall be constructed of steel in accordance with requirements of the ASME Section VIII, Division I, for working pressure of 125 psig (860 kPa) at 240°F(115°C). The tank shall contain a replaceable elastomeric bladder suitable for maximum operating temperature of 240°F (115°C). The bladder shall be designed and factory precharged with air to 12 psig (80 kPa).
2. The tank shall be provided with the following connections:
  - a. NPT System Connection.
  - b. 1-1/2" (12mm) NPT Charging Valve Connection.
  - c. 1/2" (12mm) NPT for pressure gauge.
  - d. 3/4" (20mm) NPT Drain above diaphragm.
  - e. 3/4" (20mm) NPT Drain below diaphragm
3. Tanks shall be:

125 psi (861 kPa)

Amtrol	AX/L Series
Bell & Gossett	Series D & B
Taco	Model CA/CAX
Wessels	Type NLA
Wheatley	Series WFA

## 2.11 AIR SEPARATOR TANK

- A. Air separator tank shall be a combination centrifugal type air separator with system strainer designed for collection of free and entrained air in the system. Air separator tank shall be constructed of steel in accordance with ASME Code, Section VIII, Division 1, Pressure Vessels for not less than 125 psi (860 kPa) working pressure and shall be stamped with "U" symbol certifying compliance with National Board. Inlet and outlet connections to tank shall be threaded for pipe sizes 2 inches (50mm) and smaller and shall be flanged for pipe sizes 2-1/2 inches (65mm) and larger. Strainer shall be constructed of stainless steel, having not less than 5 times the free area of connecting pipe with perforation size per paragraph 2.1, B above. Tanks shall be provided with a factory applied baked enamel finish.
- B. Air separator tank shall be:  
Bell & Gossett; Rolairtrol Series RL  
Taco; ACF Series  
Thrush; AS Series

## 2.12 WATER FLOW STATIONS

### A. Water Flow Stations

1. Venturi flow stations shall be screwed for pipe sizes 2 inches (50mm) and smaller and for pipe sizes 2-1/2" (62mm) and larger and shall have welding end connections.
2. Each venturi shall be installed with a minimum straight pipe run of 5 pipe diameters upstream between the venturi and any pipe fitting.
3. Venturi tubes shall be provided with shutoff valves and quick connection hose fittings for meter. The throat diameter of each venturi tube shall be such that at specified flow, the differential pressure in inches water gauge, will fall in the range of 8 to 50 (2 kPa - 12.5 kPa) with permanent pressure loss of not more than 10% of indicated flow rate differential pressure.
4. Each venturi tube shall be provided with an integral tag on a chain, extending outside the pipe covering on which shall be stamped or printed in a visible position, the manufacturer's name and

- address, pipe size, pump and coil identification (per equipment schedules on drawings), meter reading at specified flow rate and multiplier, if any, to be applied to the meter reading.
5. Venturis shall be selected from manufacturer's latest published flow versus differential tables.
  6. Venturi flow stations shall be:
    - a. Barco; Venturi Flow Measurement System
    - b. Gerand Engineering Company; Style VS/VW-B Venturi Flow Station
    - c. Robertson Manufacturing Company; Flow Venturi
- B. Testing
1. For testing and balancing the water systems, the Contractor shall provide a wall-mounted master meter where indicated on the drawings. The meter shall be of the same manufacturer as the venturis installed.

## 2.13 TEMPERATURE RELIEF VALVES

- A. Temperature relief valve shall be automatic type with bronze body, threaded ends and manual test level. The temperature relief setting shall be 185°F. Relief valves shall be:
1. Watts
  2. Bell & Gossett
  3. Taco
  4. Hatco

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. All equipment shall be installed where indicated on the drawings and shall be installed in accordance with manufacturer's instructions.
- B. Unless otherwise indicated on the drawings, thermometers and pressure gauges shall be installed no higher than 8 feet (2.5m) above finished floor. Final position of each thermometer and pressure gauge shall be such that it is readable from the floor.
- C. Pipe sleeves in walls, partitions and roofs and in floors on grade shall be cut flush with each surface except where clamping flanges are used. Sleeves through floors above grade shall be cut flush with the underside of the floor and shall extend 1" (25mm) above the top side of the floor. Where pipes penetrate existing slabs above grade, install a 2" (50mm) high concrete water dam around pipe.
- D. Except where otherwise specified, pipes passing through concrete and masonry walls, concrete and masonry partitions, concrete floors and roofs, and fire rated gypsum board or plaster partitions shall be provided with pipe sleeves which shall be installed at the time of construction of walls, partitions, floor or roof. Sleeves are not required for water and waste connections through a wall or partition to an individual fixture nor for cast-iron pipe through concrete slab on grade. Sleeves shall not be installed in structural members except where specifically indicated or approved by the Architect. The annular space between pipe and sleeve and between insulation and sleeve, including drain pipes at water closets, shall be sealed. In addition, penetrations through fire rated, walls, partitions and floors above grade shall be sealed with Firestopping.
- E. A strainer shall be provided on the inlet side of each pressure reducing valve. Pressure reducing valves provided with an integral strainer do not require a separate strainer.

- F. Air vents shall be installed at all high points in piping systems and elsewhere as indicated on the drawings. Inlet of each vent shall be equipped with pet cock to provide for manual operation. Provide U-tube on air vent discharge made of soft drawn copper tubing.
- G. Dielectric adapters shall be installed between copper and iron pipe connections and between ferrous and non-ferrous metal piping or equipment.
- H. Test wells shall be installed above the horizontal so as to hold oil and wells shall be filled with oil.
- I. Pressure gauges shall be connected to the piping system with threaded brass pipe and screwed brass fittings. Install gauge cock on inlet pipe to gauge. All gauges used on services exceeding 200°F (94°C) shall be mounted on a brass pigtail siphon.
- J. Where exposed piping, bare or insulated, passes through floors, walls and ceiling, except in Mechanical rooms, escutcheons shall be provided.
- K. Expansion tank shall be mounted as indicated on the drawings. Provide pressure gauge in side auxiliary opening. Contractor shall coordinate final changing in pressure with manufacturer.
- L. Air separator tank shall be suspended independent of the piping system. Provide with blowdown line with gate valve and run to floor drain.
- M. Temperature relief valve shall have discharge piped full size to nearest floor drain.

**END OF SECTION**

## SECTION 230523

### GENERAL DUTY VALVES FOR HVAC PIPING

#### 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. Work Included
  - 1. Valves for hot water system
  - 2. Valves for make-up water system
  - 3. Valves for condenser water system
  - 4. Valves for loop water system
  - 5. Miscellaneous valves.

##### 1.3 SUBMITTALS

- A. General: All submittals shall comply with the requirements of Division 1 - GENERAL REQUIREMENTS and Section 230500 COMMON WORK RESULTS FOR HVAC.
- B. Product Data: Data shall be submitted on the following items:
  - 1. Valves.

##### 1.4 QUALITY ASSURANCE

- A. Standards
  - 1. American Society of Mechanical Engineers (ASME):
    - a. Boiler and Pressure Vessel Code, Section 1, Rules for Construction of Power Boilers.
  - 2. American Society for Testing and Materials (ASTM):
    - a. Standard A48, Specification for Gray Iron Castings
    - b. Standard A126, Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
    - c. Standard A197, Specification for Cupola Malleable Iron.
    - d. Standard B62, Specification for Composition Bronze or Ounce Metal Castings.
    - e. Standard B584, Specification for Copper Alloy Sand Castings for General Application.
  - 3. Manufacturer's Standardization Society (MSS)
    - a. SP-67 Butterfly Valves
    - b. SP-70 Cast Iron Gate Valves, Flanged and Threaded Ends
    - c. SP-71 Cast Iron Swing Check Valves, Flanged and Threaded Ends
    - d. SP-80 Bronze Gate, Globe, Angle and Check Valves
    - e. SP-85 Cast Iron Globe and Angle Valves - Flanged and Threaded Ends

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Valves received and stored on the job site shall be stored in dry storage spaces, (e.g. building, a storage trailer, or shed). Items shall be stored on wooden shipping skids or pallets. Under no condition shall the units be stored in such a way that metal components are in direct contact with the ground or floor slabs.
- B. Where it is not practical to store items within an enclosure, items may be stored in shipping cartons on wooden pallets.
- C. Valves shall be covered with 6 mil polyethylene sheet taped in place to protect the equipment from damage and the weather.

**PART 2- PRODUCTS**

2.1 GENERAL

- A. Valves shall have name or trademark of manufacturer and working pressure cast or stamped on valve body.
- B. Gate Valves, globe valves, and swing check valves shall be the product of a single manufacturer.
- C. All valves requiring packing shall be designed and constructed to allow repacking under pressure.
- D. Valve discs shall be the manufacturer's standard material for the service in which the valve is used unless otherwise indicated under the individual type valve specification.
- E. Valve hand wheels shall be malleable iron, steel, or cast iron and shall conform to ASTM A197.
- F. Valves shall be manufactured in the United States.

2.2 GATE VALVES

- A. Type GV1 - Valves 2" (50mm) and smaller shall be class 125 rising stem type conforming to MSS SP-80. Body and bonnet shall be ASTM B62 cast bronze with threaded ends, inside screwed bonnet, solid wedge disc, brass packing gland, Teflon impregnated packing, and malleable iron hand wheel. Valves shall be:
  - 1. Crane No. 1700
  - 2. Hammond No. IB 640
  - 3. Lunkenheimer No. 2127
  - 4. Milwaukee No. 148
  - 5. Nibco No. T-111-MH
  - 6. Powell No. 500
  - 7. Stockham No. B-100
  - 8. Walworth No. 55
- B. Type GV2 - Valves 2" (50mm) and smaller shall be class 150 rising stem type conforming to MSS SP-80. Body and bonnet shall be ASTM B62 cast bronze with threaded ends inside screwed bonnet, solid wedge disc, brass packing gland, Teflon impregnated packing, and malleable iron hand wheel. Valves shall be:

		<u>Inside Screw</u>	<u>Union</u>
1.	Crane	No. 431	No. 431UB
2.	Hammond	No. IB641	No. IB629
3.	Lunkenheimer	No. 2151	No. 3151
4.	Milwaukee	No. 1150	No. 1151
5.	Nibco	No. T-131	No. T-134
6.	Powell	No. 514	No. 2714
7.	Stockham	No. B-122	No. B-120
8.	Walworth	No. 56	No. 11

- C. Type GV4 - Valves 2-1/2" (63mm) through 16"(400mm) shall be Class 125 outside screw and yoke rising stem type conforming to MSS SP-70. Body and bonnet shall be ASTM A126 cast iron with flanged ends, bronze trim, solid wedge disc, two piece packing gland, Teflon impregnated packing, and malleable iron hand wheel. Valves shall be:
1. Crane; No. 465-1/2
  2. Hammond; No. IR 1140
  3. Lunkenheimer; No. 1430
  4. Milwaukee; No. F-2885
  5. Nibco; No. F-617-0
  6. Powell; No. 1793
  7. Stockham; No. G623
  8. Walworth; No. 8726F

### 2.3 BUTTERFLY VALVES

- A. Type BF2 - Valves 2 1/2" (63mm) through 12" (300mm) in size shall be 200 psig (1720 kPa) WOG quarter turn type designed for dead-end service conforming to MSS SP-67. Body shall be ASTM A126 cast iron with tapped lugs, extension neck, bronze alloy disc, type 316 stainless steel stem, bronze stem bushing, EPDM O-ring stem seals, and EPDM seat sleeve. Seat sleeve shall be designed such that it serves as the flange seal and no separate gasket is required. Valves 6"(150mm) and smaller shall be lever operated. Valves 8"(200mm) and larger shall be gear operated. Valves shall be:
1. Centerline; Series LD
  2. Crane; No. 14
  3. Demco; NE-LUG Series
  4. Keystone; Fig. 122
  5. Nibco; LD-2000
  6. Stockham; LG-712
  7. Watts; Series BF-03
- B. Type BF4 – Valves 2 1/2" (63mm) through 12" (300mm) shall be 200 psig (1720 kPa) WOG quarter turn type conforming to MSS SP-67. Body shall be ASTM A536 ductile iron or ASTM A126 cast iron with extension neck, EPDM coated ductile iron disc, stainless steel stem and EPDM O-ring stem seals. Valves shall be:
1. Anvil; 7700 Series
  2. Victaulic; VIC-300 Series
  3. Nibco; GD-4765
- C. Valves 2" (50mm) to 6"(150mm) shall be lever operated. Valves 8"(200mm) and larger shall be gear operated.

## 2.4 BALL VALVES

- A. Type BL1 - Valves 2" (50mm) and smaller shall be 600 psig (4130 kPa) WOG, 2 piece, quarter turn type. Body shall be ASTM B584 bronze with threaded ends, conventional port, chrome plated brass ball, replaceable Teflon seats, brass packing gland, steel lever handle, and vinyl handle cover. Valve shall be:
1. Apollo; No. 70-100
  2. Crane; No. 9303
  3. Jamesbury ; No. 11-1100-TT
  4. Milwaukee; No. BA-100
  5. Nibco; No. T585-70
  6. Stockham; No. S-216
  7. Watts; No. B-6000
  8. Worcester; NO. 4211R

## 2.5 GLOBE VALVES

- A. Type GB1 - Valves 2" (50mm) and smaller shall be class 125 rising stem type conforming to MSS SP-80. Body and bonnet shall be ASTM B62 cast bronze with threaded ends, inside screw bonnet, bronze stem, bronze disc, brass packing gland, Teflon impregnated packing, and malleable iron hand wheel. Valves shall be:
1. Crane; No. 108
  2. Hammond; No. IB440
  3. Lunkenheimer; No. 2140
  4. Milwaukee; No. 502
  5. Nibco; No. T-211-B
  6. Powell; No. 650
  7. Stockham; No. B-16
  8. Walworth; NO. 3058
- B. Type GB4 - Valves 2-1/2" (63mm) through 16"(400mm) shall be class 125 outside screw and yoke, rising stem type conforming to MSS SP-85. Body and bonnet shall be ASTM A126 cast iron with flanged ends, bronze trim, bronze disc, bronze packing gland, Teflon impregnated packing, and malleable or cast iron hand wheel. Valves shall be:
1. Crane; No. 351
  2. Hammond; No. IR116
  3. Lunkenheimer; No. 1123
  4. Milwaukee; No. F-2981
  5. Nibco; No. F-718-B
  6. Powell; No. 241
  7. Stockham; No. G-512
  8. Walworth; No. 8906F

## 2.6 PLUG VALVES

- A. Type PV1 - Valves 2" (50mm) and smaller shall be 175 psig (1205 kPa) WOG lubricated short pattern type. Body shall be ASTM A126 cast iron with threaded ends, Teflon coated full port steel plug, and wrench operator. Valve shall be:
1. Powell; No. 2200
  2. Rockwell; No. 142
  3. Walworth; No. 1796



- B. Type PV2 - Valves 2-1/2" (63mm) through 4"(100mm) shall be 175 psig (1205 kPa) WOG lubricated short pattern type. Body shall be ASTM A126 cast iron with flanged ends, Teflon coated full port steel plug, and wrench operator. Valve shall be:
  - 1. Powell; No. 2201
  - 2. Rockwell; No. 143
  - 3. Walworth; No. 1797F
  
- C. Type PV3 - Valves 6" (150mm) through 12" (300mm) shall be 200 psig (1375 kPa) WOG lubricated short pattern type. Body shall be ASTM A126 cast iron with flanged ends, Teflon coated full port steel plug, and wrench operator. Valves shall be:
  - 1. Powell; No. 2201
  - 2. Rockwell; No. 143
  - 3. Walworth; No. 1718F

## 2.7 METERED BALANCING VALVES

- A. Type MB1 - Valves 4" (100mm) and smaller shall be 175 psig (1205 kPa) WOG combination balancing and shut-off type. Valve body shall be bronze ASTM B62 with threaded ends, bronze ball or plug disc, bronze stem, integral meter connection taps with shutoff cocks, and calibrated nameplate and flow indicator. Error of flow indicator and meter reading shall be a maximum of 2% of full scale. Valves shall be:
  - 1. Watts; Series CSM
  - 2. Bell & Gossett; Circuit Setter
  - 3. Illinois; 6000 Series
  - 4. Mepco; Model MBV
  - 5. Presco; B-Plus
  - 6. Sarco; Balanced Master
  - 7. Taco; Circuit Setter
  - 8. Tour & Anderson; Model STAD/STAS (1/2" (13mm)-2" (50mm))
  - 9. Model STAF (above 2" (50mm))
  - 10. Model STAG (grooved - 2 1/2" (63mm) - 12" (300mm))
  
- B. Meter kit shall be portable readout type designed for service with the valves supplied. Meter kit shall include differential pressure meter, two 10 foot (3000mm) hoses (2 colors), shutoff and vent valves, and carrying case. Meter kit shall be:
  - 1. Watts; Series PG
  - 2. Bell & Gossett; Series RO
  - 3. Illinois; Series PG
  - 4. Mepco; Part no. 150S07A7
  - 5. Presco; GMD Meter
  - 6. Sarco; Model S-831
  - 7. Taco; Model No. 789
  - 8. Tour & Anderson; CBI Meter
  
- C. Type MB2 - Automatic flow control valves 4" (100mm) and smaller shall be 400 psig (2760 kPa) at 250 degrees F (121 degrees C) factory set combination balancing and shut-off type. Valve body shall be forged brass with sweat and thread configuration, integral ball valve with regulator, steel handle with vinyl grip, integral meter connection taps with shut-off cocks, and calibrated nameplate and flow indicator. Flow cartridge shall be removable from the valve body to provide access for gpm changes, inspection and cleaning without breaking the main piping. The internal flow cartridge shall be permanently marked with the GPM and spring range. Body of valve shall be factory tagged with unit and flow. The internal wear of the surfaces of the valve cartridge shall be stainless steel. Error of flow shall be a maximum of 5%. Pressure drop across valve shall not exceed 5 ft (15 kPa). Valves shall be:

1. Autoflow
2. Bell & Gossett
3. Griswold
4. Hays

## 2.8 CHECK VALVES

- A. Type CV1 - Valves 2" (50mm) and smaller shall be class 125 horizontal swing type conforming to MSS SP-80. Body and cap shall be ASTM B62 cast bronze with threaded ends, inside screw cap, and bronze disc. Valves shall be:
1. Crane; No. 1707
  2. Hammond; No. IB904
  3. Lunkenheimer; No. 2144
  4. Milwaukee; No. 509
  5. Nibco; No. T-413-BY
  6. Powell; No. 578
  7. Stockham; No. B-319
  8. Walworth; No. 3406
- B. Type CV2 – Valves 2" (50mm) and smaller shall be class 150 horizontal swing type conforming to MSS SP-80. Body and cap shall be ASTM B62 cast bronze with threaded ends, union cap ring, and bronze disc. Valves shall be:
1. Crane; No. 137
  2. Hammond; No. IB944
  3. Lunkenheimer; ---
  4. Milwaukee; No. 510
  5. Nibco; No. T-433-B
  6. Powell; ---
  7. Stockham; No. B-321
  8. Walworth; ---
- C. Type CV4 - Valves 2-1/2" (63mm) through 14" shall be class 125 horizontal swing type conforming to MSS SP-71. Body and cap shall be ASTM A126 cast iron with flanged ends, bolted cap, and bronze or cast iron disc. Valve shall be:
1. Crane; No. 373
  2. Hammond; No. IR1124
  3. Lunkenheimer; NO. 1790
  4. Milwaukee; No. F-2974
  5. Nibco; No. F-918-B
  6. Powell; No. 559
  7. Stockham; No. G-931
  8. Walworth; No. 8928F
- D. Type CV6 - Valves 3" through 24" shall be class 125 silent globe type. Body shall be ASTM A48 cast iron with flanged ends, bronze trim, and stainless steel spring. Valve design shall provide an open area in the body equal to not less than 110% of the corresponding pipe area. Valve shall be:
1. APCO; 6000 Series
  2. CPV; Globe Type
  3. Kelflex; K-check
  4. Metraflex; Globe Type
  5. Mueller Steam Co.; No. 105M-AP
  6. Nibco; No. F-910

- E. Type CV7 – Valves 2 ½” (53mm) through 12: (300mm) shall be 300 psig (2065 kPa) silent butterfly type. Body shall be ASTM A536 ductile iron, ASTM A220 pearlitic malleable iron or ASTM A47 malleable iron with grooved ends, bronze alloy, ductile iron or stainless steel disc, stainless steel spring, stainless steel hinge pin and EPDM O-ring seals. Valve shall be:
1. Anvil; No. 7800 Series
  2. Victaulic; No. 716/799

2.9 MISCELLANEOUS VALVES

- A. Hose end drain valves shall be class 125 angle type. Body and bonnet shall be cast bronze with threaded inlet, hose thread outlet, inside screw, solid wedge disk, and malleable iron hand wheel. Valve shall be Nibco, No. T-113-HC-MH

**PART 3 - EXECUTION**

3.1 VALVE SERVICE

- A. Valve types specified hereinbefore shall be used on the systems and services as outlined below and shown on the drawings.
1. Valves 2” (50mm) and smaller:

<u>SYSTEM</u>	<u>SHUT-OFF SERVICE</u>	<u>BALANCING SERVICE</u>	<u>CHECK SERVICE</u>
a. Hot Water	GV2	MB2	CV2,CV6
b. Condenser Water	GV1	MB2, BL1, GB1, PV1	CV1
c. Condensate Drain	GV1	N/A	CV1
d. Make-Up Water	GV1	GB1	CV1
e. Loop Water	GV1	MB2,BL1, GB1,PV1	CV1

2. Valves 2-1/2” (63mm) and larger:

<u>SYSTEM</u>	<u>SHUT-OFF SERVICE</u>	<u>BALANCING SERVICE</u>	<u>CHECK SERVICE</u>
a. Hot Water	GV4, BF2, BF4	GB4, PV2, BF2, BF4, PV3, MB2	CV4, CV6, CV7
b. Condenser Water	GV4, BF2, BF4	BF2, BF4	CV4, CV6, CV7
c. Loop Water	GV4, BF2, BF4	BF2, BF4	CV4, CV6, CV7

3.2 INSTALLATION

- A. All valves in horizontal lines shall be installed with the stem horizontal or above. Valve handwheels shall be oriented when installed to provide accessibility for operations.
- B. Flanged butterfly valves shall be installed between ASA 150 lb. (1035 kPa) raised face steel slip-on weld flanges.

- C. Non-slam check valves shall be installed between ASA 150 lb. (1035 kPa) flat face steel slip-on weld flanges.
- D. Where indicated on the drawings provide T-wrench operator for valves located in pits.
- E. Provide 3 wrenches for each size plug valve.
- F. Provide meter kit for metered balancing valves.

**END OF SECTION**

## SECTION 230529

### HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

#### 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. Work Included
  - 1. Hangers and supporting devices for all mechanical piping.

##### 1.3 SUBMITTALS

- A. General: All submittals shall comply with the requirements of Division 1 - GENERAL REQUIREMENTS and Section 230500 COMMON WORK RESULTS FOR HVAC.
- B. Product Data: Data shall be submitted on the following items:
  - 1. Hangers and supporting devices to be used.

##### 1.4 QUALITY ASSURANCE

- A. Standards
  - 1. American Society for Testing Materials (ASTM):
    - a. Standard E84, Surface Burning Characteristics of Building Materials.
    - b. Standard A446, Specification for steel sheet, zinc coated (galvanized) by the hot dip process, structural (physical quality), edited.

##### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Hangers and support accessories and equipment curbs and rails received and stored on the job site shall be stored in dry storage spaces, (e.g. building, trailer, or shed) whenever possible. Hangers and support accessories shall be stored on wooden rails, wooden pallets, or shipping skids. Under no condition shall the hangers and support accessories be stored in such a way that metal components are in direct contact with the ground or floor slabs.
- B. Where it is not practical to store items within an enclosure, hangers and support accessories may be stored on wooden rails, wooden pallets, or shipping skids outside.
- C. Hangers and support accessories and equipment curbs and rails shall be covered with 6 mil polyethylene sheet (taped in place) to protect the equipment from damage and the weather.

**PART 2 - PRODUCTS**

2.1 GENERAL

- A. Provide all hangers and rods, turnbuckles, angles, channels and other structural supports to support the piping systems.
- B. Pipe hangers, hanger rods, trapeze type hangers, upper attachments and other supports shall be selected based on pipe size (plus insulation of pipes specified to be insulated) and the weight of the medium being transported or the medium used for testing, whichever is heavier.
- C. Rods for pipe hangers shall be carbon steel. Standard hanger rod sizes shall be:

Pipe Size	Diameter
1. 1/2" - 2" (13mm - 50mm)	3/8"(10mm)
2. 2-1/2" - 3" (62mm - 75mm)	1/2"(13mm)
3. 4" - 5" (100mm - 125mm)	5/8"(16mm)
4. 6" (150mm)	3/4"(20mm)
5. 8" - 12" (200mm - 300mm)	7/8"(22mm)
6. 14" - 16" (350mm - 400mm)	1"(25mm)
7. 18" (450mm)	1-1/8"(27mm)
8. 20" (500mm) & Larger	1-1/4"(30mm)
- D. All ferrous metal pipe hangers, except copper plated hangers, and concrete inserts shall be provided with a factory applied coat of rust inhibiting paint.
- E. Pipe hangers for suspending the following horizontal insulated piping shall be sized to fit directly around the pipe:
  - 1. Piping 2 inches (50mm) and smaller for hot water heating.
- F. Pipe hangers for suspending the following horizontal insulated piping shall be sized to fit around the pipe, pipe insulation and pipe insulation protective shields:
  - 1. Refrigerant suction piping.
  - 2. Condensate drain piping from air handling units.
  - 3. Waste piping from drinking fountains.
  - 4. Waste piping receiving condensate from air handling units.
- G. Pipe hangers for suspending the following horizontal insulated piping shall be sized to fit around the pipe, pipe insulation and pipe insulation protective saddle:
  - 1. Piping 2-1/2 (63mm) inches and larger for hot water heating.
- H. All supporting equipment with the exception of springs in spring isolation hangers shall be designed with a minimum factor of safety of five based on the ultimate tensile strength of the material.

2.2 PIPE SUPPORTS FOR SUSPENDED HORIZONTAL PIPING

- A. Pipe support for suspended horizontal piping shall be the following:

SYSTEM	PIPE MATERIAL	PIPE SIZE	HANGER NUMBER
1. Hot Water Heating	Steel	2" (50mm) & Smaller	II
2. Hot Water Heating	Copper	2" (50mm) & Smaller	IV
3. Hot Water Heating	Steel	2- <sup>1</sup> / <sub>2</sub> " (63mm) & Larger	III
4. Condenser Water	Steel	All Sizes	I
5. Loop Water	Steel	All Sizes	I

6.	Refrigerant (Insulated)	Copper	All Sizes	I
7.	Refrigerant (Uninsulated)	Cooper	All Sizes	IV
8.	Make-up Water	Steel	2" (50mm) & Smaller	I
9.	Make-up Water	Steel	2- $\frac{1}{2}$ " & Larger	I
10.	Make-up Water	Copper	All Sizes	IV
11.	Condensate Drains	Steel	All Sizes	I
12.	Chemical Feed	Steel	All Sizes	I
13.	Chemical Feed	PVC	All Sizes	I

B. Hanger numbers listed in schedule above shall be the following types:

1. Hanger Number I: Clevis hanger, steel.
2. Hanger Number II: Adjustable split ring hanger, malleable iron.
3. Hanger Number III: Adjustable swivel clevis roller hanger with black cast iron roller and carbon steel yoke and cross bolt.
4. Hanger Number IV: Clevis hanger, copper plated steel.

C. Hanger numbers listed above shall be:

	<u>I</u>	<u>II</u>	<u>III</u>	<u>IV</u>
1. B-Line Systems	B3100	---	B3111	B3104CT
2. Carpenter & Patterson	100	240	140	100CT
3. Anvil	260	104	181	CT-65
4. Erico	400	111	610	402

D. Upper Attachments

1. Steel Construction
  - a. For suspending pipes from steel beams, upper attachments shall be beam clamps and shall be:
    - 1) B-Line Systems; Fig. B3055
    - 2) Carpenter & Paterson; Fig. 268
    - 3) Anvil Fig. 133
  - b. For suspending pipes from bottom chord of steel bar joists, upper attachments shall be C-clamps with retaining clips and shall be:
    - 1) B-Line Systems; Figs. B351, B3362 and B3363
    - 2) Carpenter & Paterson; Figs. 238 and 22
    - 3) Anvil; Figs. 87 and 89
    - 4) Erico; No. 255 and 255C
  - c. For suspending pipes from the top chord of steel bar joists, upper attachments shall be top-of-beam C-clamps and shall be:
    - 1) B-Line Systems; Fig. B3034
    - 2) Carpenter & Paterson; Fig. 192
    - 3) Anvil; Fig. 92
    - 4) Erico; No. 300
2. Concrete Construction
  - a. New Construction
    - 1) For suspending pipe in concrete construction, upper attachments shall be adjustable type concrete inserts. Where weight to be supported by an insert is 300 lbs. (136 kg) or more, install two No. 3 steel reinforcing bars, each 3 ft. (900mm) long, through the yoke of the insert. Concrete inserts shall be:
      - a) B-Line Systems; Fig. B2500
      - b) Carpenter & Paterson; Fig. 75
      - c) Anvil; Fig. 281
      - d) Erico; No. 355

- 2) For suspending pipes in concrete construction, upper attachments shall be continuous concrete inserts complete with nuts. Continuous concrete inserts shall be:
  - a) B-Line Systems; Figs. B22I, B32I, B42I or B52I
  - b) Carpenter & Paterson; Fig. 650
- b. Existing Construction
  - 1) For suspending pipes in concrete construction, upper attachments shall be electro-galvanized concrete anchors. Anchors shall be flush-mount, threaded type requiring separate drilling. Anchors shall be:
    - a) Erico, No. 345-R
    - b) B-Line Systems; ADI Series
    - c) Carpenter & Paterson; Fig. 514

### 2.3 PIPE SUPPORTS FOR FLOOR SUPPORTED HORIZONTAL PIPING

#### A. General

1. Pipe supports for horizontal piping supported on concrete floors and on concrete bases shall be adjustable pipe saddle support with U-bolt and screwed floor flange. Bolt floor flange to floor and bases utilizing all bolt holes. Adjustable pipe saddle supports shall be steel and shall be:
  - a. B-Line Systems; Fig. B3090 and B3088
  - b. Carpenter & Paterson; Fig. 125SP
  - c. Erico; No. 724
2. Pipe supports for horizontal piping in trench below floor level shall be adjustable pipe roller stands. Base shall be bolted to the trench floor utilizing all bolt holes. Adjustable pipe roller stands shall be steel and cast iron and shall be:
  - a. B-Line Systems; Fig. B3118SL
  - b. Carpenter & Paterson; Fig. 40
  - c. Anvil; Fig. 274
  - d. Erico; No. 619

### 2.4 PIPE SUPPORTS FOR VERTICAL PIPING

#### A. Supports for vertical piping shall be riser clamps sized to fit directly around the pipe.

1. Riser clamps shall be steel and shall be:
  - a. B-Line Systems; Fig. B3373
  - b. Carpenter & Paterson; Fig. 126
  - c. Anvil; Fig. 261
  - d. Erico; No. 510
2. Offset pipe clamps shall be steel and shall be:
  - a. B-Line Systems; Fig. B3148
  - b. Carpenter & Paterson; Fig. 179
  - c. Anvil; Fig. 103
  - d. Erico; No. 700
3. Clamps for copper tubing shall be copper plated.

### 2.5 PIPE INSULATION PROTECTIVE SHIELDS AND SADDLES FOR HORIZONTAL PIPING

#### A. Shields shall be galvanized sheet metal type. Shields shall be 180 degrees type at all pipe hangers. Shields shall be 360 degrees type on trapeze hangers, pipe racks, and on floor supported horizontal pipes. Shields sizes shall be:

1. Pipes 2 in. (50mm) and smaller -- 18 gage x 12" long (1.3 mm x 300mm long)



- 2. Pipes 2-1/2 in. thru 6" --(150mm) 16 gage x 18" long(1.5mm x 450mm long)
- 3. Pipes 8 in. (200mm) and larger -- 14 gage x 24" long(2.0mm x 600mm long)

B. Saddles shall be steel and shall be:

		Insulation Thickness				
		<u>1" (25mm)</u>	<u>1-1/2" (37mm)</u>	<u>2" (50mm)</u>	<u>2-1/2" (63mm)</u>	<u>3" (75mm)</u>
1.	B-Line Systems	B3160	B3161	B3162	B3163	B3164
2.	Carpenter & Patterson	351	352	353	354	355
3.	Anvil	160	161	162	163	164
4.	Erico	630	631	632	633	634

### 2.6 FACTORY FABRICATED FRAMING CHANNELS AND FITTINGS

- A. Factory fabricated framing channels and fittings shall be used for:
  - 1. Constructing pipe racks for supporting multiple horizontal pipes where indicated on the drawings.
  - 2. Constructing trapeze type hangers for suspending multiple horizontal pipes where indicated on the drawings.
- B. Framing channels and fittings shall be provided with factory applied baked enamel finish.
- C. Galvanized pipe clamps, including bolts and nuts, shall be provided with the framing channels and shall be used for securing pipes to channels. Pipe roller type supports shall be provided for pipes 2-1/2 inches (63mm) and larger for hot water heating. Pipe roller supports shall include rollers, 1/2 inch (13mm) diameter axle, nuts and angle brackets. Pipe clamps on insulated pipes shall fit around pipe, pipe insulation and pipe insulation protection shield. Pipe roller supports on insulated pipes shall be sized to fit around pipe saddles.
- D. Framing channels and fittings shall be:
  - 1. B-Line Systems; Strut System
  - 2. Erico; Strut System
  - 3. Unistrut; Metal Framing System
  - 4. Anvil; Power Strut

## PART 3- EXECUTION

### 3.1 HORIZONTAL PIPE SUPPORT INSTALLATION

- A. Spacing of hangers and supports shall be as follows:
  - 1. Cast iron soil pipe shall be supported at not more than five feet intervals and near each hub or coupling.
  - 2. Copper Tubing:

<u>Nominal Tubing Size</u>	<u>Maximum Spacing of Supports - Feet</u>
a. 3/4" (20mm) & smaller	5 (1600mm)
b. 1 in. through 3 in. (25mm-75mm)	6 (1800mm)
c. 4 in. (100mm) and larger	12 (3600mm)

3. Steel Pipe:

<u>Nominal Pipe Size</u>	<u>Maximum Spacing of Supports - Feet</u>
a. Up thru 1-1/4 in. (32mm)	6 (1800mm)
b. 1-1/2" thru 2-1/2"(37mm-62mm)	8 (2400mm)
c. 3 in. and 4 in. (75 mm & 100 mm)	12 (3600mm)
d. 5 in. thru 8 in. (125mm - 200 mm)	16 (4800mm)
e. 10 in. (250mm) and larger	20 (6000mm)

4. PVC Pipe: All sizes; 4'-0" (1200mm).

- B. Additional hangers shall be provided adjacent to all valves and fittings size 8" (200mm) and larger.
- C. Intermediate pipe supports shall be provided between building structural members so as not to exceed maximum support spacing hereinbefore specified.
1. In filler type concrete construction, intermediate angle supports shall be fastened to concrete joists or beams. In no case shall angle supports be fastened in floor slabs or in roof slabs. Intermediate supports shall be fastened to concrete with concrete inserts or concrete anchors.
  2. In steel construction, intermediate supports shall be welded to steel beams and to steel joists. In no case shall supports be attached to roof purlins, roof decks, or permanent metal forms.

3.2 UNDERGROUND PIPING

- A. Piping in earth shall be laid on a firm bed for its entire length.

3.3 VERTICAL PIPE SUPPORT INSTALLATION

- A. Supports for all pipes shall fit directly around the pipe. On insulated pipes, the support shall be insulated and provided with vapor barrier as specified for pipe insulation in Section 230700 HVAC INSULATION.
- B. Vertical pipes passing through floors shall be provided with a riser clamp at each floor. Where opening in floor is sleeved, riser clamps shall have steel lugs, 1/4" thick x 2" high x 1-1/2" long (6mm thick x 50mm high x 37mm long), welded to the clamp arms so that clamp does not come in contact with the pipe sleeve; the lugs shall support the clamp from the floor. Where floor opening does not have a sleeve, a 3 inch (75) high concrete curb shall be installed around the opening.
- C. Where distance between floors is greater than 15 ft. (4500mm) or where drop within one floor level is more than 15 ft. (4500mm), vertical pipes shall be provided with offset pipe clamps anchored to walls at the approximate midpoint between floors.
- D. Exposed to sight vertical service drops to gas outlets shall be supported with not less than two equally spaced sections of factory fabricated framing channel with standard pipe clamps. Channel sections shall be 8" (200mm) long and shall be fastened to wall with not less than two spring wing toggle bolts.
- E. Copper tubing supported by channel framing shall be provided with a lead sleeve to isolate the pipe from the framing channel and the pipe clamp.

3.4 CONCRETE INSERTS AND ANCHORS

- A. In filler type concrete construction, inserts and anchors shall be installed in joists or beams only. Install inserts in sides of joists or beams.

- B. In framed type concrete construction, inserts and anchors shall be installed no closer than 6 inches (150mm) to edge of slab.

### 3.5 SHIELD AND SADDLE INSTALLATION

- A. Shields shall be installed at all pipe hangers in horizontal insulated condensate drain, and refrigerant suction piping.
- B. Saddles shall be installed at all pipe hangers in horizontal insulated hot water heating piping 2-1/2" (62mm) in size and larger. Floor supported piping shall have saddles on the top and bottom of pipe. Weld saddle lugs to pipe and fill with the same type of insulation as the pipe insulation.

**END OF SECTION**

**SECTION 230533**

**HEAT TRACING FOR HVAC PIPING**

**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. Work Included:
  - 1. Heat Tape

1.3 SUBMITTALS

- A. General: All submittals shall comply with the requirements of Division 1 - GENERAL REQUIREMENTS and Section 230500 COMMON WORK RESULTS FOR HVAC.
- B. Product Data: Data shall be submitted on the following items:
  - 1. Heat Tape
- C. Operation and Maintenance Data: Data shall be provided on the following items:
  - 1. Heat Tape

1.4 QUALITY ASSURANCE

- A. Standards:
  - 1. National Electrical Code (NEC)
  - 2. Underwriter's Laboratories (UL)

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Electric heating equipment received and stored on the job site shall be stored in dry storage spaces, (e.g. building, trailer, or shed) whenever possible. Electric heating equipment shall be stored in shipping cartons on wooden rails, or wooden pallets. Under no condition shall the electric heating equipment be stored in such a way that metal components are in direct contact with the ground or floor slabs.
- B. Where it is not practical to store items within an enclosure, electric heating equipment may be stored on wooden rails or wooden pallets outside.
- C. Electric heating equipment shall be covered with 6 mil polyethylene sheet (taped in place) to protect the equipment from damage and the weather.

**PART 2 - PRODUCTS**

2.1 HEAT TAPE

- A. Heat tape shall be self-regulating resistance type heating cables with a metallic braid and outer jacket. Heat tape shall be UL approved and rated at 8 watts per lineal foot. Heat tape shall be:
  - 1. Thermon
  - 2. Raychem
  - 3. Cromalox

**PART 3 - EXECUTION**

3.1 INSTALLATION

A. Heat Tape:

1. Install heat tape under insulation on piping aboveground and exterior to the building.
2. Heating tape shall not cross over itself. Heating tape shall be permanently connected to junction boxes provided on the electrical drawings.
3. Heating tape shall be tested prior to installation of covering insulation.
4. Heating tape shall be installed in accordance with manufacturer's recommendations.

**END OF SECTION**

## SECTION 230548

### VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

#### 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. Work Included
  - 1. Isolation Pads
  - 2. Spring Isolators
  - 3. Spring Hangers

##### 1.3 SUBMITTALS

- A. General: All submittals shall comply with the requirements of Division 1 - GENERAL REQUIREMENTS and Section 230500 COMMON WORK RESULTS FOR HVAC.
- B. Product Data: Data shall be submitted on the following items:
  - 1. Spring Hangers
  - 2. Vibration Isolators

##### 1.4 QUALITY ASSURANCE

- A. Standards
  - 1. Sheet Metal and Air Conditioning Contractor's National Association, (SMACNA): Seismic Restraint Manual Guidelines for Mechanical Systems. 1999 Edition

##### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Seismic braces received and stored on the job site shall be stored in dry storage spaces, (e.g. building, a storage trailer, or shed). Under no condition shall the units be stored in such a way that metal components are in direct contact with the ground.

#### PART 2 - PRODUCTS

##### 2.1 SOLE SOURCE

- A. All isolators and bases shall be from the same manufacturer.

## 2.2 DEFLECTION

- A. All spring isolators shall have 1" (25mm) minimum deflection unless otherwise specified.

## 2.3 TYPE I ISOLATORS

- A. Type I Isolators shall be neoprene waffle embossed pads with crossed double ribs. A steel shim plate shall be provided between the two layers. Pads shall be molded using oil resistant 25,000 PSI (172370 kPa) tensile strength neoprene. Pads shall be:
1. Kinetics Noise Control; NPD Series
  2. Amber Booth; NP-NR Series
  3. Mason Industries; WMW Series
  4. VECO; 200N

## 2.4 TYPE V ISOLATORS

- A. Type V suspension isolators shall be combination spring and neoprene hangers, incorporating double deflection neoprene noise and vibration isolation pads in series with the springs, all encased in welded steel brackets. Springs shall be designed for 50% overload capacity, and shall accommodate rod misalignment over a 30 degree arc. Brackets shall be designed to carry 50% overload without failure. Isolators shall be:
1. Kinetics Noise Control; SRH Series
  2. Amber Booth; BSR Series
  3. Mason Industries; DNSH Series
  4. VECO; Model SNRC

**PART 3 - EXECUTION**

## 3.1 INSTALLATION

- A. All isolation products shall be installed in accordance with the manufacturer's installation instructions.
- B. All spring-mounted equipment shall be leveled.
- C. Type V isolators shall have jam nuts on the top and bottom rods to prevent movement of nuts.

## 3.2 ISOLATION SCHEDULE

- A. Isolators and bases shall be installed on equipment and piping as indicated on schedule below:

	Item	Isolator	Base	Min.Deflection (In)	Notes
1.	Piping	V	N/A	1"	1, 2

- a. Schedule Notes:
- 1) Hot water and condenser water piping within mechanical room shall be isolated with Type V isolators.
  - 2) Type V isolators shall be installed in the first three pipe hangers from pumps in the hot water, and condenser water systems. and on first three pipe hangers on lines serving equipment mounted on vibration isolators.

**END OF SECTION**



## SECTION 230553

### IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

#### 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. Work Included:
  - 1. Valve Tags
  - 2. Pipe Bands
  - 3. Equipment Labels

##### 1.3 SUBMITTALS

- A. General: All submittals shall comply with the requirements of Division 1 - GENERAL REQUIREMENTS, and Section 230500 COMMON WORK RESULTS FOR HVAC.
- B. Product Data: Data shall be submitted on the following items:
  - 1. Valve Tags
  - 2. Pipe Bands
  - 3. Equipment Labels

##### 1.4 QUALITY ASSURANCE

- A. Standards
  - 1. American National Standards Institute (ANSI):
    - a. Standard A13.1, The Scheme for Identification of Piping Systems.
  - 2. National Fire Protection Association (NFPA)
    - a. Standard 45, Fire Protection for Laboratories Using Chemicals.

##### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Tapes, labels, paint received and stored on the job site shall be stored in dry storage spaces, (e.g. building, a storage trailer, or shed). Under no condition shall the units be stored in such a way that metal components are in direct contact with the ground.
- B. Tapes, labels, paint shall be covered with 6 mil (.4mm) polyethylene sheet (taped in place) to protect the equipment from damage and the weather.

**PART 2 - PRODUCTS**

## 2.1 GENERAL

- A. Pipe identification shall comply with ANSI A13.1.

## 2.2 VALVE TAGS

- A. Valve tags shall be 19 gauge (1.2 mm) minimum brass with 1-1/4" (30 mm) minimum height and width. Identification letters 1/4" (6mm) high and numbers 1/2" (12mm) high shall be stamped in tag and shall be filled with black enamel paint. Valve tags shall be:

1. Emedco; CB/W Series
2. Seton; Valve Tags
3. Brady; Valve Tags
4. Marking Services; Valve Tags

- B. Valve tag shape and designations shall be:

<u>System</u>	<u>Identification Numbers</u>	<u>Tag Shape</u>
1. Hot Water Heating	HW - 1, 2, 3, . . .	Round or Square
2. Condenser Water	CW - 1, 2, 3, . . .	Round or Square
3. Loop Water	LPW - 1, 2, 3, .	Round or Square

## 2.3 PIPE MARKINGS

- A. Pipe identification bands shall be snap-on type with clear polyester exterior surface. Bands shall include directional flow arrows and legends. Identification bands on pipe or coverings 5-1/2" (138mm) or less in diameter shall be sized to fit around pipe and overlap self. Identification bands on pipe or covering 6" (150 mm) or more in diameter shall have stainless steel spring fasteners. Pipe identification bands shall be:

1. Seton/Setmark; SNA/STR Series
2. Brady; Snap-on Series
3. Brimar Industries; System #1
4. Marking Services; MS-970 Series

- B. Bands shall be color and background as indicated below.

<u>Pipe</u>	<u>Band Color</u>	<u>Lettering</u>	<u>Lettering Color</u>
1. Loop Water Supply	Green	LOOP WATER SUPPLY	White
2. Loop Water Return	Green	LOOP WATER RETURN	White
3. Hot Water Heating Supply	Yellow	HOT WATER SUPPLY	Black
4. Hot Water Heating Return	Yellow	HOT WATER RETURN	Black
5. Condenser Water Supply	Green	CONDENSER WATER SUPPLY	White
6. Condenser Water Return	Green	CONDENSER WATER RETURN	White
7. Condensate Drain	Yellow	CONDENSATE DRAIN	Black
8. Refrigerant Suction	Yellow	REFRIGERANT. SUCTION	Black
9. Refrigerant Liquid	Yellow	REFRIGERANT. LIQUID	Black
10. Refrigerant Hot Gas	Yellow	REFRIGERANT GAS	Black

- C. Band width and lettering size shall be as follows:

Pipe or Pipe Covering Diameter (inches)(mm)	Band Width (inches)(mm)	Lettering Size (inches)(mm)
1. 3/4 to 2 (20 mm to 50 mm)	8 (200 mm)	3/4 (20 mm)
2. 2-1/2 to 6 (60 mm to 150 mm)	12 (300 mm)	1-1/4 (30 mm)
3. 8 to 10 (200 mm to 250 mm)	24 (600 mm)	1-3/4 (40 mm)
4. Over 10 (250 mm)	32 (800 mm)	3-1/2 (80 mm)

#### 2.4 EQUIPMENT LABELS

- A. Equipment identification labels shall be black plastic laminate with white letters. Labels shall be 2" high with 1/2" minimum letters. Equipment terminology shall be same as shown on equipment schedules, (i.e. AHU-1, CH-1, etc.).

#### 2.5 TAPE

- A. Identification tape shall be vinyl pressure sensitive type with adhesive backing. Tape width shall be a minimum of 2"(50 mm). Tape shall be color to match pipe identification band background. Tape shall be:
1. Emedco; T100 Series
  2. Seton; PST Series
  3. Brady; Tape
  4. Marking Services; MS-900

#### 2.6 CABLE TIES

- A. Cable ties for valve tag attached shall be self-locking nylon ties. Cable ties shall be:
1. Thomas & Betts; Ty-Rap-Nylon
  2. Ideal; Double Lock Cable (Plain Head)
  3. Efcor; Sure-Ty Self-Locking Cable Ties

#### 2.7 VALVE CHART

- A. Valve chart shall be typed listing of all valve tags. List shall include identification number, valve location in system (e.g., water heater, chilled water pump, etc.) and its function (e.g., shut-off, balancing, drain, etc.). Chart shall be mounted in a aluminum frame with glass or plastic cover. Chart shall be turned over to owner.

#### 2.8 SPECIAL IDENTIFICATION.

- A. Air discharged from the building containing a chemical hazard shall be labeled as such and identify the equipment ventilated. All labels shall comply with NFPA 45.

**PART 3 - EXECUTION**

## 3.1 INSTALLATION

- A. Valve tags shall be installed at all shut-off, balancing, metering, and drain valves. Valve tags shall be attached to the handwheel with cable ties.
- B. Pipe identification bands shall be installed on piping at each valve, each piece of equipment, each change of direction, wall penetration, each branch take-off, and at a maximum spacing of 20 feet (6.5M) on exposed straight run piping
- C. Plastic pipe bands shall be wrapped around pipe or pipe covering under pressure so that no gaps or wrinkles occur. Bands on pipe or pipe covering 6" (150 mm) or smaller shall overlap and adhere to themselves. Bands on pipe or pipe covering larger than 6" (150 mm) shall be further secured at both ends with tape. Tape shall overlap and adhere to itself.
- D. Equipment labels shall be attached to equipment using self tapping stainless steel screws or contact-type permanent adhesive.

**END OF SECTION**

## SECTION 230593

### TESTING, ADJUSTING AND BALANCING FOR HVAC

#### 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. Work Included
  - 1. Performance Testing
  - 2. Balancing
- B. Description
  - 1. The Contractor shall obtain the services of an independent test and balance agency who shall performance test and balance the following systems:
    - a. All air distribution (i.e., supply, return, exhaust)
    - b. Hot water heating
    - c. Condenser water
    - d. Loop water

##### 1.3 SUBMITTALS

- A. General: All submittals shall comply with the requirements of Division 1 - GENERAL REQUIREMENTS and Section 230500 COMMON WORK RESULTS FOR HVAC.
- B. Product Data: Data shall be submitted on the following:
  - 1. Balance procedure
  - 2. Balance forms
- C. Certificates: Certificates shall be submitted on the following:
  - 1. Test equipment calibration including date of last calibration.
  - 2. Certificate of membership in AABC or NEBB.
- D. Reports: Reports shall be submitted on the following:
- E. Field balance report.

##### 1.4 QUALITY ASSURANCE

- A. Standards
  - 1. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE):
    - a. Fundamentals.
  - 2. Associated Air Balance Council (AABC):

- a. National Standards for Field Measurements and Instrumentation, Total System Balance, Air Distribution - Hydronic Systems - Air Pollution - Sound Vibration.
3. National Environmental Balancing Bureau (NEBB):
  - a. Procedural Standards for Testing - Balancing - Adjusting of Environmental Systems.
- B. Qualification of Testers:
  1. The balancing personnel shall be familiar with and perform the balancing in accordance with AABC MN-1-1989 or NEBB-1998 procedures using forms of appropriate organization.
  2. The balancing firm shall be a certified member of AABC or NEBB.
  3. The independent test and balance company shall have a minimum of five years experience as an independent test and balance company.

## **PART 2 - PRODUCTS**

### 2.1 EQUIPMENT

- A. Instruments used for balancing shall have been calibrated within 6 months prior to the balancing of the systems.
- B. All instruments required to balance the system shall be provided at the Contractor's expense.

## **PART 3 - EXECUTION**

### 3.1 GENERAL BALANCING

- A. Water
  1. Adjust and balance water systems indicated hereinbefore to obtain design flow rates for system as a whole and for each component individually. Use flow measuring devices and/or pressure gauges.
  2. Coils with two - way control valves shall have valve positioned full open; coil pressure drop shall be adjusted to required value.
  3. Coils with three - way control valves shall have valve positioned full open to coil; coil pressure drop shall be adjusted to required value. Three - way control valve shall then be positioned to full by-pass; by-pass pressure drop shall be adjusted to match coil drop.
- B. Air
  1. Adjust and balance air systems indicated hereinbefore to obtain design flow rates for systems as a whole and for each inlet and outlet. Use balancing dampers and/or flow setting devices for inlet, outlet and branch adjustments. Use fan speed adjustment for belt drive fans. When balancing air devices in rooms, doors to room shall be closed.
  2. Pitot tube traverses shall be performed in accordance with ASHRAE Fundamentals.
- C. Final readings shall be set with -5% to +10% of design conditions.

### 3.2 REPORT

- A. The report of performance testing and balancing shall include data listed below:
  1. Name and address of project, name and address of Contractor, dates of all tests, name and telephone number of test engineer.

2. Grilles, registers and diffusers:
    - a. Fan System and/or zone number.
    - b. Room number.
    - c. Size of inlet or outlet.
    - d. Manufacturer's effective data.
    - e. Required flow and velocity.
    - f. Initial flow and velocity.
    - g. Final flow and velocity.
  3. Fans (including fans which are part of air conditioning equipment):
    - a. System and/or fan number.
    - b. Fan manufacturer, serial number and model number.
    - c. Motor manufacturer, horsepower, voltage, phase, RPM, type and service factor, amperage nameplate rating.
    - d. Scheduled data on drawings or in specifications.
    - e. Final air flow.
    - f. Final RPM.
    - g. Final total static pressure.
    - h. Final suction static pressure.
    - i. Final motor amperage.
    - j. Final brake horsepower.
  4. Water Coils (including coils which are part of air conditioning equipment):
    - a. System and/or equipment number.
    - b. Manufacturer and type.
    - c. Scheduled data on drawings or in specifications.
    - d. Water flow.
    - e. Entering and leaving water temperature.
    - f. Entering and leaving air temperature (dry bulb and wet bulb).
    - g. Air flow.
    - h. Air pressure drop.
    - i. Water pressure drop.
    - j. Load (BTU/HR).
  5. Pumps:
    - a. System and/or pump number.
    - b. Manufacturer, size and model.
    - c. Motor manufacturer, horsepower, voltage, phase, RPM, type, and amperage nameplate rating.
    - d. Scheduled data on drawings or in specifications.
    - e. Discharge and suction pressures.
    - f. Flow.
    - g. Amperage.
    - h. Brake horsepower.
- B. Any deviations from design data shall be explained in the report - possible reasons for and solutions to.
- C. Report shall be signed and dated by balance engineer.
- D. Test and balance shall not be performed until system installation is complete.
- E. Permanently mark the settings of all valves, dampers and other adjustment devices in a manner that will allow the settings to be restored. If a balancing device is provided with a memory stop, it shall be set and locked

**END OF SECTION**

**SECTION 230700**  
**HVAC INSULATION**

**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. Work Included:
  - 1. Pipe Insulation
  - 2. Ductwork Insulation
  - 3. Ductwork Liners
  - 4. Equipment Insulation

1.3 SUBMITTALS

- A. General: All submittals shall comply with the requirements of Division 1 - GENERAL REQUIREMENTS and Section 230500 COMMON WORK RESULTS FOR HVAC .
- B. Product Data: Data shall be submitted on the following items:
  - 1. Insulation
  - 2. Field Applied Jacketing
- C. Certificates: Certificates shall be submitted on the following:
  - 1. Certificates of compliance to the specified standards.

1.4 QUALITY ASSURANCE

- A. Standards
  - 1. American Society for Testing and Materials (ASTM):
    - a. Standard E84, Surface Burning Characteristics of Building Materials.
    - b. Standard C423, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
    - c. Standard C547, Mineral Fiber Performed Pipe Insulation
    - d. Standard C534, Preformed Flexible Elastomeric Cellular Thermal Insulation.
    - e. Standard C553, Mineral Fiber Blanket and Felt Insulation
    - f. Standard C612, Mineral Fiber Block and Board Thermal Insulation.
    - g. Standard C916, Standard Specification for Adhesives for Duct Thermal Insulation
    - h. Standard C1071 Thermal and Acoustical Insulation (Mineral Fiber, Duct Lining Materials)
    - i. Standard C1290 Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts
    - j. Standard G21, Practice for Determining Resistance of Synthetic Polymeric Material to Fungi



2. National Fire Protection Association (NFPA):
  - a. Standard 255, Test Methods, Surface Burning Characteristics of Building Materials.
  - b. Standard 96, Ventilation Control and Fire Protection of Commercial Cooking Operations.
3. Underwriters' Laboratories (UL):
  - a. Standard 723, Surface Burning Characteristics of Building Materials.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Insulation received and stored on the job site shall be stored in dry storage spaces, (e.g. building, trailer, or shed) whenever possible. Insulation shall be stored on wooden rails, wooden pallets, or shipping skids. Under no condition shall the insulation be stored in such a way that components are in direct contact with the ground or floor slabs.
- B. Where it is not practical to store items within an enclosure, insulation may be stored on wooden rails, wooden pallets, or shipping skids outside.
- C. Insulation shall be covered with 6 mil polyethylene sheet (taped in place) to protect the equipment from damage and the weather. UV sensitive material such as PVC and PVDC insulation material shall be protected from sunlight to avoid exposure to UV light from the sun.

### **PART 2 - PRODUCTS**

#### 2.1 FLAME AND SMOKE RATING

- A. Insulation material, adhesives, jackets, and tapes specified herein shall comply with ASTM E84, NFPA 255, and UL 723 for:
  1. Maximum flame spread rating: 25
  2. Maximum smoke developed rating: 50, unless indicated otherwise hereinafter.
  3. Compliance shall be for insulation, adhesive, and jacket or facing.

#### 2.2 FIBERGLASS PIPE INSULATION

- A. Insulation shall be one piece, designed for use on pipes up to 800°F (430° C) conforming to ASTM C 547.
- B. Maximum Conductivity ('K' value) of 0.23 BTU/in per Sq Ft. per °F (0.00014W/cm<sup>2</sup> °C) per hour at 75°F (24 ° C) mean temperature.
- C. Vapor Retarder jacket shall be white Kraft paper, reinforced with glass fiber yarn and bonded to aluminum foil, secure with self-sealing longitudinal laps and butt strips.
- D. Insulation shall be:
  1. Knauf; AJS/SSL pipe insulation
  2. Johns Manville; Micro-Lok AP-T
  3. Owens Corning; Fiberglas SSL II

E. Insulation thickness shall be as indicated in tables below:

System	Pipe sizes in inches (mm)				
	½ (12) Thick Insulation	1 (25) Thick Insulation	1-1/2 (37) Thick Insulation	2 (50) Thick Insulation	2-1/2 (62) Thick Insulation
1. Condensate Drain		All Sizes			
2. Make-up Water	All Sizes				
3. Heating Hot Water (105- 200°F) (41-93°C)		2" (50mm) & smaller	2-1/2" (62mm) & larger		

F. Thickness of insulation on pipes installed outside the building shall be increased a minimum of 1/2 inch (13mm).

### 2.3 FOAMGLAS PIPE INSULATION

- A. Insulation shall be closed cell, foamed glass type designed for use on surfaces up to 900°F (482°C).
- B. Insulation shall have a minimum density of 8 lb./Cu. Ft.(128 Kg/,m3) and a maximum conductivity ('K' value) of 0.33 Btu/In. per Sq. Ft. per °F per hour (0.00020W/cm2 °C) at 75°F (24°C) mean temperature.
- C. Insulation shall be provided with a factory applied aluminum foil and Kraft paper vapor barrier.
- D. Insulation shall be:
  - 1. Pittsburgh Corning
  - 2. ASC Industries; Foamglas
  - 3. Cell-U-foam
- E. Insulation thickness shall be 2 inches (50mm).

### 2.4 FOAMED PLASTIC PIPE INSULATION

- A. Insulation shall be self sealing, flexible cellular, elastomeric Type conforming to ASTM C 534, designed for use on pipes from -40°F to 220°F (-40°C to 105°C).
- B. Insulation shall have a minimum density of 6 lb./cu.ft. (96 Kg/m3) and a maximum conductivity ('K' value) of 0.28 Btu/In. per sq. ft. per °F per hour (0.00016W/cm2 °C) at 75°F (24°C) mean temperature, and a maximum permanence of 0.17 LB/sq. ft.
- C. Adhesives used for connections shall be manufacturer's standard waterproof vapor retarder.
- D. Insulation used outdoors shall be provided with manufacturer's Standard UV-Protection.
- E. Insulation shall be:
  - 1. Johns Manville           Aerotube AP/SS
  - 2. Armacell                 AP/SS Armaflex
  - 3. Rubatex                 R-180-FS
  - 4. Halstead                 F/R Insutube

- F. Insulation thickness shall be 3/4 inch (19mm).

## 2.5 FIBERGLASS BLANKET INSULATION

- A. Insulation shall be flexible fiberglass blanket conforming to ASTM C 553 and ASTM C 1290 designed for use on surfaces up to 250°F (121°C).
- B. Insulation shall have a minimum density of 1.0 lb. cu. ft. (16 Kg/m<sup>3</sup>) and a maximum conductivity ('K' value) of 0.26 Btu/In. per sq. ft. per °F per hour (0.00015W/cm<sup>2</sup> °C) at 75°F (24°C) mean temperature.
- C. Vapor barrier jacket shall be FSK, aluminum foil reinforced with fiberglass yarn and laminated to fire resistant Kraft.
- D. Insulation shall be:
  - 1. CertainTeed
  - 2. Knauf; Standard Duct Wrap
  - 3. Ductwrap
  - 4. Johns Manville; Microlite Type 100.
  - 5. Owens Corning; All service faced ductwrap, Type 100.
- E. Insulation thickness shall be 2 inches (50mm).

## 2.6 RECTANGULAR DUCT LINER

- A. Duct liner shall be fibrous glass conforming to ASTM C 1071 designed for use on surface up to 250°F (121°C).
- B. Air side surface shall have an acrylic coating treated with antimicrobial agent proven to resist microbial growth as determined by ASTM G 21.
- C. Duct liner shall have a minimum density of 1.5 lb./cu. ft (24 Kg/m<sup>3</sup>) and a maximum conductivity ('K' value) of 0.28 BTU/in per sq. ft. per °F per hour (0.00016W/cm<sup>2</sup> °C) at 75°F (24°C) mean temperature.
- D. Duct liner shall have a minimum noise reduction coefficient of 0.70 based on "type A Mounting" and tested in accordance with ASTM C 423.
- E. Duct liner shall be suitable for air velocities up to 5,000 Ft. /min (25.4 m/s).
- F. Duct liner shall be:
  - 1. CertainTeed
  - 2. Knauf; ToughGard Ductliner
  - 3. Duct liner M
  - 4. Johns Manville; Permalite Linacoustic
  - 5. Owens Corning; Aeroflex Plus
- G. Liner thickness shall be 1/2 inches (13mm).

## 2.7 ROUND DUCT LINER

- A. Duct liner shall be rigid performed round fibrous glass designed for use on surfaces up to 250°F (121°C).

- B. Airside surface shall have an acrylic coating treated with an antimicrobial agent proven to resist microbial growth as determined by ASTM G 21.
- C. Duct liner shall have a minimum density of 1-1/2 lb./cu. ft (24 Kg/m<sup>3</sup>) and a maximum conductivity ('K value') of .23 BTU/in per sq. ft. per °F per hour (0.00014W/cm<sup>2</sup> °C) at 75°F (24°C) mean temperature.
- D. Duct liner shall have a minimum noise reduction coefficient of 0.70 based on "Type A mounting" and tested in accordance with ASTM C 423.
- E. Duct liner shall be suitable for air velocities up to 5,000 ft/min. (25.4 m/s).
- F. Duct liner shall be:
  - 1. Johns Manville; Spiracoustic

## 2.8 MINERAL FIBER INSULATION

- A. Insulation shall be rigid mineral wool board conforming to ASTM C 612 designed for use on surfaces up to 1800°F (982°C).
- B. Insulation shall have a minimum density of 8 lb./cu. ft. (128 Kg/m<sup>3</sup>) and a maximum conductivity of 0.42 Btu/In. per sq. ft. per °F per hour (0.00024W/cm<sup>2</sup> °C) at 400°F (205°C) mean temperature.
- C. Insulation shall be:
  - 1. Rockwool Mfg. Co.; Delta Mineral Wool Board
  - 2. Owens Corning; High Temperature Industrial Board Type 1280
- D. Insulation thickness shall be 2 inches (50mm).

## 2.9 MINERAL FIREPROOFING BOARD INSULATION

- A. Insulation shall be rigid mineral wool board with factory applied aluminum foil jacket.
- B. Insulation shall have a minimum density of 8 lb./cu. ft. (128 Kg/m<sup>3</sup>) and a maximum conductivity of ('K' value) of 0.23 BTU/in per sq. ft. per °F per hour (0.00013W/cm<sup>2</sup> °C) at 75°F (24°C) mean temperature.
- C. Insulation shall be:
  - 1. USG Interiors, Inc.; Therma Fiber
- D. Insulation shall be 2-1/2 inches (62mm).

## 2.10 ADHESIVES

- A. Insulation cement shall be:
  - 1. Fibrex; FBX Super Blend
  - 2. Rockwood Mfg. Co.; Delta-Maid One Shot
- B. Fire Retardant Adhesive for blanket and liner insulation shall be conform to ASTM C 916 and shall be:
  - 1. Childers; CP-56
  - 2. Foster; 85-60
  - 3. King; 11-400

4. Mon-Eco; 22-65
5. Viamco; 795

## 2.11 FABRICS

- A. Reinforcing fabric shall be 10 by 20 or 10 by 10 white glass on nylon fabric.

## 2.12 COATINGS

- A. Vapor barrier coating (white) shall be:

1. Childers; Chil-Perm CP-30
2. Epolux; Calaler 650
3. Foster; Tite Fit 30-35
4. King ; ---
5. Mon-Eco ; 55-10

- B. Breather Coating (white) shall be:

1. Childers; Chil-Seal CP-50A
2. Epolux; Cadalag 336
3. Foster; Seal Fas 30-36
4. King ; 11-275
5. Mon-Eco ; 11-07
6. Vimasco; 713

- C. Asphalt mastic shall be:

1. Foster; 60-25
2. Lion Oil Co.; Seal-Kote
3. Pittsburgh Corning; Pittcoat 300

- D. Fire resistive, vapor barrier, water proof mastic (grey) shall be:

1. Childers; CP-10/11 AF
2. Epolux; Cadolon 500
3. Foster; Monolar 60-39
4. King ; ---
5. Mon-Eco ; 55-50
6. Vimasco; WC-5FR

- E. Asphalt based Aluminum paint shall be as recommended by insulation manufacturer.

## 2.13 FASTENERS AND TAPES

- A. Securing wire shall be 16 gauge stainless steel.

- B. Metal weld pins shall be 12 gauge galvanized steel.

- C. Metal stick pins shall be 12 gauge galvanized steel with perforated base plate.

- D. Foil reinforced Kraft tape; 3" (75mm) wide shall be:

1. Compac; 122-2
2. Fasson; 0821
3. Venture; 1525 CW

4. 3M; 898
  5. Nashua; FSK
- E. Steel bands shall be 1/2" x 0.020" (13mm x 0.5mm) thick stainless steel.
- F. Wire mesh shall be 1" (25mm) wide galvanized steel.

#### 2.14 FIELD APPLIED COVERS AND JACKETING

- A. Polyvinyl Chloride (PVC)
1. PVC fitting and valve covers shall be factory preformed for the shape used for.
  2. PVC jacketing shall be cut and curled and sized for pipe installed on.
  3. PVC installed on covers and jacketing shall have a minimum thickness of 20 mil.
  4. PVC covers and jacketing shall be:
    - a. Speedline Corp.
    - b. Johns Manville; Zeston 2000 PVC
    - c. Proto; PVC Covers
- B. Aluminum
1. Aluminum jacketing shall be 0.016 inch (0.4mm) thick with smooth finish.
  2. Aluminum fitting covers shall be 0.024 inch (0.6mm) thick with smooth finish.
- C. Stainless Steel
1. Stainless steel jacket and fitting covers shall be 0.10 inch (2.5mm) thick with smooth finish.

### PART 3 - EXECUTION

#### 3.1 GENERAL INSTALLATION

- A. Do not apply insulation which has become wet.
- B. Do not use staples for securing any insulation.
- C. Apply insulation only on clean, dry surfaces.
- D. Continue insulation through wall and ceiling openings and sleeves, except terminate duct insulation at fire dampers and at flexible duct connections at air handling units.
- E. Provide continuous unbroken vapor seal on all cold surfaces where vapor jackets are used.
- F. Insulate and vapor seal supports that are secured to cold surfaces to prevent condensation.
- G. Do not insulate unions, except in chilled water lines.
- H. Fill pipe insulation protective saddles with same insulation as adjoining pipe insulation.
- I. Perform work at ambient and equivalent temperatures as recommended by the adhesive manufacturer.

### 3.2 FIBERGLASS PIPE INSULATION

- A. Insulate the following:
  - 1. All condensate drain piping.
  - 2. All hot water heating piping located aboveground inside building.
- B. Butt all joints of pipe insulations together and secure jacket laps. Seal butt joints with joints strips furnished with insulation.
- C. Insulate fittings with fibrous blanket insulation wrapped under compression of minimum of 2:1 to thickness equal to adjoining pipe insulation. Cover with PVC fitting covers. Assembly shall be secured with stainless steel tacks pushed into the throat joint and circumferentially bound with all service vapor barrier tape.
- D. Insulate flanges, couplings, and valves with an oversized pipe insulation section sized to provide the same insulation thickness as on the adjoining pipe section. An oversized insulation section shall be used to form a collar between the two insulation sections with low density blanket insulation being used to fill gaps. Jacketing shall match that used on adjoining pipe sections. Ends shall be finished with the same mastic as specified for fittings.
- E. Finish all fittings, valves, and flanges in condensate drain lines with two, 1/16"(1.6mm) thick coats of white vapor barrier coating. Apply at a rate of no more than 15 sq. ft. /gallon (0.37 m<sup>3</sup>/l) and reinforce with glass fabric embedded between the two coats. Lap glass fabric on itself and on adjoining pipe insulation.

### 3.3 FOAMGLAS PIPE INSULATION

- A. Insulate the following:
  - 1. Aboveground piping exposed to the weather, outside building. Extend insulation one foot below finished grade or 6 inches (150mm) within building as applicable.
    - a. Condenser water piping to a point 2 ft. (600mm) above static water level.
    - b. Cooling tower make-up water piping.
    - c. Cooling tower drain piping.
- B. Butt all joints. Adhere butting sections to each other with asphalt mastic.
- C. Secure insulation in place with steel wire 18" (450mm) on center maximum.
- D. Insulate all fittings with mitered sections of Foamglas, asphalt mastic and hold in place with wire.
- E. On underground lines apply tack coat of asphalt mastic over all insulation surfaces at minimum rate of 4 gal. /100 sq. ft. (0.62 m<sup>3</sup>/l) or 1/16" (1.6mm) thick wet film. Embed glass membrane into wet tack coat. Smooth membrane to avoid wrinkles. Overlap seams 2" (50mm) minimum. Apply asphalt mastic finish coat to entire membrane surface at minimum rate of 8 gallons/100 sq. ft. (0.31 m<sup>3</sup>/l) or 1/8" (3.2mm) thick wet film. Allow one hour minimum between successive coats. Total mastic minimum thickness shall be at least 122 mils (3mm).
- F. As an option to paragraph E. above, Pittwrap, or equal, shall be provided and installed in accordance with manufacturer's instructions.

- G. Apply aluminum jacketing and aluminum fitting covers on all aboveground lines. Longitudinal joints shall be positioned on the bottom.
- H. Oversize (to next larger size) insulation on piping provided with heating tape. Fill void between pipe and insulation by wrapping Fiberglas blanket insulation held in place with spirally wrapped wire loops at 12" (300mm) on center maximum.
- I. Foamglass inserts (min. 180° section) at pipe hangers and supports in Fiberglass pipe insulation, of same thickness as adjoining insulation and a minimum length of 12 inches (300mm). Vapor seal as specified for insulation on fittings, valves and flanges.

### 3.4 FOAMED PLASTIC PIPE INSULATION

- A. Insulate the following:
  - 1. All refrigerant suction and hot gas piping.
- B. Snap insulation around pipe and butt all joints together. Seal butt and longitudinal joints with insulation manufacturer's adhesive.
- C. Insulate fittings, with mitered sections of pipe insulation. Seal all butt and longitudinal joints with insulation manufacturer's adhesive.
- D. Insulate valves and couplings with oversized sections of pipe insulation. Seal all joints with manufacturer's adhesive.

### 3.5 FIBERGLAS BLANKET INSULATION

- A. Insulate the following:
  - 1. All galvanized steel supply air ductwork.
  - 2. That portion of ceiling diffusers which are exposed above ceilings in non-return air plenums.
  - 3. All galvanized steel outside air ductwork.
  - 4. All galvanized steel return air ductwork.
- B. Wrap insulation around ducts. Butt all circumferential joints. Overlap longitudinal joints 2"(50mm) minimum. Secure insulation with wire spirally wrapped at 12" (300mm) on center intervals.
- C. For ducts over 24" (600mm) wide, adhere insulation to bottom of duct with 100% coverage of fire retardant adhesive. In addition impale insulation on the bottom of ducts on metal stick pins maximum 18" (450mm) on center adhered to duct. Secure insulation on pins with speed washers and seal with white vapor barrier coating.
- D. Seal circumferential joints at fire dampers, flexible connections, and ends of ducts with pressure sensitive tape.
- E. Tape longitudinal joints with pressure sensitive tape for duct insulation.
- F. Seal penetrations and punctures with pressure sensitive tape and apply white vapor barrier coating.
- G. Wrap portions of ceiling diffusers described above with insulation. Overlap ends of insulation 2"(50mm) minimum. Tape all joints with pressure sensitive tape.



3.6 FIBERGLAS LINER

- A. Insulate the following:
  - 1. All galvanized steel transfer ducts.
  - 2. Supply and return ducts where noted on plans.
- B. Cut insulation to provide overlapped and compressed longitudinal corner joints.
- C. Install liner with coated surface facing the air stream.
- D. Adhere duct liner to duct work with 100% coverage of fire retardant adhesive applied by spraying. Coat all exposed leading edges and transverse joints.
- E. In addition to adhesive, secure liner using metal pins welded to the duct and speed washers. Space metal pins in accordance with SMACNA manual for "Duct Liner Applications Standards."

3.7 MINERAL FIBER INSULATION

- A. Insulate kitchen hood exhaust ductwork.
- B. Insulation shall be applied on 22 gauge sheet metal with all joints butted together. The insulation and sheet metal shall be spaced off exhaust duct 1" (25mm) with non-combustible spacers. Insulation shall be secured to sheet metal with weld pins and wrapped with wire mesh.
- C. Installation shall be in accordance with NFPA 96.

3.8 MINERAL FIREPROOFING BOARD INSULATION

- A. At contractor's option, insulate kitchen hood exhaust ductwork.
- B. Insulation shall be secured with metal pins welded to ductwork and speed washers. Locate metal pins a maximum of 4" (100mm) from edge of insulation spaced at a maximum 12" (300mm) on center. Butt all edges and seal pins with grey breather coating reinforced with glass fabric.

**END OF SECTION**

## SECTION 230900

### INSTRUMENTATION AND CONTROL FOR HVAC

#### 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

##### 1.3 RELATED DOCUMENTS

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

##### 1.4 SUMMARY

- A. Furnish and install building management and automatic temperature control system as specified hereafter and indicated on the drawings. Systems shall consist of all central processing hardware and software, electronic control equipment, thermostats, valves, dampers, operators, switches, sensors, controllers and wiring.
- B. The Building Management System (BMS) and Automatic Temperature Control (ATC) Systems shall be complete in all respects, tested and ready for operation.
- C. The system shall be completely electronic including valve and damper actuators and a full DDC/VAV system, wherein all VAV terminals are centrally controlled b the BMS/ATC system.

##### 1.5 SUBMITTALS

- A. General: All submittals shall comply with the requirements of Division 1 - GENERAL REQUIREMENTS and Section 230500 COMMON WORK RESULTS FOR HVAC .
- B. Product Data: Data shall be submitted on the following items:
  - 1. Control Devices
  - 2. Valves
  - 3. Dampers
  - 4. Control System Diagrams
  - 5. Points List by Systems
- C. Operation and Maintenance Instructions: Data shall be provided for the following items:
  - 1. Control Devices
  - 2. Valves
  - 3. Dampers
  - 4. Control Diagrams

## 1.6 QUALITY ASSURANCE

- A. Qualifications of BMS/ATC Installers:
  - 1. Installers shall have a minimum experience of three years in the engineering, installation, calibration and software programming of DDC controls in commercial projects.
  - 2. The installer shall have a local office within a 100 mile radius of the job site, staffed with factory trained engineers capable of providing instruction, routine maintenance and emergency maintenance service on all system components.
  - 3. Installer shall be ALC Controls to match existing Board of Education System.

## 1.7 RELATED WORK

- A. All automatic valves and separable wells provided under this section shall be installed in accordance with GENERAL DUTY VALVES FOR HVAC PIPING Section 230523.
- B. Piping connections, taps and wells required for flow, pressure or temperature devices shall be provided under HYDRONIC PIPING Section 232113.
- C. All automatic dampers provided under this section shall be installed and assembled into the ductwork under AIR DUCT ACCESSORIES Section 233300.

## PART 2 - PRODUCTS

### 2.1 GENERAL

- A. The Building Management System shall provide the necessary Hardware, Software, and Network Communication abilities to provide Scheduling, Monitoring, Trending, Historical Storage, and alarm functions for the HVAC equipment and systems as described in this specification. Control capabilities shall include: Time of Day scheduling, Direct Digital Control, Custom Control, Boolean Logic, Optimum Start/Stop, Duty Cycling, Electrical Demand Control, Temperature Control, After Hours Override, Reports and Logs, Trend Prints, Remote Communications, Alarm Logging, Run Time and Maintenance, and Expanded Informational Messages.
- B. The Building Management system shall allow full user operation with a minimum of training. It shall have an English language display, with both user prompts and a "help" user tutorial. It shall contain management reports for the monitoring of both current and historical energy usage, heating and cooling degree day, building status and after hours occupancy information.
- C. All applications programs shall be pre-engineered and pre-tested. Program entries shall be fill-in-the-blank editing format, with English language prompting. This shall be verified by standard format programming worksheets included with the submittals.

### 2.2 BUILDING MANAGEMENT SYSTEM

- A. The Building Management System (BMS) shall be composed of one or more independent, standalone, microprocessor-based master control panels. The master panels shall provide centralized control for all distributed stand alone unit controllers located on each major piece of HVAC equipment. Master panels shall communicate with HVAC unit controllers and provide for the miscellaneous equipment points required by the sequence of operation. Master panels shall be of a modular design, allowing point

expansion by the addition of input/output cards. Before contract award, Building Management System supplier may be required to document expansion points available in the proposed system.

- B. Each master panel memory shall be protected for a minimum of 30 days in the event of power failure. Internal clock shall continue to run during a power failure so that the system makes the appropriate adjustment to all connected points when power is restored. Should database be lost, provide a means of rapid reprogramming from an archive copy of the database.
- C. The operating system of the master panels provided shall manage communication signals, both in and out, to allow panels to share real and virtual point information with each other and to allow central monitoring, central alarms, and editing of all panels from a single operator station as described below. The system of panels shall be programmable to autodial out upon system alarm, if required.
- D. Binary outputs shall provide a continuous low voltage signal for on/off control of remote devices. Where specified or indicated on the point list outputs shall have three position manual override switch (On/Off/Auto), a status light, and shall be selectable for either normally open or closed operation.
- E. Analog Outputs shall provide a modulating signal for control of remote devices. Outputs shall provide either a 0 to 10 VDC or a 4 to 20 milliamp output signal as required to provide proper control for the output device.
- F. Binary Inputs shall allow the monitoring of on/off signals from remote devices. The Binary Inputs shall be compatible with commonly available signaling devices. All status points shown on point list or mentioned in unit sequence of operation shall be positive proof binary switches, sensing the medium being controlled.
- G. Analog Inputs shall allow the monitoring of variable, low voltage, current, or resistance signals and shall have a minimum of a 12 bit resolution. The Analog Inputs shall be compatible with, and field configurable to, commonly available sensing devices.
- H. Timed Override Switches: The system shall include the necessary switch hardware and corresponding inputs for the remote, timed initiation of after hours equipment operation in a building. Switch types and locations are as scheduled.
- I. Alarms: The system shall provide audio, visual, contact closure and remote telephone annunciation for:
  - 1. Remote equipment failure
  - 2. Equipment run time, number of starts, or date
  - 3. Program failure
  - 4. Card failure
  - 5. Sensor failure
- J. In addition, each analog sensor and binary input and output shall be individually alarmed for values in excess of individual high/low limits or status.
- K. System Diagnostics: The system shall continuously check the status of all processor and memory circuits. Upon failure, the panel shall:
  - 1. Switch equipment into preassigned failure mode per normally open/closed relay setting.
  - 2. Emit alarm.
  - 3. Display card failure identification

### 2.3 BMS MASTER PANEL SOFTWARE

- A. Anti-Recycle Protection: Anti-Recycle Equipment Protection Timers protection of each HVAC unit shall be provided through individually programmable "minimum on", and "minimum off" timers. These shall have the priority over all application software functions except fire shutdown/smoke evacuation modes. All timers shall be individually programmable from 0 to 120 minutes.
- B. User Access: User access shall be through the use of a prompted, menu driven, English language communications routine. When using the system, the user shall be able to both list program options from menu and directly access them. At any time, the user shall be able to depress a "Help" key in order to display instructions for the user interface. The communications routine shall be compatible with any ASCII based, RS232 compatible terminal. User access shall be secured using individual security passwords for a minimum of eight users. It will be partitioned into multiple levels of user access with data entry restrictions being assignable by password. User log on/log off attempts will be recorded.
- C. Time-of-Day Scheduling: The scheduling program shall have 32, eight-day (seven days plus Holiday) Master Schedules. To these Master Schedules, up to 24 system loads (HVAC equipment, lights, etc.), or groups of loads, can be assigned. The Master Schedules shall be individually editable for each of the days of the week and Holiday. On any day, up to six time-of-day events shall be edited including: equipment start and stop, optimum start and stop duty cycle start and stop, and night purge cycle start.
- D. Direct Digital Control: The Direct Digital Control program shall allow the modulating control of remote devices based upon sensed data. The control shall allow the combination of proportional, integral, and derivative control routines (PID Control). Control routines shall allow full flexibility in setting parameters and provide ease of adjustment for nontechnical operators. The Direct Digital Control program shall include a dynamic graphic display printout routine to indicate the status and real-time performance of the control loop. Direct Digital Control loop setup and modification shall be done through a single, preformatted edit screen, with parameters listed in English language.
- E. Custom Control Language: The Custom Control Language capability shall be suitable for user written, real time, and equation based custom control routines. Any binary or analog points in the system shall be available as inputs to custom routines. Equation options shall include math functions such as: addition, subtraction, multiplication, division, square root, minimum, maximum, average; and logical functions: and, or, greater than, less than, equal to, not equal to, less than or equal to, greater than or equal to, variable timing, and delays.
- F. Optimum Start/Stop: The optimum start/stop program shall determine the required equipment start/stop timing by using inside/outside temperatures and the user's time-of-day schedule. The optimum start/stop program shall run independently for each controlled load or zone, and shall automatically self adjust based upon historical data.
- G. Duty Cycle: The duty cycling program shall be capable of suspending cycle control if sensed temperature and/or humidity is outside the user-defined comfort range.
- H. Electrical Demand Control: The Building Management master panels shall allow the control of the building peak kilowatt demand by selectively turning off loads. The control program shall be based upon a predicative sliding window technique, shall contain a self-adjusting demand limiting routine, and shall be able to control two independent demand limiting applications. The user shall be able to designate the estimated kw value, maximum off time and priority level for each load. For each of the demand routines, the program will shed the predicted kw requirements by starting with the lowest level of priority. When all available loads within a priority level have been shed, the program will then proceed to the next priority level. HVAC equipment and comfort are protected by equipment "maximum off" entries and

demand limiting temperature deadbands. Anti-recycle timers will protect the controlled equipment. The system shall be able to monitor building power consumption from signals generated by a pulse generator (provided by others) mounted at the building power meter or from a watts transducer and current transformer attached to the building's feeder lines. Input capability shall also be provided for an end-of-billing period indication.

- I. Temperature Control: The control program shall coordinate day and night temperature control and optimum start and stop. In all cases, it shall be able to initiate contact closure and/or adjust equipment operation based upon occupied and unoccupied heating and cooling setpoints. The program shall include user selectable deadbands for automatic adjustment of demand, night setback and duty cycling strategies based upon deviation from zone set point. It shall also be capable of automatically terminating equipment operation in order to prevent simultaneous heating and cooling within a zone.
- J. After Hours Override: The user shall have the ability to override the scheduled status of a load for a user defined period of one to 720 minutes. The system shall be capable of accepting a signal to begin after hour operation through a remote binary input mounted switch, a remote analog input mounted switch, and/or a computer command, initiated by the operator. The system shall be able to independently override a minimum of 27 timed override groups, each containing a minimum of four loads, and keep track of total minutes of override per month for each group.
- K. Run Time And Maintenance: The system shall be able to monitor equipment status and generate maintenance messages based upon user designated run time, starts and/or calendar date limits. A minimum of 32 separate devices shall be monitorable under run time and maintenance.
- L. Expanded Messages: The user shall be able to define a minimum of ten 40-character expanded messages for automatic printing in the event of system alarm and/or run time and maintenance event.

#### 2.4 USER EDITING CAPABILITIES

- A. English language based user programming shall allow a user to examine and change all panel data.
- B. Operator interface shall be controlled using a mouse and/or function keys. The Graphics package shall have prompts on the displays for system function keys.
- C. There shall be three levels of security. The security system shall have a minimum of six users, each with designated three letter operator ID and four character password.
- D. The system shall protect itself from unauthorized use by automatically logging off following the last keystroke. The delay time shall be user designated.
- E. All program set up must be through a fill-in-the-blank editing format following system prompts. Packages requiring programming or logic statements to set are unacceptable.
- F. For ease of system operation, a HELP directory describing system operation shall be included.

#### 2.5 DIAGNOSTICS

- A. Central System Alarm Operation: When a panel reports the alarm message, software shall automatically store the message and notify the user. User notification shall be accomplished by sending the alarm message to a printer, sounding an audible tone in the personal computer, and flashing an alarm message on the display.

- B. System Alarms and Trouble Shooting Library: Included shall be displays containing symptom/diagnosis trouble shooting guides for central system, panels, and microprocessor based HVAC unit controllers connected to remote panels. This shall allow the operator to use the alarm message/failure code received from the panel or HVAC unit to generate trouble shooting information related to the problem.
- C. Self-Diagnostics: Software shall initiate system self-tests that notify the operator of any detected failures. All panels failing to respond shall be identified on a display printout.

## 2.6 REPORTS AND LOGS

- A. The system shall include the capability to store for user review and for printing, the following reports and logs. In addition, these reports may also be saved to diskette as an ASCII file, making the information available for use by other software packages.
- B. Current summary report: An instantaneous summary of building status including heating and cooling degree days, on and off peak electrical demand performance, current electrical KWH consumption, and summary for critical temperature sensors listing current, today's minimum, and today's maximum values.
- C. Monthly summary report: An end of month summary of building status including heating and cooling degree days, on and off peak electrical demand performance, current electrical KWH consumption, and a summary of critical temperature sensors listing the month's minimum and maximum values.
- D. Monthly demand limiting report: A report for logging the electrical demand performance (both on and off peak) and KWH consumption for each of the two utility meter programs. Included are the times of today's and yesterday's demand peaks as well as the time and date of the monthly demand peaks. This report logs electrical performance for the present day and previous 32 days.
- E. Yearly demand limiting report: A report for logging the electrical demand performance (both on and off peak) and KWH consumption for each of the two utility meter programs. This report logs electrical performance for the present month and previous 12 months.
- F. Yearly meter report: A report for logging the electrical KWH consumption for up to six submeters. This report logs electrical performance for the present month and previous 12 months.
- G. Yearly degree day report: A current month's and previous 12 month summary of heating and cooling degree days.
- H. Weekly temperature report: A previous seven day's summary of the minimum and maximum temperatures for the critical zone temperature sensors.
- I. Weekly override time report: A previous seven day's summary of after hours override usage (in hours and minutes) for the 27 timed override groups.
- J. Monthly override time report: A current and previous month's summary of after hours override usage (in hours and minutes) for the 27 timed override groups.
- K. Trend logs: A total of 32 custom reports that allow the storage of up to 24 samples of a sensed value based upon a scheduled basis.
- L. Event log: A summary of up to 32 system events including alarms, operator log-on, and diagnostics.
- M. Input/output status reports: Allows operator review of all points and their status in the system.

- N. HVAC equipment reports: Automatic, preformatted reports, that indicate the control status and status of all input/output points of connected air conditioning equipment.
- O. Custom reports: Up to 19 reports, each containing the status of up to 20 user designated points. The reports shall provide a simple method to group related points into a single report.

## 2.7 MISCELLANEOUS

- A. Duct Mounted Control Dampers
  1. Duct mounted Dampers shall be designed to limit leakage to a maximum of 1% at 1500 FPM with a static pressure differential of 4" WG. The frame shall be minimum 16 gauge galvanized steel, flanged for duct mounting. Blades shall be minimum 16 gauge galvanized steel with a maximum width of 6". Shafts shall be minimum 1/2" diameter. Maximum damper sections size shall be 48" x 72", with larger damper installed in sections with appropriate jack shafting and bracing. Bearings shall be free of lubrication requirements and permanently fastened to the damper frame.
  2. All multiple blade duct mounted proportional control dampers shall be opposed blade type and all two-position dampers shall be parallel or opposed blade type.
  3. Duct mounted Dampers shall be minimum leakage type equipped with replaceable butyl rubber blade edge seals. Replaceable spring loaded stainless steel jamb seals shall be provided on sides of frame.
  4. The damper linkage shall operate individual blade axles, connected together outside the frame. The linkage and direct blade drive are prohibited.
  5. Dampers shall not be installed with blade in a vertical position.
- B. Actuators
  1. Electronic damper operators shall be positive positioning, spring return. Motors shall be of the low voltage synchronous type and shall be non-overloading at a continuous stall.
  2. Actuators to be factory selected, mounted and tested for proper operation based on unit size, type and torque requirements. Damper operators shall be located outside the airstream.
- C. Control Valves
  1. Electronic, positive positioning, spring return, low voltage (24 VAC) actuators to be properly selected for the valve body and service.

## PART 3 - EXECUTION

### 3.1 SEQUENCES OF OPERATION

- A. Sequences of operation shall be affected as specified in Section 230993.

### 3.2 INSTALLATION REQUIREMENTS

- A. All control wiring performed in the installation of the BMS/ATC system as described in this specification shall be in accordance with NEC, NFPA 70, and per applicable state and local codes. Where exposed, conduit shall be run parallel to building lines properly supported and sized at a maximum of 40% fill. In no cases shall field installed conduit smaller than 1/2" trade size be allowed. Where conductors are concealed (tenant spaces), cable rated for use in return air plenums shall be used.



3.3 OPERATING AMBIENTS

- A. Electronic controls mounted in unconditioned space shall be rated for ambient operating conditions from -40f to 158f. Controls not meeting these limits shall be mounted in an accessible location within conditioned space.

3.4 OWNER TRAINING

- A. See MECHANICAL GENERAL section.

3.5 CALIBRATION AND ADJUSTMENTS

- A. After completion of the installation, perform final calibrations and adjustments of the equipment provided under this contract and supply services incidental to the proper performance of the ATC and BMS system under warranty below.

3.6 ACCEPTANCE PROCEDURE

- A. Upon completion of the calibration, contractor shall startup the system and perform all necessary testing and run diagnostic tests to ensure proper operation. Contractor shall be responsible for generating all software and entering all database necessary to perform the sequence of control and specified software routines. An acceptance test in the presence of the Architect's designated representative shall be performed.
- B. The contractor shall submit a letter of certification stating the following:
  1. That the thermostats have been checked, calibrated and are working as specified.
  2. That the sequence of operation has been checked by the contractor and is as specified.
  3. All items called to be labeled are labeled.
  4. Permanent full-sized, nonfading copy of the as built control diagrams and schematics has been placed in the main mechanical room as required below.
  5. The owner's representatives have been instructed verbally and in writing, in control operation.
  6. That all thermostats and controls are set to operating conditions.
  7. That all temporary controls including software have been removed.

**END OF SECTION**

**SECTION 230993**

**SEQUENCE OF OPERATIONS FOR HVAC CONTROLS**

**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. Work Included
  - 1. Heating and Air conditioning controls.

1.3 SUBMITTALS

- A. General: All submittals shall comply with the requirements of Division 1 - GENERAL REQUIREMENTS and Section 230500 COMMON WORK RESULTS FOR HVAC .
- B. Sequence Data: Data shall be submitted with control diagrams in Section 230900 INSTRUMENTATION AND CONTROL FOR HVAC.

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

**PART 3 - EXECUTION**

3.1 BOILERS

- A. Boiler (B-1 & B-2) shall be controlled through Building Automation System (BAS).
  - 1. On receipt of a start signal from the BAS the boiler controls shall be enabled. After proof of hot water flow, the boiler shall be enabled.
  - 2. On a change in boiler set water temperature, the boiler shall modulate to maintain 68°F (adj) hot water supply temperature.
  - 3. On receipt of a stop signal from the BAS, de-activation of its associated hot water pump, or loss of hot water flow, the boiler shall be disabled.

3.2 COOLING TOWERS

- A. Cooling Tower (CT – 1, 2 & 3) shall be controlled through Building Automation System (BAS).
  - 1. On receipt of a start signal from the BAS, the cooling tower controls shall be enabled.
  - 2. On a rise in condenser water return temperature above 95°F, the fan speed shall modulate by means of a variable frequency drive to maintain the set temperature.
  - 3. On a drop in tower basin temperature below 80°F, condenser water shall bypass to the basin to maintain the minimum set condition.

4. On a drop in tower basin temperature below 40°F, the basin heater shall be energized to maintain the minimum set condition.
5. On receipt of a stop signal from the BAS, the cooling tower fan shall be de-energized.
6. On a drop in basin water level below set condition, the make-up water float valve shall open. On a return to water level set condition, the make-up water valve shall close.

### 3.3 HOT WATER PUMPS

- A. Hot water pump (P- 6 & 7) shall be controlled through Building Automation System (BAS).
  1. On receipt of a start signal from the BAS, the pump shall be energized.
  2. On receipt of a stop signal from the BAS, the pump shall be de-energized.
  3. Each pump shall operate in a lead/lag sequence to maintain water temperature.

### 3.4 CONDENSER WATER PUMPS

- A. Condenser water pump (P- 4 & 5) shall be controlled through Building Automation System (BAS).
  1. On receipt of a start signal from the BAS, the pump shall be energized.
  2. On receipt of a stop signal from the BAS, the pump shall be de-energized.
  3. Pumps shall operate as a lead/lag sequence that changes the lead/lag every two weeks.

### 3.5 LOOP WATER PUMPS

- A. Loop water pump (P-1, 2 & 3) shall be controlled through Building Automation System (BAS).
  1. Pumps shall operate as a lead/lag sequence that changes the lead/lag every two weeks.
  2. The pumps shall be energized by the BAS during occupied hours.
  3. On receipt of a start signal from the BAS, the pump shall be energized.
  4. On receipt of a stop signal from the BAS, the pump shall be de-energized.

### 3.6 SPLIT SYSTEM HEAT PUMP

- A. Unit shall be energized during occupied hours as determined by BAS.
- B. Wall mounted thermostat shall cycle the heating or cooling as needed to maintain room temperature setpoint.

### 3.7 EXHAUST FANS

- A. EF-1.1, 1.2, 1.3, 1.4, 1.8, 1.9, 1.10, 1.11, 1.13, 1.14, 1.15, 1.18, 2.6, 2.7, 2.8, 2.9, 2.13, 4.4, 6.1, 6.4, 6.5, 6.7 and 6.9 shall be interlocked with lights. Provide fan 5 minute shut-off delay.
- B. EF-1.12 shall be energized by pressure sensor in dryer exhaust duct.
- C. EF-1.17, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9, 3.10, 3.11, 3.12, 3.15, 3.16, 3.17, 3.18, 3.19, 3.20, 3.21, 3.22, 3.23, 3.24, 3.25, 3.26, 3.27, 3.28, 4.5 & 6.6 shall be reconnected to existing controls.
- D. EF-1.19, 1.20 and 2.3 shall be reconnected to existing kitchen hood controls.
- E. EF-2.2, 4.6 and 6.3 shall interlock with ERV serving room or area.
- F. EF-2.10, 2.12, 3.2, 3.13, 4.2, 6.2 and 6.8 shall be controlled with wall mounted thermostat.

3.8 ENERGY RECOVERY UNITS

- A. Unit shall be energized during occupied hours as determined by the BAS.
- B. Unit shall be de-energized by:
  - 1. Activation of smoke detector in the supply duct.
  - 2. Zone signal from building fire alarm system.
- C. Under normal operation, a signal from the BAS shall energize the fans. With fans energized:
  - 1. Outside air damper shall open.
  - 2. Exhaust air damper shall open.

3.9 WATER SOURCE HEAT PUMPS

- A. Water source heat pump (WSHP – 1 - \* to 15 - \*)
  - 1. Units shall be energized during occupied hours as determined by BAS.
  - 2. Wall mounted zone sensors shall modulate the heating, cooling and hot-gas reheat as required to maintain room temperature and humidity set point.
  - 3. Units noted on drawings with supply duct mounted smoke detector when energized shall send a signal to the fire alarm and the fire alarm shall stop the unit upon activation.
- B. Water source heat pump (WSHP – 20 - \*)
  - 1. Units shall be energized during occupied hours as determined by BAS.
  - 2. Duct return air sensor shall modulate the heating, cooling and hot-gas reheat as required to maintain room temperature and humidity set point.
  - 3. Units noted on drawings with supply duct mounted smoke detector when energized shall send a signal to the fire alarm and the fire alarm shall stop the unit upon activation.
- C. Water source heat pump (WSHP – 35 - \*)
  - 1. Unit shall be interlocked with EF-2.3.
  - 2. Duct discharge air sensor shall modulate the heating, cooling and hot-gas reheat as required to maintain discharge air temperature and humidity set point.
  - 3. Units noted on drawings with supply duct mounted smoke detector when energized shall send a signal to the fire alarm and the fire alarm shall stop the unit upon activation.

3.10 HEAT TAPE

- A. Heat Tape on pipes exposed to the weather shall be energized as determined by the outside air temperature and the BAS.

3.11 ELECTRIC HEATERS

- A. UH-7 shall be controlled by wall mounted thermostat.
- B. UH – 1, 2, 3, 4, 5, 6, 8 & 9 shall be controlled by built-in thermostats.

**END OF SECTION**

**SECTION 232113**  
**HYDRONIC PIPING**

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Work Included
  - 1. Condenser water piping
  - 2. Hot water heating piping
  - 3. Refrigerant piping
  - 4. Make-up water piping
  - 5. Loop water piping
  - 6. Condensate drain piping

1.3 SUBMITTALS

- A. General: All submittals shall comply with the requirements of Division 1 - GENERAL REQUIREMENTS and Section 230500 COMMON WORK RESULTS FOR HVAC.
- B. Product Data: Data shall be submitted on the following items:
  - 1. Manufacturer's notarized certificates of conformance to specified standards for pipe, fittings, and flanges.
- C. Certificates: Provide copies of certificates for the following:
  - 1. Welder's Qualification

1.4 QUALITY ASSURANCE

- A. Standards
  - 1. American National Standards Institute (ANSI):
    - a. Standard B16.1, Cast Iron Pipe Flanges and Flanged Fittings, 25, 125, and 800 pound.
    - b. Standard B16.3, Malleable Iron Screwed Fittings, 150 and 300 pound.
    - c. Standard B16.5, Steel Pipe Flanges, Flanged Valves and Fittings including ratings for Class 150, 300, 400, 600, 900, 1500 and 2500.
    - d. Standard B16.21, Nonmetallic Flat Gaskets for Pipe Flanges.
    - e. Standard B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
    - f. Standard B31.1, Power Piping and Addenda.
    - g. Standard C606, Standard for Grooved and Shouldered Joints.
  - 2. American Society for Testing and Materials (ASTM):
    - a. Standard A53, Pipe, Steel, Black and Hot-Dipped Zinc-Coated, Welded and Seamless.

- b. Standard A234, Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
  - c. Standard A307, Carbon Steel Externally Threaded Standard Fasteners.
  - d. Standard A312, Seamless and Welded Austenitic Stainless Steel Pipe.
  - e. Standard A351, Castings, Austenitic, Austenitic - Ferritic for Pressure Containing Parts.
  - f. Standard B88, Specification for Seamless Copper Water Tube.
  - g. Standard B280, Specification for Seamless Copper Tubes for Air Conditioning and Refrigeration Field Service.
  - h. Standard F2389-07, Standard Specification for Pressure Rated Polypropylene (PP) Piping system
3. Federal Specifications (Fed. Spec.):
- a. Specification WW - U - 516C, Union, Brass or Bronze, Threaded Pipe Connections and Solder - Joint Tube Connections.
  - b. Specification WW - U - 531E, Unions, Pipe Steel or Malleable Iron; Threaded Connections.
- B. Qualifications of Welders
- 1. All welders employed for the work shall be qualified under the requirements of ANSI B31.1.0, Section 127.5.
  - 2. Evidence of welders' qualifications shall be submitted to the Architect before any welds are made.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. The interior of all pipe and fittings shall be kept free from dirt and foreign matter at all times.

**PART 2 - PRODUCTS**

2.1 PIPE AND FITTINGS

- A. Pipe and fitting material options for mechanical systems shall be as indicated in table below:

<u>SERVICE</u>	<u>PIPE MATERIAL TYPE</u>
Hot Water	1,2 (Piping 2 $\frac{1}{2}$ " and smaller maybe type 8)
Refrigerant Piping	9
Condenser Water	1,2, 13
Cold Water Make-Up	8
Pump Drains	6
Condensate Drains	6
Loop Water	1,2 (Piping 2 $\frac{1}{2}$ " and smaller maybe type 8), 13
Chemical Feed for Hot Water Systems	1
Chemical Feed for Condenser Water	7
Cooling Tower Overflow & Drain	1,2, 13

B. Pipe and fittings options indicated above shall be the material indicated in table below:

MATERIAL TYPE	PIPE SIZE	PIPE TYPE	PIPE SPEC	FITTING TYPE	FITTING SPEC
1	2" (50mm) & Smaller	Sch. 40 black steel, screwed end GRB ERW	ASTM A53 ERW	Class 150 black malleable iron, screwed	ANSI B16.3
2	2 $\frac{1}{2}$ " – 10" (62 mm) – (250 mm) Inclusive	Sch. 40 black steel, GRB ERW	ASTM A53 ERW	Standard Weight butt welding type	ASTM A234
6	2 $\frac{1}{2}$ " (62 mm) & Under	Sch. 40 galvanized steel, screwed	ASTM A53	Class 150 galvanized malleable, iron, screwed	ANSI B16.3
7	All Sizes	Sch. 40 Type 316/316L stainless steel	ASTM A312	Class 150 Type 316 stainless steel, screwed	ASTM A351
8	All Sizes	Type 'L' hard-drawn Copper	ASTM B88	Wrought copper, solder joint	ANSI B16.22
9	All Sizes	Type ACR rigid drawn tempered tube	ASTM B280	Wrought copper, silver brazed joint	ANSI B16.22
13	All Sizes	Std. Weight Black Steel GRB ERW, Cut or Roll Grooved End	ASTM A53 ERW	Ductile iron or steel, grooved	ASTM A-536 Or ASTM A-234

## 2.2 FLANGES

- A. Flanges shall be faced true and provided with 1/16" (1.6mm) ring type gasket conforming to ANSI B16.21. Flanges will have raised or flat face to mate with adjacent flanges or valves, fittings, and equipment.
- Flanges in threaded pipe lines shall be 125 or 250 lbs. (860 kPa or 1720 kPa) cast iron screwed flanges conforming to ANSI B16.1.
  - Flanges in welded pipe lines shall be 150 or 300 lbs. (1035 kPa or 2065 kPa) steel slip-on or weld neck type welding flanges conforming to ANSI B16.5.
  - Flange bolts shall be carbon steel, standard bolt sets and nuts shall be carbon steel hexagon type. Steel for bolts and nuts shall conform to ASTM A307, Grade A for use with steel flanges and Grade B for use with cast-iron flanges.
  - Flange class shall be selected to match valve or equipment connection requirement.
- B. Unions in steel pipe shall be 150 lbs. (1035 kPa) malleable iron type, screwed, Fed. Spec. WW-U-531E. Unions in copper tubing shall be wrought or cast bronze, Fed. Spec. WW-U-516C, solder end joints.
- Unions provided between copper and ferrous pipe connections shall be the insulated type to separate dissimilar metal connections in piping systems and prevent galvanic corrosion. Temperature rating shall be equal to or exceed the maximum temperature of respective system in which the union is installed.

## 2.3 GROOVED COUPLINGS

- A. Grooved end couplings shall consist of two or more bolted coupling sections which enclose a resilient gasket and mate with pipe or fitting grooved ends. Coupling sections shall be constructed of ductile, ASTM A 536, or malleable, ASTM A47, iron with factory applied rust inhibiting paint finish. Coupling design shall be self-restrained such that the coupling feet (keys) engage the pipe or fitting groove for the entire joint circumference and are restricted to the pipe of fitting groove when bolts are tightened.
- B. Gasket for water service shall be EPDM, ASTM D2000, designed for operating temperatures from -30°F (-35° C) to +230°F(110°C).
- C. Bolts shall be heat treated, track head steel bolts, ASTM A183 with a minimum tensile strength of 110,000 psi (758423 kPa) and electroplated zinc finish.
- D. Grooved end couplings for use on copper systems shall be rigid "zero deflection" design with 300 psi (2069kPa) minimum working pressure and copper finish. Couplings shall be:
  - 1. Victaulic; Style 606
  - 2. Anvil; Fig. 7400
- E. Grooved end couplings for steel systems shall be rigid "zero-deflection" design with 750 psi (5171kPa) minimum working pressure. Coupling shall be:
  - 1. Victaulic; Style 07
  - 2. Anvil; Fig. 7401
  - 3. Guston Bacon
- F. Grooved end couplings for steel systems shall be flexible design allowing for pipe deflection without leakage. Coupling shall have 500 psi (3447) kPa minimum working pressure. Coupling shall be:
  - 1. 1000 psi (6895kPa):
    - a. Victaulic; Style 77
    - b. Anvil; Fig. 7001
    - c. Guston Bacon
  - 2. 500psi (3447kPa);
    - a. Victaulic; 75
    - b. Anvil; 7000
    - c. Guston Bacon

## 2.4 ASPHALT MASTIC

- A. Asphalt mastic for underground piping shall be:
  - 1. Foster; 60-25
  - 2. Insul-Coustic; IC-320
  - 3. Lison-Oil Co.; Seal Kote

## PART 3 - EXECUTION

### 3.1 PIPE INSTALLATION

- A. Pipes shall have burrs removed by reaming.
- B. Changes in direction of piping shall be made with fittings.



- C. Changes in pipe sizes in horizontal pipelines shall be made with eccentric reducing couplings, except reducing tees and reducing elbows will be allowed for connections for pressure gauges and gauge cocks, for thermometers and test wells, and for pipe mounted insertion-type temperature control devices.
  - 1. In condenser water lines, loop water, and hot water heating lines, eccentric reducing couplings shall be installed with the flat side on top to maintain the top of the pipeline flush.
  - 2. In condensate drain lines, eccentric reducing couplings shall be installed with the flat side on bottom to maintain the bottom of the pipe line flush.
  - 3. Reducing tees, reducing elbows and concentric reducing couplings will be allowed for changing pipe sizes in vertical risers, except in pump suction lines eccentric reducing couplings only will be allowed.
- D. Above ground hot water and loop water horizontal supply and return lines shall be installed level.
- E. Open ends of pipe lines shall be plugged during installation to keep dirt and foreign material out of the system.
- F. All elbows 2-1/2" (62mm) and larger at pump suction connections shall be the long radius type.
- G. All steel piping installed underground for shall be cleaned of rust, grease and scale. After cleaning, the pipe shall be provided with a coat of oxide chromate primer and then finished with an asphalt mastic protective coating. Asphalt mastic shall be applied at a coverage of not less than 8 gallons (30 L) per 100 sq. ft. (9.3 sq. M) (1/8"(3mm) thick wet film).
- H. Pipe and tubing specified to be grooved shall have grooves formed in accordance with the manufacturer's published instructions.
- I. Branch lines for water lines shall take off below centerline of mains.

### 3.2 PIPE JOINTS

- A. Screw Joints for Steel Pipe: After cutting and before threading, pipe shall be reamed and shall have burrs removed. Threading shall be made with tapered threads. Screw joints shall be made up with Teflon paste or tape applied to male threads only. Caulking of threaded joints to stop or prevent leaks will not be permitted.
- B. Copper tubing shall be cut square and burrs shall be removed. Both inside and outside of tubing shall be cleaned with steel wool before joining.
  - 1. Joints in copper tubing for water service shall be made with a noncorrosive pflux and solid string lead free solder composed of 95% tin and 5% antimony. 50-50 solder will not be permitted.
  - 2. Joints in copper tubing for refrigerant piping shall be silver brazed with silver solder having a melting point in excess of 1000 degrees F (538 degrees C).
- C. Welded joints shall be fusion welded. Changes in direction of piping shall be made with welding fittings only. Mitering or notching pipe to form elbows and tees will not be permitted.
  - 1. Branch take-offs at 90 degrees from mains shall be made with welding tee fittings, except where main size is larger than 2 inches (50 mm) factory fabricated forged steel shaped fittings may be used in lieu of welding tees if the main is two pipe sizes or more larger than the branch takeoff; shaped fittings shall be weldolets for branch sizes  $2\frac{1}{2}$ " (62mm) and larger, and threadolets from branch sizes 2" (50mm) and smaller.
  - 2. Branch takeoffs at 45 degrees to mains shall be made with factory fabricated latrolets.

3. Defective welds shall be removed and replaced at no additional cost to the Owner. Repairing of defective welds by adding new material over the defects or by peening will not be permitted.
- D. Grooved mechanical pipe joints shall be installed in accordance with the coupling manufacturer's latest published recommendations with regard to intended service, maximum pressure rating, and maximum allowable end load and temperature range.

**END OF SECTION**

**SECTION 232123**  
**HYDRONIC PUMPS**

**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. Extent of each type of Pumps for HVAC Systems is indicated on drawings and by provisions of this section.

1.3 SUBMITTALS

- A. General: All submittals shall comply with the requirements of Division 1 - GENERAL REQUIREMENTS and Section 230500 COMMON WORK RESULTS FOR HVAC.
- B. Product Data: Data shall be submitted on the following items:
  - 1. Pumps.
  - 2. Pump manufacturer's inspection and alignment report.
- C. Certificates:
  - 1. Pump alignment reports by manufacture's representative.
- D. Operation and Maintenance Data: Data shall be provided for the following items:
  - 1. Pumps

1.4 QUALITY ASSURANCE

- A. Standards
  - 1. American National Standards Institute (ANSI):
    - a. Standard B16.1, Cast Iron Pipe Flanges and Flanged Fittings, 25, 125, and 800 pound.
    - b. Standard B15.1, Section 8
  - 2. American Society for Testing and Materials (ASTM):
    - a. Standard B584, Specification for Copper Alloy Sand Castings for General Application.
  - 3. Anti-Friction Bearing Manufacturers Association (AFBMA):
    - a. Standard 9, Load Ratings and Fatigue Life for Ball Bearings.
  - 4. Hydraulic Institute Standards
    - a. HI-01 Standards for Centrifugal, Rotary and Reciprocating Pumps
- B. All horizontal split case and end suction pumps shall be the products of a single manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Pumps received and stored on the job site shall be stored in dry storage spaces, (e.g. building, trailers, or sheds) whenever possible. Pumps shall be stored on wooden shipping skids or rails. Under no condition shall the units be stored in such a way that metal components are in direct contact with the ground or floor slabs.
- B. Where it is not practical to store items within an enclosure, pumps may be stored on wooden shipping skids or rails outside.
- C. Pumps shall be covered with 6 mil polyethylene sheet (taped in place) to protect the equipment from damage and the weather.

1.6 EXTRA MATERIALS

- A. Each pump shall be provided with a spare mechanical seal. The spare seal shall be packaged in the original carton from the factory and shall be delivered to the Owner at the time of the final inspection. Each spare seal shall be labeled to identify the seal by pump number.

**PART 2 - PRODUCTS**

2.1 INLINE PUMPS

- A. Inline pumps shall be the single stage, close coupled centrifugal type. Pumps shall be constructed as follows:
- B. Impeller shall be the enclosed type and shall be hydraulically and dynamically balanced.
- C. Bearings shall be grease lubricated and bearing housing shall be designed so as to flush lubricant through and provide continuous cleaning of bearing surfaces.
- D. Pump casing shall be designed for not less than 125 psi (8.6 bar) working pressure for water service at temperatures up to 225°F (107°C). Pump casing shall be provided with tappings for gauge and drain fittings.
- E. Combination motor bracket/volute cover plate shall maintain alignment of motor to pump casing.
- F. Pump motor shall have capacity to prevent overloading with pump operating at any point on the characteristic curve and motor shall have drip proof enclosure. Motor shall be as specified in Section 230513 COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT.
- G. Pumps shall be:
  - 1. Armstrong; Series 4300
  - 2. Aurora; 380 Series
  - 3. Bell and Gossett; Series 60 and Booster
  - 4. Taco; 1600/1900 Series
  - 5. Grundfos

## 2.2 FLEXIBLE COUPLED END SUCTION PUMPS

- A. Flexible couple end suction pumps shall be horizontal, frame mounted, single stage centrifugal type. Pumps shall be constructed of the following materials:
  - 1. Casing; Cast Iron
  - 2. Case Wearing Rings; Bronze, replaceable type
  - 3. Ball Bearings; Steel, regreaseable type
  - 4. Seal; Mechanical, Ni-Resist rated for 250°F (122°C).
  - 5. Shaft Sleeve; Bronze
  - 6. Impeller; Bronze, ASTM B584
  - 7. Shaft; Carbon steel, high tensile
- B. The pump casing shall be designed for not less than 175 psi (12 bar) working pressure for water service at temperatures up to 225°F (107°C). A manually operated petcock shall be installed on the top of the pump casing for venting. Pumps with suction connection size 2" (50mm) and smaller shall have threaded suction and discharge connections; pumps with suction connection size 2-1/2" (64mm) and larger shall have flanged suction and discharge connections. Flanges shall be equivalent to ANSI B16.1, 125 lb. class flange ratings. Flanges shall be drilled and tapped for gauge ports.
- C. Power frame connection to the liquid end of the pump shall be a registered fit to assure concentricity of all pump parts. Adapters used to connect power frame and pump casing shall be specifically designed for use with mechanical seals.
- D. Case wear rings shall be locked in position to prevent rotation.
- E. Bearings shall be grease lubricated and shall have a minimum B-10 life of 20,000 hours rated in accordance with AFBMA Standard 9.
- F. Mechanical seal shall be the single unbalanced type. Seal set shall be Ni-Resist and washer shall be carbon.
- G. Shaft sleeves shall be slip-fit over the shaft, shall extend full length through the seal box and shall be locked in place.
- H. Impeller shall be the enclosed type and shall be hydraulically and dynamically balanced. Impeller diameter shall not exceed 85% of the casing diameter as measured from the cut-water.
- I. The maximum allowable shaft deflection at the mechanical seal face is 0.002" (0.05mm) with the pump operating at full load conditions.
- J. The pump and motor shall be mounted on a common formed steel base. The pump shall be connected to the driving electric motor through a Woods Sure-Flex flexible coupling and the coupling shall have a formed sheet steel coupling guard conforming to ANSI Standard B15.1, Section 8, bolted to the base plate. Motor shall be as specified in Section 230513 COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT.
- K. The pump motor shall have capacity to prevent overloading with the pump operating at any point on the characteristic curve, and the motor shall have an open drip-proof enclosure.
- L. Flexible-coupled end suction centrifugal pumps shall be:
  - 1. Aurora; Model 344
  - 2. Bell & Gossett; Series 1510

3. Peerless Pump Company; Series F
4. Taco; FI Series
5. Weinman; 550 Series
6. Armstrong
7. Grundfos

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. After grouting base mounted pumps and connecting the suction and discharge piping to the pump, the pump and motor shall be realigned in accordance with the standards of the Hydraulic Institute.
- B. After completion of installation and realignment, rust and scale shall be removed from exposed - to - sight surfaces of pump shafts. After cleaning shaft surfaces, a protective spray coating of lubricant/rust inhibitor shall be applied to the exposed - to - sight shaft surfaces.
- C. After completion of installation and realignment, each pump shall be checked by the pump manufacturer's representative for alignment and operation. Report of this inspection and approval of the installation by the manufacturer's representative shall be submitted to the Architect.

**END OF SECTION**

**SECTION 232500**  
**HVAC WATER TREATMENT**

**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. Work Included
  1. Chemical cleaning of all HVAC piping systems.
  2. Chemical treatment for all HVAC piping systems.

1.3 SUBMITTALS

- A. General: All submittals shall comply with the requirements of Division 1 - General Requirements and Section 230500 COMMON WORK RESULTS FOR HVAC.
- B. Product Data: Data shall be submitted on the following items:
  1. Chemical Equipment
  2. Chemical Safety Data Sheets
  3. Chemical Data Literature
- C. Water Analysis
  1. Contractor shall test water available at or near the project site. Water analysis shall be submitted with a written description of the proposed chemical treatment program.
- D. Operation and Maintenance Data: Data shall be provided on the following items:
  1. Chemical Feed Pumps
  2. Agitators
  3. Control Panel
  4. Water Meters
  5. Bleed Valves
  6. Cleaning Agents and Instructions
  7. Chemical Safety Data Sheets

**PART 2 - PRODUCTS**

2.1 GENERAL

- A. All chemical treatment equipment and chemicals shall be supplied by:
  1. Garrett-Callahan;

## 2.2 CHEMICALS

- A. Cleaners
  - 1. Chemicals used for cleaning shall be selected for the removal of grease, dirt, mill scale, welding slag, and foreign material in the system.
- B. Closed Loop Treatment Systems (Loop and Hot Water)
  - 1. Chemicals used for treatment shall include corrosion inhibitors, scale inhibitors, and biocides.
- C. Open Loop Treatment Systems (Condenser Water)
  - 1. Chemicals used for treatment shall include scale inhibitors; corrosion inhibitors; biocides to inhibit filming/fouling; and acid to control alkalinity and pH.
- D. Health and Safety
  - 1. Chemicals used for cleaning and treatment shall comply with county, state and federal EPA water pollution regulations.
  - 2. Chemicals used for treatment shall have no detrimental effect on the materials in the systems being treated when used in accordance with the manufacturer's instructions.
  - 3. Chemicals used in hot water heating and steam systems serving domestic water heating shall be recognized as safe by the U.S. Food and Drug Administration (FDA). Chemical equipment shall be permanently labeled to indicate that only additives recognized as safe by the FDA shall be used.

## 2.3 TREATMENT EQUIPMENT

- A. Chemical Tanks
  - 1. Chemical tanks shall be the polyethylene delivery drums in which the chemicals are transported. Drums shall be self-supporting with a threaded top access port.
  - 2. Bypass feeder tanks shall be 5 gallon black steel, welded construction type with threaded inlet, outlet and fill openings. Tank shall have a minimum operating pressure of 175 psig at 250° F. Tanks shall be:
    - a. J. L. Wingert Co.; HD Series
    - b. Neptune; DBF Series
    - c. Milton Roy LMI
- B. Pumps
  - 1. Chemical feed pumps (for water systems) shall be the positive displacement, adjustable flow, diaphragm type with thermoplastic construction, total enclosed continuous duty motor, anti-siphon/pressure relief valve, suction foot valve/strainer assembly, and discharge check valve assembly. Pump shall be sized for treatment requirements and injection against system operating pressure. Wetted pump components shall be selected for compatibility with chemicals being transported. Pump motors shall be 120 volt, single phase, 60 Hz with 6 foot long power cord and ground plug. Pumps shall be:
    - a. Liquid Metronics (LMI)
    - b. Pulsatron
    - c. Morr



C. Water Meters

1. Make-up water meters shall be turbine or nutating disc type with brass body, sealed magnetic drive, electric contacting register capable of totalizing output and pulse output. Meter shall be designed for 200 psig operating pressure. Make-up meter shall be:
  - a. Lakewood; Model MR/WP
  - b. Hersey; Model 420
  - c. Pulsafeeder; Model WM/WWR
2. Bleed line water meters shall be turbine or nutating disc type with brass body, sealed magnetic drive, and totalizing register. Meter shall be designed for 150 psig operating pressure. Bleed line meter shall be Hersey; Model 123

D. Agitators

1. Agitators shall be propeller type with 316 stainless steel mounting base, totally enclosed motor, and 316 stainless steel shaft and propeller. Motor shall be 120 volt, single phase, 60 Hz with 6 foot power cord and grounding plug. Mounting base shall be clamp or bracket type to match tank mounting.

E. Bleed and Blowdown Valves

1. Bleed valves shall be diaphragm globe type with brass body, normally closed solenoid operator, and continuous duty coil. Bleed valve shall have a minimum working pressure of 175 psig and shall be serviceable without removing it from the system.
2. Blowdown valves shall be in-line serviceable, motor operated, ball type. Valve shall be rated for 425 psig at 450°F. Motor operator shall be electric, unidirectional type with permanently lubricated gear train and an epoxy coated NEMA 1 housing. Operator shall be rated for 150 in-lbs torque with a 5 second cycle time.

F. Injection Nozzles

1. Injection nozzle assembly shall consist of 1/2" diameter CPVC injection nozzle, 3/4" threaded pipe connection, and brass corporation check stop. Injection nozzle assembly shall have a minimum operating pressure of 125 psig at 100°F.
2. Injection nozzles (for steam systems) shall be type 316 stainless steel with 1/2" diameter injection nozzle, 3/4" threaded pipe connection and check stop. Injection nozzle assembly shall have a minimum operating pressure of 150 psig at 250°F.

G. Chemical Tubing

1. Chemical feed and sensor tubing shall be as specified in Section 232113 HYDRONIC PIPING.

H. Liquid Level Switch

1. Liquid level switch shall be float actuated type with polypropylene housing, polyvinyl chloride float tubing, polypropylene encapsulated reed switch float, duplex receptacle for chemical pump and alarm, low voltage transformer and power cord. Liquid level switch shall be Liquid Metronics (LMI), Model 26731/27417.

I. Controllers

1. Conductivity and inhibitor feed controller shall be the solid state electronic type with continuous conductivity sensor, inhibitor reset timer, digital dual function readout display, linear adjustment dials, calibration switches, AUTO-MANUAL switches with lights, input and output relays, and locking ABS enclosure. Unit shall have the following characteristics:
  - a. Reset Timer; 1 - 100 sec.
  - b. Conductivity Range; 0 - 5000 micromhoms
  - c. Accuracy; 2% Full scale
  - d. Output Relay; 10 amps at 120 volts
  - e. Enclosure; NEMA 3R

- f. Power; 120 Volts, 60 Hz w/cord and plug.
2. Conductivity sensor shall be carbon electrode type with ABS housing rated at 150 psig at 100°F. Sensor shall be mounted on exterior side of controller housing. Controller shall be:
  - a. ANCO; Model 175
  - b. Lakewood; Model 175
  - c. Moor; Series QA
3. pH Controller shall be the solid state electronic type with continuous sample sensor, digital pH readout display, linear adjustment dials, calibration switches, Auto-Manual feed switches with lights, output relays, flow switch, alarm timer, and locking ABS enclosure. Unit shall have the following characteristics:
  - a. Set Point Range; 5 - 10 pH
  - b. Display Range; 0 - 14 pH
  - c. Set Points; HIGH - acid feed
  - d. ; LOW - caustic feed
  - e. Alarm Timer; 5 - 90 minutes
  - f. Output Relay; 10 amps at 120 volts
4. pH Sensor shall be glass electrode type with PVC housing rated at 150 psig at 100°F. Flow switch shall have 1/2 GPM capacity with integral check valve and flow sight port. Sensor and flow switch shall be mounted on exterior side of controller housing. Controller shall be:
  - a. ANCO; Model 350
  - b. Lakewood; Model 350
  - c. LMI; AC 4500 111A2

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Install chemical treatment equipment in accordance with manufacturer's recommendations.
- B. Install a by-pass with globe valve on all water meters and bleed valves.
- C. Install unions on inlet and outlet of water meters.
- D. Install suction strainer on inlet to chemical pumps not provided with integral strainer.
- E. Install shut-off valves on inlet and outlet of chemical feed pumps.
- F. Install shut-off valves on inlet and outlet of coupon rack. Install 3 to 5 gpm flow restrictor and strainer on inlet to rack. Install valved bypass around coupon rack.
- G. Mount test cabinet on wall.

#### **3.2 PREPARATION**

- A. Systems shall be operational, filled, started, and vented prior to cleaning. Use water meter to record capacity in each system.
- B. Place equipment control valves in open position during cleaning.

### 3.3 CLEANING

- A. Before operating the heating and cooling equipment, the Contractor shall chemically clean and flush cooling and heating piping systems and equipment except cooling towers. During the cleaning and flushing process, strainers shall be cleaned and drain valves shall be opened periodically to remove sediment from the systems. Chemical solutions shall be circulated through the piping until the systems are clean, after which the systems shall be flushed with clean water. After the flushing process, the piping systems shall be refilled with clean water and charged with operating chemicals as hereinafter specified, leaving the pH level in a neutral range. Engineer and owner shall be on site to witness system flush.

### 3.4 COOLING TOWER PRE-TREATMENT

- A. Flush dirt, sediment and debris from tower.
- B. Kill and remove any biological growth.
- C. Refill basin and add zinc passivator.
- D. Circulate for 72 hours, then drain tower.
- E. Refill with clean water.

### 3.5 CLOSED SYSTEM TREATMENT (HOT AND LOOP WATER)

- A. Provide bypass feeder.
- B. Introduce closed system treatment through by-pass feeder tank when indicated by test.

### 3.6 OPEN SYSTEM TREATMENT (CONDENSER WATER)

- A. Provide a multifunction conductivity controller, pH Controller, make-up and blowdown water meters, chemical treatment pump(s), chemical tank(s), automatic timer(s), injection nozzle(s), and chemical feed tubing.
- B. Continuously monitor condenser water through the conductivity cell of the conductivity controller. On a rise in conductivity to the set point, the controller shall open the bleed valve. On a drop in conductivity below the set point, the controller shall close the bleed valve. Inhibitor feed and biocide feed shall be locked out when bleed valve is open.
- C. Continuously monitor condenser water pH through a pH cell of the pH controller. On a rise in pH above the set point, the controller shall energize the acid feed pump and introduce acid treatment through injection nozzles. On a drop in pH below the set point, the controller shall de-energize the acid feed pump.
- D. Continuously meter condenser water make-up. On a given volume level of make-up energize the inhibitor [and dispersant] chemical pumps for a pre-set time. Introduce inhibitor [and dispersant] treatment through injection nozzles.

- E. Introduce biocide treatment through injection nozzles. On activation of automatic timers chemical pump shall be energized for a preset time. Introduce two biocides on an alternating basis.
- F. On a drop in chemical tank fluid level below a minimum set point level switch shall deactivate pump, sound an audible alarm [and send a signal to the building automation system.

### 3.7 CHEMICAL SUPPLY

- A. Chemical Supply for Loop and Hot Water Systems
  - 1. The Contractor shall provide the initial charge in each system.
- B. Chemical Supply for Condenser Water System
  - 1. The Contractor shall provide a 12 months supply of chemicals. The chemical manufacturer's representative shall visit the facility every month during the first year of operation. He shall test the water to assure that the treatment is being used is correct and proper dosage is being used and shall verify equipment is operating. Each visit shall be verified in writing to the Owner.

**END OF SECTION**

## SECTION 233113

### METAL DUCTS

#### 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. Work Included:
  - 1. Ductwork

##### 1.3 SUBMITTALS

- A. General: All submittals shall comply with the requirements of Division 1 - GENERAL REQUIREMENTS and Section 230500 COMMON WORK RESULTS FOR HVAC.
- B. Product Data: Data shall be submitted on the following items:
  - 1. Ductwork including coordinated layout drawings indicating locations of equipment of all other trades above ceilings as well as ductwork.

##### 1.4 QUALITY ASSURANCE

- A. Standards
  - 1. American Society for Testing and Materials (ASTM):
    - a. Standard E84, Surface Burning Characteristics of Building Materials.
  - 2. National Fire Protection Association (NFPA):
    - a. Standard 90A, Installation of Air Conditioning and Ventilating Systems.
    - b. Standard 90B, Installation of Warm Air Heating and Air Conditioning Systems.
    - c. Standard 255, Test Methods, Surface Burning Characteristics of Building Materials.
  - 3. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):
    - a. HVAC Duct Construction Standards, Metal and Flexible.
    - b. Duct Cleanliness for New Construction Guidelines
  - 4. Underwriter's Laboratories (UL):
    - a. Standard 181, Factory-Made Air Duct Materials and Duct Connectors.
  - 5. American Conference of Governmental Industrial Hygienists
    - a. Industrial Ventilation, 24th Edition, 2001, a Manual of Recommended Practice.

##### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Air distribution system components received and stored on the job site shall be stored in dry storage spaces, (e.g. building, trailer, or shed) whenever possible. Air distribution system components shall be stored on wooden rails or wooden pallets. Under no condition shall the air distribution system

components be stored in such a way that metal components are in direct contact with the ground or floor slabs.

- B. Where it is not practical to store items within an enclosure air distribution system components may be stored on wooden rails, wooden pallets, or shipping skids outside.
- C. Air distribution system components shall be covered with 6 mil polyethylene sheet (taped in place) to protect the equipment from damage and the weather.

## PART 2 - PRODUCTS

### 2.1 DUCTWORK

#### A. General

- 1. Ductwork shall be constructed of lock forming quality galvanized steel sheets except:
  - a. Ductwork indicated to be pre-manufactured flexible duct.
  - b. Dishwasher exhaust ductwork.
  - c. Kitchen hood exhaust ductwork.
- 2. Galvanized coating shall be not less than 1.25 ounces total for both sides per square foot (301 g. per square meter) of sheet metal.
- 3. Ductwork shall be square, rectangular, round, or flat oval, as indicated on the drawings.
- 4. Turning vanes shall be installed in all 90 degree square and rectangular elbows and at other locations shown on the drawings. In any supply, return or exhaust air ductwork with velocities of 1800 FPM (9 m/s) or higher, the turning vanes shall be the double thickness type, with vanes welded to the runners and runners welded to the duct.
- 5. Ductwork shall be classified and constructed in the following SMACNA pressure classes, or 150% of the scheduled fan S.P., whichever is greater:

System or Zone	Pressure Class
a. Supply air ductwork from air handling units to air distribution devices.	+ 2
b. Supply air ductwork from supply fans or air distribution system components.	+ 2
c. Return air ductwork	- 2
d. Exhaust ductwork (general building)	- 2
e. Dishwasher exhaust ductwork	- 4
f. Kitchen hood exhaust ductwork	- 4

#### B. Galvanized Steel Ductwork

- 1. Except where indicated otherwise, herein or on the drawings, duct construction shall conform to the recommendations of the SMACNA HVAC Duct Construction Manual for pressure classes specified hereinbefore.
- 2. All galvanized areas damaged by welding shall be coated with rust inhibitive aluminum paint.
- 3. Round and flat oval ductwork shall be spiral lock-seam construction, except as follows:
  - a. Concealed round duct up to 12" (300mm) in diameter in pressure class 2" shall be longitudinal seam construction.
  - b. Round ducts 61" (25mm) and larger in diameter shall be longitudinal seam construction with fusion welded butt seams. Sections supplied in lengths greater than four feet shall have angle iron rings welded to the duct on four foot centers (maximum). Welding of the angle ring to duct shall apply not less than one inch of weld for each foot of angle ring.
- 4. Round and flat oval fittings shall be fusion welded butt seam type with all welds continuous along seams. All divided flow fittings shall be manufactured as separate fittings - tap collars welded into spiral duct sections will not be permitted. All divided flow fittings 12" (300mm) and smaller shall have radiused entrance produced by machine or press forming; all divided flow fittings

14"(355mm) and larger shall have conical entrance produced by machine or press forming. All divided flow entrances shall be free of weld build-up, burrs, and irregularities. Fittings shall be the same manufacturer as ductwork.

5. Pre-insulated round and flat oval ductwork shall be as specified above. In addition, ductwork shall have 2" (50mm) of fiberglass duct insulation sandwiched between outer casing and solid inner galvanized steel liner.
6. Duct sealant shall be a U.L. listed synthetic latex base mastic or mineral impregnated woven fiber tape with adhesive. Duct sealing compounds shall be low VOC type with a maximum VOC emission of 250 grams per liter
  - a. Sealant shall have fire hazard classification per ASTM E84 of flame spread-5 and smoke development-0. Sealant shall be:
    - 1) Kingco
    - 2) United McGill
    - 3) Foster
  - b. Fiber tape and adhesive shall be:
    - 1) Uni-cast
    - 2) United McGill
    - 3) Hardcast
  - c. Tape width in inches, shall be:
    - 1) Duct Diameter, 0 to 10 Inches: 2.
    - 2) Duct Diameter, 11 to 20: 3.
    - 3) Duct Diameter, 22 and Larger: 4.

C. Dishwasher Exhaust Ductwork

1. Exhaust ductwork shall be constructed of 18 gauge (1.3mm), Type 302 stainless steel with No. 4 finish on exposed surfaces and welded joints. Provide a 2" (50mm) wide stainless steel ceiling collar around the duct at penetration through the ceiling.

D. Kitchen Hood Exhaust Ductwork

1. Except where indicated otherwise, herein, or on the drawings, duct construction shall conform to the requirements of NFPA 96 with all welded joints and seams.
2. Ductwork shall be carbon steel not less than 0.054 inches (1.61mm) (No. 16 MSG) or stainless steel not less than 0.043 inches (1.3mm) (No. 18 MSG) in thickness.

E. Flexible Ductwork

1. Insulated flexible duct shall be Class 1 air duct in accordance with UL 181 and shall comply with NFPA 90A and 90B. Insulated flexible duct shall consist of an inner film layer for minimum working pressure of 6" wg. (1.5kPa) bonded to steel or aluminum spring wire helix, fiberglass insulation, and a vapor barrier jacket. Insulation shall have a maximum C-value of .23 BTU/hr/sq. ft./degree F. (1.30 W/hr/sq m /K) at 75 degrees F. (24 degrees C) mean temperature. Vapor barrier jacket shall have a maximum vapor transmission rate of 0.1 grains/sq. ft./hr/inch Hg (perm). The assembly shall have a maximum flame and smoke rating of 25/50 per ASTM E84 and NFPA 255. Minimum working pressure for duct pressure class 4" and below shall be 6" wg.(1.5kPa); Insulated flexible duct shall be:
  - a. Atco 070
  - b. Flex-aire Type VFS
  - c. Flexmaster Type 9
  - d. Thermoflex Type G-KM
  - e. Wiremold Type WG

## 2.2 SPIN-IN COLLARS

- A. Spin-in collars shall be galvanized steel for use with rectangular or square sheet metal ductwork. Spin-in collars shall have 45° air scoop and damper. Spin-in collars for sheet metal shall be:
- |    |            | <u>Scoop &amp; Damper</u> |
|----|------------|---------------------------|
| 1. | Clevaflex  | DESC                      |
| 2. | Flex-aire  | TI-DEL                    |
| 3. | Flexmaster | FLDE                      |
| 4. | Spiraline  | DESC                      |

## 2.3 FLEXIBLE DUCT CONNECTIONS

- A. Flexible duct connections shall be non-combustible glass fabric double coated with neoprene:
1. Duro-Dyne
  2. Vent Fabrics
  3. Young Regulator

## 2.4 BLANK - OFF PANELS

- A. Blank-off panels for un-utilized sections of louvers shall be sandwich construction with 22 gauge (0.85mm) galvanized steel outer panels (both sides) and insulation core. Insulation core shall be 1" (25mm) thick fiberglass duct liner as specified in Section 230700 HVAC INSULATION.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Galvanized Steel Ductwork
1. Ductwork shall be installed in accordance with recommendations of SMACNA HVAC Duct Construction Standards Manual.
  2. Duct-to-duct joints in round duct up to and including 60" (1500mm) in diameter and in equivalent size flat oval ducts shall be made by using sleeve couplings, reinforced by rolled beads. Duct-to-fitting joints in round duct up to and including 60" (1500mm) in diameter and in equivalent size flat oval ducts shall be made by slip-fit of the projecting collar on the fitting into the duct. Sleeve shall be the same gauge galvanized steel as the duct; insertion length of sleeve coupling and fitting collar shall be not less than 2" (50mm). After the joint is slipped together, sheet metal screws shall be installed for mechanical strength; screws shall be equally spaced, no more than 12" (300mm) on centers and with a minimum of 3 screws in each joint. Screws shall be placed at 1/2" (12mm) from the joint bead. Duct-to-duct joints in ducts up to and including 12" (300mm) in diameter for pressure class 2" (50mm) and below may be the beaded-crimp type and each joint shall be fastened with sheet metal screws, equally spaced, not more than 12" (300mm) on centers and with a minimum of 3 screws in each joint. The beaded-crimp joint shall provide at least a 1" (25mm) lap to accommodate the sheet metal screws.
  3. Duct-to-duct and duct-to-fitting joints in round ducts larger than 60"(1500mm) in diameter, and in equivalent size flat oval ducts, shall be the loose flange type. The ends of ducts and fittings shall have 5/8"(16mm) flanges to form a gasketing surface for sealing. Bolting flanges shall be 2" x 2" x 3/16" (50mm x 50mm x 5mm) ring type steel angles attached to the duct and fitting by



continuous weld; bolt spacing on flanges shall not exceed 6" (150mm) on centers. Flanged joints shall be sealed with neoprene rubber gaskets.

4. All duct joints (longitudinal, transverse) and duct penetrations shall be sealed using methods outlined in SMACNA HVAC Air Duct Leakage Test Manual.

B. Dishwasher Exhaust Ductwork

1. Joints in ductwork shall be electric welded with corrosion resistant steel rods. Exposed welded joints shall be ground even with adjoining material surfaces and shall be polished.

C. Kitchen Hood Exhaust Ductwork

1. Joints in ductwork shall be electric welded with corrosion resistant steel rods. Exposed welded joints shall be ground even with adjoining material surfaces and shall be polished.

D. Flexible Ductwork

1. Flexible ducts shall be installed in an extended condition free of sags and kinks, using only the minimum length required to make the connection. Abrupt bends and turns that crimp the duct and restrict air flow will not be permitted. Horizontal supports shall be 3/4" (19mm) wide, 22 gauge (0.85mm) flat galvanized steel sheet banding material. Flexible ducts shall be supported on 36" (900mm) centers. Maximum length of flexible duct in pressure class 2" (50mm) and below shall be 6 feet (3000mm).

E. Duct Closure Collars

1. Duct collars shall be provided where ducts pass through masonry walls and partitions which extend full height to the underside of the structure and shall be fabricated from 22 gauge (0.85mm) galvanized steel sheet. Duct collar shall be provided on both sides of walls and partitions, except collar shall be omitted on that side of the wall where registers and grilles are installed. Flanges shall be installed tight against the wall. The space between the duct and the wall shall be packed with fiberglass blanket insulation.

### 3.2 DUCT SUPPORT SPACING

A. Duct hangers and supports shall be in accordance with SMACNA HVAC Duct Construction Standards except:

1. Hangers shall be spaced not over 8'-0" (2400mm) on centers.
2. For rectangular ducts; with longest dimensions up through 60" (1500mm), hangers shall be the galvanized steel strap type; with longest dimension 61" (1525mm) and larger, hangers shall be trapeze type constructed of galvanized steel angles with round hanger rods. Sizes for strap hangers and trapeze angles and rods shall be based on duct size as scheduled in the SMACNA HVAC Duct Construction Standard.
3. For round ducts, hangers shall be galvanized steel strap hangers. Sizes and number for strap hangers shall be based on duct size as scheduled in the SMACNA HVAC Duct Construction Standard.

**END OF SECTION**

**SECTION 233300**  
**AIR DUCT ACCESSORIES**

**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. Work Included:
  - 1. Dampers
  - 2. Fire Dampers
  - 3. Access Doors for Ductwork

1.3 SUBMITTALS

- A. General: All submittals shall comply with the requirements of Division 1 - GENERAL REQUIREMENTS and Section 230500 COMMON WORK RESULTS FOR HVAC.
- B. Product Data: Data shall be submitted on the following items:
  - 1. Dampers
  - 2. Fire Dampers
  - 3. Access Doors for Ductwork
- C. Operation and Maintenance Instructions: Data shall be provided for the following items:
  - 1. Fire Dampers

1.4 QUALITY ASSURANCE

- A. Standards
  - 1. American Society for Testing and Materials (ASTM):
    - a. Standard E84, Surface Burning Characteristics of Building Materials.
  - 2. National Fire Protection Association (NFPA):
    - a. Standard 90A, Installation of Air Conditioning and Ventilating Systems.
    - b. Standard 90B, Installation of Warm Air Heating and Air Conditioning Systems.
    - c. Standard 255, Test Methods, Surface Burning Characteristics of Building Materials.
  - 3. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):
    - a. HVAC Duct Construction Standards, Metal and Flexible.
    - b. Duct Cleanliness for New Construction Guidelines
  - 4. Underwriter's Laboratories (UL):
    - a. Standard 181, Factory-Made Air Duct Materials and Duct Connectors.
    - b. Standard 555, Fire Dampers and Ceiling Dampers.
    - c. Standard 555S, leakage rated dampers for use in smoke control systems.
  - 5. American Conference of Governmental Industrial Hygienists
    - a. Industrial Ventilation, 24th Edition, 2001, a Manual of Recommended Practice.

- 6. Air Movement and Control Association International Inc. (AMCA)
  - a. Standard 500-L-99, Laboratory Methods for Testing Louvers for Ratings

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Air distribution system components received and stored on the job site shall be stored in dry storage spaces, (e.g. building, trailer, or shed) whenever possible. Air distribution system components shall be stored on wooden rails or wooden pallets. Under no condition shall the air distribution system components be stored in such a way that metal components are in direct contact with the ground or floor slabs.
- B. Where it is not practical to store items within an enclosure air distribution system components may be stored on wooden rails, wooden pallets, or shipping skids outside.
- C. Air distribution system components shall be covered with 6 mil polyethylene sheet (taped in place) to protect the equipment from damage and the weather.

**PART 2 - PRODUCTS**

2.1 MANUAL DAMPERS AND DAMPER HARDWARE

- A. Splitter Dampers shall be constructed of not less than 20 gauge (1mm) galvanized steel sheet. The length of the damper blade shall be the same as the width of the widest duct section at the split, but in no case shall the blade length be less than 12 inches (300mm).
- B. Butterfly and Multi-Louver Dampers
  - 1. Dampers shall be single blade butterfly type in ducts up to and including 18" x 12" (450mm x 300mm) size; for ducts larger than 18" x 12"(450mm x 300mm), in either or both dimensions, the dampers shall be the multi-louver type.
  - 2. Single blade butterfly dampers shall be constructed of not less than 16 gauge (1.6mm) galvanized steel blade mounted in a galvanized steel frame. For rectangular dampers, the top and bottom edges of the blade shall be crimped to stiffen the blade. Damper shall be provided with an extended rod to permit installation of a damper regulator. Dampers shall be:

	Rectangular Model	Round Model
a. Manufacturer		
b. Air Balance, Inc.	AC-115	----
c. American Warming & Ventilating	VC-21	VC-22
d. Arrow United Ind., Inc.	1700	----
e. Louvers & Dampers, Inc.	CD-500	CD-600
f. Ruskin	CD-35	CDR-25
g. Safe Air/Dowco Corp.	611	BDR
h. Leader	BS-1	BR4
  - 3. Multi-louver dampers shall be the opposed blade type, constructed of not less than 16 gauge (1.6mm) galvanized steel blade mounted in galvanized steel channel frame. Blade spacing shall not exceed 6 inches (150mm) and the top and bottom edges of the blades shall be crimped to stiffen the blades. Damper blades shall be interconnected by rods and linkages to provide simultaneous operation of all blades. Damper shall be provided with an extended rod to permit installation of a damper regulator. Rectangular dampers shall be:
    - a. Air Balance, Inc.; AC-116.
    - b. American Warming & Ventilating, Inc.; VC-21.
    - c. Arrow United Ind., Inc.; 1770.

- d. Louvers & Dampers, Inc.; CD-400.
- e. Ruskin; CD-35.
- f. Safe Air/Dowco Corp.; 610.
- g. Leader; DO3.

C. Damper Hardware

1. Splitter Damper Hardware. When neither dimension of a damper exceeds 18 inches, the damper shall be provided with a ball joint bracket attached to the outside of the duct. The bracket shall have a set screw for securing damper rod in position. The damper operating rod shall be not less than 1/4" (6mm) diameter steel rod and shall be secured to the damper blade with a clip. When either dimension of a damper exceeds 18 inches (450mm), the damper shall be provided with 2 ball joint brackets and rods. The rods shall be located at quarter points on the damper.
2. Butterfly and Multi-Louver Hardware
  - a. Duct mounted dial regulators with operating handle shall be provided on dampers which are located above non-fire rated, lift out acoustical tile ceilings supported on an exposed grid system.
  - b. Concealed ceiling mounted dial regulators shall be provided on volume control dampers which are located above the following type ceilings:
    - 1) Gypsum board ceilings.
    - 2) Plastered ceilings
    - 3) Acoustical tile ceilings with concealed grid system.
    - 4) Fire rated acoustical tile ceilings secured with clips on an exposed grid system.
  - c. Concealed regulators shall be provided with plain, off white covers. The Contractor shall provide steel channel blocking above the ceiling to support and anchor the regulators. Dampers with operating rods parallel to the line of the ceiling shall be provided with miter gears for connecting the regulator operating rod to the damper operator rod.
  - d. Damper hardware shall be:
    - 1) Duro-Dyne
    - 2) Vent Fabrics
    - 3) Young Regulator

2.2 FIRE DAMPERS

A. Fire dampers shall be fusible link type tested for closure under air flow, (i.e. Dynamic Closure) conforming to UL 555 and labeled for installation in fire rated walls and floors. Dampers in floor shall have spring operator. Dampers, except for lower sections of a multiple section assemble, and those installed behind grilles and registers, shall have blades out of the airstream when damper is in the open position. Dampers in walls or floors rated 2 hours or less shall be rated for 1-1/2 hours; dampers in walls rated 3 or 4 hours shall be rated for 3 hours. Dampers shall be constructed of galvanized steel.

B. Fire dampers in pressure class 2 inches square and rectangular ductwork shall be:

	<u>1-1/2 Hour</u>	<u>3 Hour</u>
1. Air Balance, Inc.	Model 119 Frame B	Model 319P Frame B
2. Greenheck	DFD-150B	DFD-350B
3. Louvers & Dampers	HFD-VM/HM Frame B	----
4. Nailor Industries.	Model 0120 Frame B	Model 0520 Frame B
5. Prefco	Model 5500E4 Frame B	Model 5500E4 Frame BFBC3
6. Ruskin	Model DIBD20 Style B	Model DIBD23 Style B
7. Safe Air, Inc.	Model 150 Frame B	Model 300 Frame B
8. Leader	D1-215-BX	D1-255-BX
9. Vent Products	Model 5400 Frame B	----

C. Fire dampers in round and flat oval ductwork shall be:

	<u>1-1/2 Hour</u>	<u>3 Hour</u>
1. Air Balance, Inc.	Model 119 Frame CL	Model 319P Frame CL
2. Greenheck	DFD-150 CR/CO	DFD-355CR/CO
3. Louvers & Dampers	HFD-VM/HM Frame C	----
4. Nailor Industries.	Model 1030 Frame C	Model 0530 Frame C
5. Prefco	Model 5500 Frame CR/CO	Model 5500 Frame BFCR/CO 3
6. Ruskin	Model DIBD2 Style CR/CO	Model DIBD23 Style CR/CO
7. Safe Air, Inc.	Model 150 Frame C	Model 300 Frame C
8. Leader	D1-215-C0/CR	D1-255-CO/CR
9. Vent Products, Inc.	Model 5500 Frame CR/CO	----

D. 1-1/2 Hour fire dampers installed behind grilles and registers shall be:

1. Air Balance, Inc.; Model 119 Frame F.
2. Greenheck.; DFD-110A.
3. Louvers & Dampers.
4. Nailor Industries.; Model 0210 Frame A.
5. Prefco; Model 5500E2.
6. Ruskin; Model DIBDT.
7. Safe Air, Inc.; Model 152A.
8. Leader; D-115.

2.3 DUCT AND PLENUM ACCESS DOORS

A. Duct and plenum access doors up to 24" x 24" (300mm x 300mm) in duct pressure classes 2" (50mm) and below shall be the sizes indicated on the drawings. Doors shall be double wall construction of not less than 24 gauge (0.7mm) galvanized steel sheet, with 1" (25mm) thick neoprene coated fiberglass insulation between the walls. Doors shall have a continuous hinge on one side and cam latch with striker plate on the other side; doors with the height over 12 inches (300mm) shall have not less than 2 cam latches with striker plates. Door frame shall be constructed of not less than 22-gauge (0.8mm) galvanized steel and shall have knock-over edges for securing to duct. The door assembly shall be double gasketed to provide seals from the door to the frame and from the frame to the duct. Access doors shall be:

1. Air Balance; Model FSA100.
2. Cesco; Model HAD-10.
3. Nailor; Model 08SH.
4. Ruskin; Model ADH24.
5. Safe Air/Dowco Corp.; Model SAH.
6. Leader; Model ADH.

B. Duct and plenum access doors in duct pressure class 2" (50mm) where either dimension (width or height) exceeds 24" (300mm) shall be constructed in accordance with Figure 2-12 in SMACNA HVAC Duct Construction Standards. Door shall have continuous piano type hinge on one side and handle type latches on the other side; handle latches shall be provided on both the inside and the outside of the door. Door shall be provided with 1" (25mm) thick neoprene coated fiberglass insulation. Door and frame shall be constructed of galvanized steel sheet of not less than the gauges indicated in Table based on the size of the door indicated on the drawing. Doors shall be installed to open against pressure.

### **PART 3 - EXECUTION**

#### 3.1 INSTALLATION

##### A. Fire Dampers

1. Fire dampers shall be installed in accordance with the manufacturer's instructions.

##### B. Duct Access Doors

1. Access doors serving fire dampers or fire/smoke dampers shall be labeled "FIRE DAMPER" OR "FIRE/SMOKE DAMPER" respectively. Letters shall be not less than 1/2" (12mm) high.
2. Where access door serving fire or fire/smoke dampers has external insulation. Label shall be placed on outside of insulation.

**END OF SECTION**

**SECTION 233423**  
**HVAC POWER VENTILATORS**

**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. Work Included
  - 1. Fans

1.3 SUBMITTALS

- A. General: All submittals shall comply with the requirements of Division 1 - GENERAL REQUIREMENTS and Section 230500 COMMON WORK RESULTS FOR HVAC.
- B. Product Data: Data shall be submitted on the following items;
  - 1. Fans
- C. Operation and Maintenance Instructions: Data shall be provided for the following items:
  - 1. Fans

1.4 QUALITY ASSURANCE

- A. Standards:
  - 1. Air Moving and Conditioning Association (AMCA):
    - a. Publication 99-401, Classification for Spark Resistant Construction.
    - b. Publication 210, Laboratory Methods of Testing Fans for Rating.
  - 2. American Society for Testing Materials (ASTM):
    - a. Standard E84, Surface Burning Characteristics of Building Materials.
  - 3. National Fire Protection Association (NFPA):
    - a. Standard 255, Test Methods, Surface Burning Characteristics of Building Materials.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Fans received and stored on the job site shall be stored in dry storage spaces, (e.g. building, trailer, or shed) whenever possible. Fans shall be stored on wooden rails or wooden pallets. Under no condition shall the fans be stored in such a way that metal components are in direct contact with the ground or floor slabs.
- B. Where it is not practical to store items within an enclosure fans may be stored on wooden rails, wooden pallets, or shipping skids outside.
- C. Fans shall be covered with 6 mil polyethylene sheet (taped in place) to protect the equipment from damage and the weather.

**PART 2 - PRODUCTS**

2.1 GENERAL

A. Testing and Ratings

1. Fans shall be tested and rated in accordance with AMCA 210.

B. Drives

1. V-Belt drives shall be designed for not less than 150% of connected driving capacity and motor sheaves shall be adjustable to provide not less than 20% speed variation. Sheaves shall be selected to drive the fan at a speed to produce the scheduled capacity indicated on the drawings when set at the approximate midpoint of the sheave adjustment. Motors with V-belt drives shall be provided with adjustable bases.

C. Balancing

1. Centrifugal fan wheels shall be statically and dynamically balanced.

D. Disconnects

1. Safety disconnect switches shall conform to requirements of Division 26 - ELECTRICAL.

2.2 CENTRIFUGAL ROOF FANS

- A. Fans shall be centrifugal roof exhausters with waterproof design so that water cannot enter the building through fan housing whether or not fan is operating. Fan shall be equipped with a back draft damper on inlet and a birdscreen on outlet.

- B. Fan shall have a one-piece aluminum housing enclosing the motor and drive, an aluminum shroud enclosing the fan wheel, and an aluminum curb cap. Curb cap shall have a 1" wide by 1/4" thick foam rubber gasket factory applied to underside perimeter of curb cap. An internal power wiring post shall extend from motor compartment through curb cap. Where wiring post penetrates housing and curb cap, penetration shall be sealed.

- C. Fan wheel shall be backward inclined centrifugal type with aluminum construction. On belt drive units, shaft bearings shall be self-aligning, pillow block ball type. Bearings not permanently sealed and lubricated shall have grease fittings.

- D. Fan motor shall comply with Section 230513 COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT. Motor and drive shall be located in a ventilated compartment outside of the air stream. Fan shall have factory installed disconnect switch pre-wired to motor and mounted within motor compartment. Motor and drive shall be mounted on vibration isolators.

- E. Direct drive fans shall be provided with an electronic speed controller.

- F. Fans shall be:

		Direct Drive
1.	Acme	Model PV
2.	Breidert	Model RED
3.	Carnes	Model VED
4.	Cook	Model ACE-D
5.	Greenheck	Model G
6.	PennBarry	Series DMX



### 2.3 WALL CENTRIFUGAL FANS

- A. Fans shall be wall centrifugal exhausters with air discharge away from wall and waterproof design so that water cannot enter the building through fan housing whether or not fan is operating. Fan shall be equipped with a back draft damper on inlet and a birdscreen on outlet.
- B. Fan shall have aluminum housing enclosing the motor and drive, an aluminum shroud enclosing the fan wheel, and an aluminum curb cap. Curb cap shall have a 1" wide by 1/4" thick foam rubber gasket factory applied to underside perimeter of curb cap. An internal power wiring post shall extend from motor compartment through curb cap. Where wiring post penetrates housing and curb cap, penetration shall be sealed. A 1/4" diameter static pressure tube shall be factory installed through fan housing at the inlet side of the fan wheel. Exposed end of tube shall have a plastic cap.
- C. Fan wheel shall be backward inclined centrifugal type with aluminum construction. On belt driven units, shaft bearings shall be self-aligning, pillow block ball type. Bearings not permanently sealed and lubricated shall have grease fittings.
- D. Fan motor shall comply with Section 230513 COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT. Motor and drive shall be located in a ventilated compartment outside of the air stream. Fan shall have factory installed disconnect switch pre-wired to motor and mounted within motor compartment. Motor and drive shall be mounted on vibration isolators.
- E. Direct drive fans shall be provided with an electronic speed controller.
- F. Fans shall be:

	Direct Drive	Belt Drive
1. Breidert	Model WXD	Model WXB
2. Carnes	Model VWD	Model VWB
3. Cook	Model ACW-D	Model ACW-B
4. Greenheck	Model CW	Model CWB

### 2.4 UPBLAST CENTRIFUGAL FANS

- A. Fans shall be up blast centrifugal roof exhausters with air discharge vertically away from roof and waterproof design so that water cannot enter the building through fan housing whether or not fan is operating. Fans serving as exhaust for grease removal kitchen hoods shall be U.L. listed for that purpose.
- B. Fan shall have aluminum housing enclosing the motor and drive, an aluminum shroud enclosing the fan wheel and an aluminum curb cap. Curb cap shall have a 1" wide by 1/4" thick foam rubber gasket factory applied to underside perimeter of curb to underside perimeter of curb cap. An internal power wiring post shall extend from motor compartment through curb cap. Where wiring post penetrates housing and curb cap, penetration shall be sealed. Base of fan housing shall have drain tube.
- C. Fan wheel shall be backward inclined centrifugal type with aluminum construction. On belt driven units, shaft bearings shall be self-aligning, pillow block ball type. Bearings not permanently lubricated and sealed shall have grease fittings.
- D. Fan motor shall comply with Section 230513 COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT. Motor and drive shall be located in a ventilated compartment outside of the air stream. Fan shall have factory installed disconnect switch pre-wired to motor and mounted within motor compartment. Motor and drive shall be mounted on vibration isolators.
- E. Direct drive fans shall be provided with an electronic speed controller.

F. Fans shall be:

		Direct Drive	Belt Drive
1.	Acme	Model PDU	Model PNU
2.	Breidert	Model TXD	Model TXB
3.	Carnes	Model VUD	Model VUB
4.	Cook	Model ACRU-D	Model ACRU-B
5.	Greenheck	Model CUE	Model CUBE
6.	PennBarry	Model FMX	Model FMX

2.5 CEILING CENTRIFUGAL FANS

- A. Fans shall be the ceiling centrifugal type with insulated metal housing, back draft damper, and integral exhaust grille.
- B. Housing shall be galvanized steel with 1/2" thick (minimum) coated Fiberglas insulation. Insulation shall comply with ASTM E84 and NFPA 255 for maximum ratings of flame - 25 and smoke - 50.
- C. Fan wheel shall be forward curved centrifugal type with direct drive.
- D. Fan motor shall comply with Section 230513 COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT. Motor and drive shall be mounted on vibration isolators.
- E. Fans shall be:
  - 1. Acme; Model V.
  - 2. Breidert; Model FF/FFC.
  - 3. Carnes; Model VCD
  - 4. Cook; Model GC (Gemini)
  - 5. Greenheck; Model SP.
  - 6. PennBarry; Model Z (Zephyr)

2.6 WALL PROPELLER FANS

- A. Fans shall be wall propeller type with wall mounting panel, wire fan guard, and motor guard screen. Fan shall have a gravity back draft damper.
- B. Wall panel shall be steel, reinforced with steel channel for motor and fan mounting frame. Exposed surfaces shall have baked enamel or epoxy finish. Panel shall have a spun venturi formed into the panel. For exhaust service, venturi shall point out; for supply service, venturi shall point in.
- C. Fan wheel shall be axial blade type construction of steel or aluminum. Blades shall be welded to fan hub. Fan shall have 3 blades (minimum). Fan shall have same finish as wall panel. On belt driven units, shaft bearing shall be self-aligning, pillow block type. Bearings not permanently sealed and lubricated shall have grease fittings.
- D. Fan motor shall comply with Section 230513 COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT. Motor and drive shall be mounted on vibration isolators.
- E. Fans shall be:

		Direct Drive Exhaust	Direct Drive Supply
1.	Acme	Model FQ	-----
2.	Breidert	Model BDG	-----
3.	Carnes	Model LJD	-----
4.	Cook	Model SWD	-----
5.	Greenheck	Model SE	Model SS

6. PennBarry Model P -----

2.7 ROOF BLOWER FANS

- A. Fans shall be roof mounted, filtered, make-up air, belt driven, forward curved, centrifugal blower type with waterproof design so that water cannot enter the building through the fan housing whether or not the fan is operating
- B. Hood construction shall be of heavy gauge extruded aluminum louvers with mitered and welded corners. Hoods shall include an insulated aluminum cover hinged for access. Fans used for supply shall have a filter frame in fan inlet. Filters shall be 1 inch thick cleanable type constructed of aluminum mesh.
- C. Fan wheels shall be of the forward-curved type, constructed of heavy gauge steel. Motors shall be permanently lubricated, heavy duty, ball bearing type, carefully matched to the fan load and furnished at the specified voltage, phase and enclosure.
- D. Fan motor shall comply with Section 230513 COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT. Motor and drive shall be mounted on vibration isolators. Fan shall have a factory installed disconnect switch pre-wired to motor and mounted on housing.
- E. Fan housing shall be:
  - Supply
  - 1. Acme -----
  - 2. Breidert -----
  - 3. Greenheck Model RSFP
  - 4. PennBarry -----

2.8 DRYER VENT BOOSTER FAN

- A. Fan shall be inline rated for dryer exhaust. Fan shall have galvanized steel housing with backward inclined blades to allow lint to pass through.
- B. Fans shall be HVI certified and ETL listed.
- C. Fan shall be FanTech or equal.

**PART 3 - EXECUTION**

3.1 INSTALLATION

- A. Centrifugal roof exhausters shall be mounted on roof curb. Fan curb cap shall be secured to roof curb with cadmium plated screws a maximum of 12" on center.
- B. Wall centrifugal exhausters shall be secured to wall using all bolt holes.
- C. Upblast centrifugal roof exhausters shall be mounted on roof curb. Fan curb cap shall be secured to roof curb with cadmium plated steel screws a maximum of 12" on center.
- D. Ceiling centrifugal exhaust fans shall be supported by 1" x 6" gauge galvanized steel straps secured to each corner of the fan housing and to overhead building structure members. Straps shall be attached to fan housing with not less than 2 sheet metal screws per strap. In steel bar joist construction, straps shall be looped around the bottom chord of joists and fastened with not less than 2 sheet metal screws through the strap to secure the loop.
- E. Roof caps shall be secured to curb with cadmium plated steel screws.

- F. Wall propeller fans shall be mounted in wall per manufacturer's recommendations.
- G. Blower roof fans shall be mounted on roof curbs. Fan curb cap shall be secured to roof curb with cadmium plated steel screws a maximum of 12" on center.
- H. All new roof mounted fans shall be installed on existing curbs. Provide and install adapter curbs as needed.

**END OF SECTION**

## SECTION 233713

### DIFFUSERS, REGISTERS AND GRILLES

#### 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. Work Included
  - 1. Grilles
  - 2. Registers
  - 3. Diffusers
- B. SUBMITTALS
  - 1. General: All submittals shall comply with the requirements of Division 1 - GENERAL REQUIREMENTS and Section 230500 COMMON WORK RESULTS FOR HVAC.
- C. Product Data: Data shall be submitted on the following items:
  - 1. Grilles
  - 2. Registers
  - 3. Diffusers

##### 1.3 QUALITY ASSURANCE

- A. Standards
  - 1. National Fire Protection Association (NFPA):
    - a. Standard 255, Test Methods for Surface Burning Characteristics of Building Materials.

##### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Air distribution devices received and stored on the job site shall be stored in dry storage spaces, (e.g. building, trailer, or shed) whenever possible. Air distribution devices shall be stored on wooden rails or wooden pallets. Under no condition shall the air distribution devices be stored in such a way that metal components are in direct contact with the ground or floor slabs.
- B. Where it is not practical to store items within an enclosure air distribution devices may be stored on wooden rails, wooden pallets, or shipping skids outside.
- C. Air distribution devices shall be covered with 6 mil polyethylene sheet (taped in place) to protect the equipment from damage and the weather.

**PART 2- PRODUCTS**

2.1 GENERAL

A. Finish

1. Steel grilles, registers, and diffusers shall be provided with a factory applied white baked enamel finish unless indicated otherwise, herein or on the drawings.
2. Aluminum grilles, registers, and diffusers which are ceiling mounted shall be provided with a factory applied white baked enamel finish unless indicated otherwise, herein or on the drawings.
3. Aluminum grilles and registers which are wall or floor mounted shall be factory etched to a satin finish and coated with a clear lacquer.

B. Mounting

1. Model numbers indicated herein are for surface mounting in exposed tee-bar grids or for integral mounting in exposed tee-bar grids. Where grilles, registers or diffusers are to be installed in concealed spine ceilings or plaster ceilings the mounting frame shall be adjusted to match the ceiling requirements. In plaster ceilings, provide plaster frames.

2.2 GRILLES & REGISTERS

- A. Type 'C' return, exhaust, and transfer air grilles and registers shall be aluminum with fixed horizontal vanes, 35 degrees setting (minimum) and flat margin with gasket. Vane spacing shall be 3/4" (20mm) (maximum) on center. Registers shall be provided with steel opposed blade dampers key operated from face of register. Type 'C' grilles and registers shall be:

<u>Manufacturer</u>	
Carnes	RALAH Series
Tuttle & Bailey	A70D Series
Krueger	80/80H Series
Titus	350-F Series
Anemostat	X3HD Series
E.H. Price	630 Series
J & J Register	S90H Series
Millaire	1100H Series
Metal Aire	RH Series (2/3"center)

- B. Type 'E' heavy duty return air grilles shall be steel with fixed horizontal vanes 38 degrees setting (minimum) and flat margin. Vane spacing shall be 1/2" (12mm) (maximum) on center. Registers shall be provided with steel opposed blade dampers. Type 'E' grilles and registers shall be:

<u>Manufacturer</u>	<u>Grilles (RG-B,EG-B,TG-B)</u>
Carnes	-----
Tuttle & Bailey	-----
Krueger	-----
Titus	33R
Anemostat	-----
E. H. Price	-----
Metal Aire	HDRH
J & J Register	-----

- C. Type 'D' supply air registers shall be aluminum with double deflecting individually adjustable horizontal and vertical vanes and flat margin with gasket. Vertical vanes shall be in front; vane spacing shall be 3/4" (20mm) on center. Registers shall be provided with steel opposed blade damper key operated from face of register. Type 'D' grilles and registers shall be:

Manufacturer

Carnes	RWDAV Series
Tuttle & Bailey	A64 Series
Krueger	5880 V Series
Titus	300-F Series
Anemostat	X2V Series
E. H. Price	620 Series
J & J Register	990V Series
Millaire	110V Series
Metal Aire	VH Series (2/3" center)

- D. Type 'B' return, exhaust, and transfer air grilles shall be aluminum or steel with 1/2" x 1/2" x 1/2" (12mm x 12mm) egg crate grid face panel and flat margin. Panel shall be sized to fit exposed tee-bar ceiling system with channel frame. Type 'B' grilles shall be:

24" x 24"  
 (600mm x 600mm)

<u>Manufacturer</u>	<u>Flat Margin</u>	<u>Lay-In</u>
Carnes	RAPAF	RAPAH
Tuttle & Bailey	CRE 500	CR500U
Krueger	EGC-5	EG-5
Titus	50-F	50-F
Anemostat	GC-5L	-----
E.H. Price	F80	80 Channel Frame
J & J Register	EC-5	EC-5
Millaire	1400 AG	1400 AG-T Bar
Metal Aire	CC5	CC-5-TBC

2.3 CEILING DIFFUSERS

- A. Type 'A' ceiling diffusers shall be aluminum with removable perforated face panel, adjustable diffusion louvers, opposed blade damper, and round neck or round neck adapter. Face panel shall fit 24"x24" (600mm x600mm) lay-in tee-bar ceiling grid. Throw pattern shall be four way unless otherwise indicated on the drawings. Type 'T' ceiling diffusers shall be:

Manufacturer

Carnes	-----
Tuttle & Bailey	-----
Krueger	-----
Titus	PCS
Anemostat	-----
E. H. Price	-----
J & J Register	-----
Millaire	-----
Metal Aire	7600

**PART 3 - EXECUTION**

3.1 INSTALLATION

- A. Grilles and registers mounted in walls shall be secured to ductwork with sheet metal screws.
- B. Grilles, registers, and ceiling diffusers not sized to fit ceiling grid systems shall be secured to ductwork with sheet metal screws. Where diffuser is attached to duct system with flexible duct, diffusers shall be supported from structures with two galvanized steel wire hangers.
- C. Grilles, registers, and ceiling diffusers sized to fit ceiling grid system shall be supported from grid system.

**END OF SECTION**



**SECTION 233723**  
**HVAC GRAVITY VENTILATORS**

**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. Work Included
  - 1. Roof Hoods

1.3 SUBMITTALS

- A. General: All submittals shall comply with the requirements of Division 1 - GENERAL REQUIREMENTS and Section 230500 COMMON WORK RESULTS FOR HVAC.
- B. Product Data: Data shall be submitted on the following items:
  - 1. Roof Hoods

1.4 QUALITY ASSURANCE

- A. Standards
  - 1. American Society for Testing Materials (ASTM):
    - a. Standard E84, Surface Burning Characteristics of Building Materials.
    - b. Standard A446, Specification for steel sheet, zinc coated (galvanized) by the hot dip process, structural (physical quality), edited.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Roof hoods received and stored on the job site shall be stored in dry storage spaces, (e.g. building, trailer, or shed) whenever possible. Roof hoods shall be stored on wooden rails or wooden pallets. Under no condition shall the roof hoods be stored in such a way that metal components are in direct contact with the ground or floor slabs.
- B. Where it is not practical to store items within an enclosure roof hoods, equipment curbs and rails may be stored on wooden rails, wooden pallets, or shipping skids outside.
- C. Roof hoods shall be covered with 6 mil polyethylene sheet (taped in place) to protect the equipment from damage and the weather.

**PART 2 - PRODUCTS**

2.1 ROOF HOODS

- A. Roof hoods shall be all galvanized steel construction, ASTM A446, grade C, G90 with a factory applied prime coat to permit finish painting on the job site. Relief and exhaust hoods shall have perimeter to throat ratios of 1 to 1. Intake hoods shall have perimeter to throat ratios of 2 to 1. Hoods shall have a base curb cap for mounting on roof curb and corners of curb cap shall be welded. Each hood shall have a

factory installed 1" wide x 1/4" thick foam rubber gasket applied around the entire underside of the curb cap.

- B. Perimeter opening of each hood shall be equipped with galvanized welded steel mesh birdscreens.
- C. The underside of the hood and the interior of the airshaft shall be insulated with factory applied 1" thick (minimum), 1-1/2 lb. density fiberglass insulation with flame retardant foil-reinforced kraft facing vapor barrier; insulation shall be attached to hood using mechanical fasteners and waterproof adhesive.
- D. The throat of each hood shall be equipped with a damper mounting frame to permit installation of a damper. The damper shall be as specified in Section 230900 INSTRUMENTATION AND CONTROL FOR HVAC.
- E. The top of the hood shall be hinged and latched for access to the damper.
- F. Intake hoods shall be equipped with a 1" thick cleanable filter at the perimeter opening.
- G. Pressure drop at indicated air quantity and throat dimensions shall not exceed quantities indicated on drawings. Shop drawings shall indicate dimensions of each unit, installed weight and pressure drop at rated air flow.
- H. Roof hoods shall be:

Acme	IV Series
Greenheck	Fabrahood
Penn	Airette Series

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Roof hood shall be secured to roof curb with galvanized steel lag bolts and washers, a maximum of 12 inches on centers. Roof hood installed on existing curb. Provide and install curb adaptor as required.

**END OF SECTION**

**SECTION 235216**  
**CONDENSING BOILER**

**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. The boiler shall have a rated output of not less than that shown on the drawings.
- B. The boiler shall fit in the space requirements of the boiler room, allowing for cleaning or maintenance. Clearances shall comply with the manufacturer's recommendations unless otherwise indicated.

1.3 SUBMITTALS

- A. General: All submittals shall comply with the requirements of Division 1 - GENERAL REQUIREMENTS and Section 230500 COMMON WORK RESULTS FOR HVAC.
- B. Product Data: Data shall be submitted on the following items:
  - 1. Boiler
  - 2. Boiler Start-up Report
- C. Operation and Maintenance Data: Provide data on the following:
  - 1. Boiler and Controls
  - 2. Boiler Trim

1.4 QUALITY ASSURANCE

- A. Standards
  - 1. American Gas Association (AGA)
    - a. Certification
  - 2. American National Standard Institute (ANSI)
    - a. Standard Z21.12 "Gas Fired Low Pressure Steam and Hot Water Boilers".
  - 3. American Society of Mechanical engineers (ASME)
    - a. Boiler and Pressure Vessel Code, Section IV Heating Boilers
- B. Permits
- C. See specification, Section 230500 COMMON WORK RESULTS FOR HVAC.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Boiler received and stored on the job site shall be stored in dry storage spaces, (e.g. building, trailer, or shed) whenever possible. Boiler shall be stored on wooden rails, wooden pallets, or shipping skids. Under no condition shall the Boiler be stored in such a way that metal components are in direct contact with the ground or floor slabs.
- B. Where it is not practical to store items within an enclosure, Boiler may be stored on wooden rails, wooden pallets, or shipping skids outside.
- C. Boiler shall be covered with 6 mil polyethylene sheet (taped in place) to protect the equipment from damage and the weather
- D. All openings to the boiler shall be sealed or capped.

**PART 2 - PRODUCTS**

2.1 BOILER

- A. Boiler shall be design certified by (AGA) American Gas Association Laboratory under ANSI Standard Z21.13. A standard nameplate shall be affixed to the boiler containing the manufacturer's name and address, the boiler trace name, and boiler catalog name. Boilers shall be:  

Lochinvar	Crest Condensing Boiler
Teledyne Laars	- - -
Raypak	- - -
- B. The 316L stainless steel combustion chamber shall be designed to drain condensation to the bottom of the heat exchanger assembly. The complete heat exchanger assembly shall carry a twelve (12) year limited warranty.
- C. The boiler shall operate at a minimum of 95% annual fuel utilization efficiency. The boiler shall be certified for indoor installation.
- D. The boiler shall be constructed with a heavy gauge steel jacket assembly, primed and pre-painted on both sides. The combustion chamber shall be sealed and completely enclosed, independent of the outer jacket assembly, so that integrity of the outer jacket does not affect a proper seal. A burner/flame observation port shall be provided. The burner shall be a premix design and constructed of high temperature stainless steel with a woven metal fiber outer covering to provide modulation firing rates. The boiler shall be supplied with a gas valve designed with negative pressure regulation and be equipped with a variable speed blower system, to precisely control the fuel/air mixture to provide modulating boiler firing rates for maximum efficiency. The boiler shall operate in a safe condition at a derated output with gas supply pressures as low as 4 inches of water column. The boiler shall be equipped with leveling legs.

- E. The boiler shall utilize a 24 VAC control circuit and components. The control system shall have an electronic display for boiler set-up, boiler status and boiler diagnostics. All components shall be easily accessed and serviceable from the front and top of the jacket. The boiler shall be equipped with; a temperature/pressure gauge, high limit temperature control certified to UL353, ASME certified pressure relief valve, outlet water temperature sensor, return water temperature sensor, a UL 353 certified flue temperature sensor, outdoor air sensor, low water flow protection and built-in adjustable freeze protection.
- F. The boiler shall be installed and vented with a direct vent vertical system with a vertical roof top termination of both the vent and combustion air. The flue shall be PVC, CPVC or stainless steel sealed vent material terminating at the roof top with the manufacture's specified vent termination. A separate pipe shall supply combustion air directly to the boiler from the outside. The air inlet pipe may be PVC, CPVC, ABS, galvanized, dryer vent or stainless steel sealed pipe. The air inlet must terminate on the roof top with the manufacturer's specified air inlet cap. Vent and combustion air piping material to be coordinated with manufacturer.

## 2.2 TESTS

- A. Boiler, burner and controls shall be factory assembled, wired and tested. All wiring shall be run in metal conduit. Boiler manufacturer shall provide operating and maintenance instructions plus a complete control wiring diagram with type written outline of operation, all of which shall be included in the operation and maintenance manual. In addition, a copy of the wiring diagram and the outline of operation shall be framed under glass and mounted on a wall near the boiler, or affixed to the control panel cover.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Boiler shall be installed in accordance with the manufacturer's recommendations.
- B. Relief valve piping shall be supported independent of relief valve so as to place no strain on the valve.
- C. A factory trained technician shall supervise start-up, adjustment and instruction of operating personnel. A start-up report shall be furnished in triplicate to the Engineer.

**END OF SECTION**

## SECTION 235700

### HEAT EXCHANGERS FOR HVAC

#### 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. Work Included:
  - 1. Flat Plate Heat Exchanger

##### 1.3 SUBMITTALS

- A. General: All submittals shall comply with the requirements of Division 1 - GENERAL REQUIREMENTS and Section 230500 COMMON WORK RESULTS FOR HVAC.
- B. Product Data: Data shall be submitted on the following items:
  - 1. Flat Plate Heat Exchanger
- C. Operation and Maintenance Data: Data shall be provided on the following items:
  - 1. Flat Plate Heat Exchanger

##### 1.4 QUALITY ASSURANCE

- A. Standards
  - 1. ASME Code for unfired pressure vessels.
  - 2. American Society of Mechanical Engineers (ASME):
    - a. Boiler and Pressure Vessel Code and Interpretations: Section VIII, Pressure Vessels, Division.

##### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Flat Plate Heat Exchanger received and stored on the job site shall be stored in dry storage spaces, (e.g. building, trailer, or shed) whenever possible. Flat Plate Heat Exchanger shall be stored on wooden rails, wooden pallets, or shipping skids. Under no condition shall the Flat Plate Heat Exchanger be stored in such a way that metal components are in direct contact with the ground or floor slabs.
- B. Where it is not practical to store items within an enclosure, Flat Plate Heat Exchanger may be stored on wooden rails, wooden pallets, or shipping skids outside.
- C. Flat Plate Heat Exchanger shall be covered with 6 mil polyethylene sheet (taped in place) to protect the equipment from damage and the weather

## PART 2 - PRODUCTS

### 2.1 PLATE AND FRAME HEAT EXCHANGER

- A. The Flat Plate Heat Exchanger shall consist of one-piece nitrile gasketed plates clamped between stationary frame and pressure plate by a series of threaded lateral bolts. Heat exchanger shall be factory assembled and shall have the capacity as indicated on the drawings.
- B. Heat exchanger shall be bolted construction as opposed to welded construction for ease of assembly, disassembly and cleaning.
- C. Frame shall be carbon steel with baked enamel epoxy finish. Plate shall be 304 stainless steel with a minimum thickness of 0.6 mm. Tie bolts shall be carbon steel with carbon steel nuts. Connections shall be studded port type constructed of carbon steel. All connections shall be provided with 316 s.s. liners to minimize erosion. Port velocity shall not exceed 18 fps.
- D. The top and sides of the plate pack shall be entirely enclosed within an 18 gauge, type 304 stainless steel shroud.
- E. Heat exchanger shall meet and be constructed under the ASME Code for unfired pressure vessels and the exchanger shall be stamped with the ASME "U" symbol. Provide manufacturer's data report, Form No. U-1 after testing of heat exchanger and before final acceptance by the Owner, to demonstrate heat exchanger has been designed, fabricated and tested in accordance with Section VIII, Division 1 of ASME Code.
- F. Heat exchanger shall be factory tested at 1.5 times the working pressure and at 275°F. Working pressure shall be 150 psig.
- G. Plate heat exchanger shall be designed, submitted, and certified to provide a minimum of 5% excess surface area to maintain design performance in the event of fouling. Heat exchanger frame and compression bolts shall have capacity for future installation of at least 20% additional plates.
- H. Provide heat exchanger with a complete second set of plates to be crated and left on site in area designated by owner.
- I. Submittal shall indicate and certify inlet and outlet temperatures, pressure drops, flow rates, number of plates and amount of heat exchanged. In the event that the installed heat exchanger does not meet design criteria, the manufacturer shall take corrective measures to provide design performance at no cost to the Owner.
- J. Heat exchanger shall be:
  - Alfa-Laval
  - American Vicarb
  - Bell & Gossett
  - Baltimore Air Coil
  - Mueller

**PART 3 - EXECUTION**

3.1 INSTALLATION

- A. Flat plate heat exchangers shall be installed in accordance with manufacturer's installation instructions and as shown on the drawings.

**END OF SECTION**



**SECTION 236500**  
**COOLING TOWER**

**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. Work Included:
  - 1. Factory assembled steel induced draft crossflow cooling tower.

1.3 SUBMITTALS

- A. General: All submittals shall comply with the requirements of Division 1 - GENERAL REQUIREMENTS and Section 230500 COMMON WORK RESULTS FOR HVAC.
- B. Product Data: Data shall be submitted on the following items:
  - 1. Cooling Tower
- C. Operation and Maintenance Instructions: Data shall be provided on the following items:
  - 1. Cooling Tower

1.4 QUALITY ASSURANCE

- A. Standards:
  - 1. National Fire Protection Association (NFPA):
    - a. Standard 214, Cooling Tower - Water.
    - b. Factory Mutual

**PART 2 - PRODUCTS**

2.1 COOLING TOWER

- A. Cooling tower shall be factory assembled induced draft, crossflow, vertical discharge double flow design.
- B. Tower shall be non-combustible as described in NFPA 214 for towers above 375 tons (1320 KW). For towers 375 tons (1320 KW) and below, the fill/louver/eliminator system shall be approved by Factory Mutual.
- C. The tower shall be equipped with removable panels and access doors to permit access to all parts for service and maintenance.

- D. Capacity shall be as indicated on drawings.
- E. Cooling tower shall be:
  - 1. Marley; NC8402NAN. To match existing. No alternates are acceptable.
- F. Casing shall be 16 gauge galvanized steel panels with overlapping vertical joints. Louvers shall be galvanized steel or PVC integral with fill, factory installed. Casings shall be supported by galvanized steel structural framework.
- G. Water inlet shall utilize variable flow nozzles for uniform air-water contact.
- H. Cold Water Basin:
  - 1. Tower cold water basin shall be 14 gauge galvanized steel. Basin shall be self-cleaning with depressed center sump, with suction, drain, overflow and cleanout connections. Suction outlet shall be equipped with anticavitation device and lift out galvanized screen. Suction outlet pipe connection shall be flanged; drain, overflow and cleanout pipe connections shall be threaded. Towers of more than one cell shall include stainless steel flumes for flow and equalization between cells.
  - 2. Tower basin shall be equipped with float switch. Float switch shall be interlocked to operate electric slow acting solenoid make-up water valve as indicated on the drawings.
- I. Distribution basins shall be open gravity type constructed of galvanized steel with non-metallic metering orifices. Return water pipe connections on distribution basin shall be equipped with flanges.
- J. Fill shall be film-type, vacu-formed PVC, with louvers and drift eliminators formed as part of each fill sheet. PVC shall have a flame spread rating of 25 or less. Fill shall be suspended from hot dipped galvanized structural tubing supported from the upper tower structure, and shall be elevated above the floor of the cold water basin to facilitate cleaning. Guaranteed drift losses shall not exceed 0.005% of the design water flow rate.
- K. Fans shall be propeller type with aluminum hub and blades. Fan assembly shall be factory adjusted for blade setting and balance. Drive assembly for Marley cooling tower shall consist of right angle "Geareducer" and drive shaft. Drive assembly for Baltimore Air Coil cooling tower shall consist of solid-backed, multi-grooved, neoprene/polyester "Power Band" designed for cooling tower service. Bearings shall have a minimum C-10 life of 40,000 hours. Cooling tower shall be equipped with a galvanized steel grille type fan guard over each fan cylinder.
- L. Bolts, nuts and washers shall be 3000 series.
- M. Motors and VFDS shall be as specified in Section 230513 COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT.
- N. In addition to the suction outlet, water make-up, overflow and drain connections, the tower shall be equipped with a flanged connection to allow for bypass of condenser water return through a motor operated control valve. Flanged outlet shall be the same size as the suction outlet connection.
- O. Cooling tower shall be equipped with an aluminum ladder and handrail for access to fan deck and a galvanized handrail around top perimeter of tower. Ladder and handrail shall be constructed to OSHA Standards.

- P. Basin heater and float control: Provide a system of electric immersion heaters and controls for each cell of the tower to maintain basin water temperature at 40°F (5°C) at 0°F (-18 °C) ambient during periods of shutdown. The system shall consist of one or more stainless steel electric immersion heaters installed in threaded couplings provided in the side of the basin. A NEMA 4 enclosure shall house a magnetic contactor to energize heaters; a transformer to provide 24 volt control circuit power; and a solid state circuit board for temperature and low water cut-off. A control probe shall be located in the basin to monitor water level and temperature.

### **PART 3- EXECUTION**

#### **3.1 INSTALLATION**

- A. Cooling tower shall be installed on existing basin as noted on drawings.
- B. Coordinate support spacing and location prior to erection.

**END OF SECTION**

## SECTION 238126

### SPLIT SYSTEM HEAT PUMP UNITS

#### 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

##### 1.3 Work Included:

- 1. Indoor Units
- 2. Outdoor Units

##### 1.4 SUBMITTALS

- A. General: All submittals shall comply with the requirements of Division 1 - GENERAL REQUIREMENTS and Section 230500 COMMON WORK RESULTS FOR HVAC.
- B. Product Data: Data shall be submitted on the following items:
  - 1. Indoor Units
  - 2. Outdoor Units
- C. Operation and Maintenance Data: Data shall be provided on the following items:
  - 1. Indoor Units
  - 2. Outdoor Units

##### 1.5 QUALITY ASSURANCE

##### A. Standards

- 1. Air Movement and Control Association (AMCA):
  - a. Standard 210, Laboratory Method of Testing Fans for Rating, 1985 Edition.
- 2. American Refrigeration Institute (ARI)
  - a. Standard 240, Air Source Unitary Heat Pump Equipment, 1981 Edition.
  - b. Standard 410, Forced Circulation Air Cooling and Air Heating Coils, 1987 Edition.
- 3. Underwriters' Laboratories (UL):
  - a. Standard 900.

##### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Split system units received and stored on the job site shall be stored on wooden rails, wooden pallets, or shipping skids. Under no condition shall the condensing units or air handling units be stored in such a way that metal components are in direct contact with the ground or floor slabs.
- B. Split system units shall be covered with 6 mil polyethylene sheet (taped in place) to protect the equipment from damage and the weather.

## PART 2 - PRODUCTS

### 2.1 GENERAL

- A. Split system heat pump units shall be factory fabricated and matched indoor and outdoor units. Indoor and outdoor units shall be constructed and rated in accordance with ARI 240. Split system heat pump units shall be:

Carrier  
Trane  
York

### 2.2 INDOOR UNITS

- A. Indoor units shall be horizontal or vertical draw through arrangement as indicated on the drawings.
- B. Casing shall be steel with internal reinforcing frame and factory baked enamel finish.
- C. Fan shall be centrifugal type with direct driven 3 speed motor. Fan shall be dynamically balanced and rated in accordance with AMCA 210. Fan bearings shall have grease fittings accessible from outside of casing while unit is operating.
- D. Refrigerant coil shall have copper tubes and aluminum fins. Fins shall be mechanically bonded to the tubes. Coil performance shall be rated in accordance with ARI 410. Coils shall be factory pressure tested.
- E. Heating coil shall be manufacturer's standard resistance electric heating coil.
- F. Filter shall be manufacturer's standard 1" (25 mm) thick high velocity flat type filter. Filter shall conform to UL 900 for Class I construction.

### 2.3 OUTDOOR UNITS

- A. Outdoor units shall be designed for exposed operation. Outdoor units shall include compressor, coil, coil fan, motors, reversing valve, charging valves, sight glass, filter-dryer and controls. Units shall require only one electrical service connection.
- B. Enclosure shall be constructed of steel with baked enamel finish. Coil section air intake and discharge shall have wire screen guards.
- C. Compressor(s) shall be reciprocating hermetic type with oil pump, crankcase heater, high pressure limit switch, and vibration isolators. Compressor motor shall have both thermal and current overload protection.
- D. Coil shall be constructed with copper tubes and aluminum fins. Fins shall be mechanically bonded to tubes. Coil capacity shall be rated in accordance with ARI 210.
- E. Fan(s) shall be propeller type with direct driven permanently lubricated motor and fan guard(s). Fans shall be statically and dynamically balanced and rated in accordance with AMCA.
- F. Controls shall be mounted in a separate compartment with hinged cover and accessible from outside the units while operating. Controls shall include line to 24 volt transformer, compressor and fan contactors, automatic defrost cycle, cooling to heating change over, and overload protection.

**PART 3 - EXECUTION**

3.1 INSTALLATION

- A. Horizontal indoor units shall be suspended from structure with hanger rods with isolators.
- B. Vertical indoor units shall be supported from floor with angle mounts or on housekeeping pad.
- C. Outdoor units shall be mounted on concrete base.

**END OF SECTION**

**SECTION 238127**

**SPLIT SYSTEM UNITS - DUCTLESS**

**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

1.3 Work Included:

- 1. Indoor Unit
- 2. Outdoor Unit
- 3. Refrigerant Piping

1.4 SUBMITTALS

- A. General: All submittals shall comply with the requirements of Division 1 - GENERAL REQUIREMENTS and Section 230500 COMMON WORK RESULTS FOR HVAC.
- B. Product Data: Data shall be submitted on the following items:
  - 1. Indoor Unit
  - 2. Outdoor Unit
  - 3. Refrigerant Piping
- C. Operation and Maintenance Data: Data shall be provided on the following items:
  - 1. Indoor Unit
  - 2. Outdoor Unit
  - 3. Refrigerant Piping

1.5 QUALITY ASSURANCE

- A. Standards
  - 1. Air Movement and Control Association (AMCA):
    - a. Standard 210, Laboratory Method of Testing Fans for Rating, 1985 Edition.
  - 2. American Refrigeration Institute (ARI)
    - a. Standard 240, Air Source Unitary Heat Pump Equipment, 1981 Edition.
    - b. Standard 410, Forced Circulation Air-Cooling and Air-Heating Coils, 1987 Edition.
  - 3. Underwriters' Laboratories (UL):
    - a. Standard 900,
  - 4. Environmental Protection Agency (EPA)
    - a. Clean Air Act

**PART 2 - PRODUCTS**

2.1 GENERAL

- A. Split system heat pump units shall be factory fabricated and matched indoor and outdoor units. Indoor and outdoor units shall be constructed and rated in accordance with ARI 240. Units shall be single zone. Split system heat pump units shall be:
  - Samsung ---

Hitachi	---
Sanyo	---
Mitsubishi	P Series
LG	---
Trane	---
Carrier	---

## 2.2 INDOOR UNIT

- A. Indoor unit shall be ceiling arrangement or wall mount as indicated on the drawings.
- B. Fan shall be centrifugal type with direct driven 3-speed motor. Fan shall be dynamically balanced and rated in accordance with AMCA 210. Fan bearings shall have grease fittings accessible from outside of casing while unit is operating.
- C. Refrigerant coil shall have copper tubes and aluminum fins. Fins shall be mechanically bonded to the tubes. Coil performance shall be rated in accordance with ARI 410. Coils shall be factory pressure tested.
- D. Filter shall be manufacturer's standard.
- E. Drain pan shall be factory insulated galvanized steel.

## 2.3 OUTDOOR UNIT

- A. Outdoor unit shall be designed for exposed operation. Outdoor unit shall include compressor, coil, coil fan, motors, reversing valve, charging valves, sight glass, filter-dryer and controls. Unit shall require only one electrical service connection.
- B. Enclosure shall be constructed of steel with baked enamel finish. Coil section air intake and discharge shall have wire screen guards.
- C. Compressor(s) shall be reciprocating hermetic type with oil pump, crankcase heater, high pressure limit switch, and vibration isolators. Compressor motor shall have both thermal and current overload protection.
- D. Coil shall be constructed with copper tubes and aluminum fins. Fins shall be mechanically bonded to tubes. Coil capacity shall be rated in accordance with ARI 210.
- E. Fan(s) shall be propeller type with direct driven permanently lubricated motor and fan guard(s). Fans shall be statically and dynamically balanced and rated in accordance with AMCA.
- F. Controls shall be mounted in a separate compartment with hinged cover and accessible from outside the unit while operating. Controls shall include line to 24 volt transformer, compressor and fan contactors, high pressure cut out, automatic defrost cycle, cooling to heating change over, low ambient control to 25°F and overload protection. Provide manufacturer's standard wired thermostat.

## 2.4 REFRIGERANT PIPING

- A. Provide and install manufacturer's standard charged line set.



**PART 3 - EXECUTION**

3.1 STORAGE

- A. Indoor and outdoor units shall be stored on wooden pallets or rails. Units shall be covered with 6 mil (minimum) polyethylene, taped in place.

3.2 INSTALLATION

- A. Ceiling units shall be suspended from structure with hanger rods with isolators.
- B. Wall units shall be supported from the wall with angle mounts.
- C. Outdoor unit shall be mounted on concrete base.
- D. Install refrigerant piping as recommended by the manufacturer and EPA.

3.3 OPERATION

- A. The equipment shall not be operated during construction without air filters at all return air openings to the ductwork and equipment.
- B. All air filters required during construction to protect the equipment shall be supplied by the contractor at no additional cost to the owner.

**END OF SECTION**

**SECTION 238146**  
**WATER SOURCE HEAT PUMPS**

**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. Work Included:
  - 1. Heat Pumps

1.3 SUBMITTALS

- A. General: All submittals shall comply with the requirements of Division 1 - GENERAL REQUIREMENTS and Section 230500 COMMON WORK RESULTS FOR HVAC.
- B. Product Data: Data shall be submitted on the following items:
  - 1. Heat Pumps
- C. Operation and Maintenance Data: Data shall be provided on the following items:
  - 1. Heat Pumps

1.4 QUALITY ASSURANCE

- A. Standards
  - 1. Air Conditioning and Refrigeration Institute (ARI), Standard 320-98.
  - 2. Underwriter's Laboratories, Inc. (UL).

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Heat Pumps received and stored on the job site shall be stored in dry storage spaces, (e.g. building, trailer, or shed) whenever possible. Heat Pumps shall be stored on wooden rails, wooden pallets, or shipping skids. Under no condition shall the heat pumps be stored in such a way that metal components are in direct contact with the ground or floor slabs.
- B. Where it is not practical to store items within an enclosure, heat pumps may be stored on wooden rails, wooden pallets, or shipping skids outside.
- C. Heat Pumps shall be covered with 6 mil polyethylene sheet (taped in place) to protect the equipment from damage and the weather

## PART 2- PRODUCTS

### 2.1 GENERAL

- A. Water source heat pump units shall be packaged, factory assembled, and shall be horizontal concealed type. Units shall have capacities as indicated on the drawings.
- B. Units shall be complete with compressor, air coil, water to refrigerant heat exchanger, reversing valve, expansion device, blower and motor, condensate drain pan, filters, piping, casing, and controls.
- C. Units shall be completely factory pre-piped and pre-wired except for required external piping and wiring connections.
- D. Units shall be UL labeled and conform to ARI Standard 320.
- E. Heat exchanger shall be supplied with water.
- F. Each compressor shall have an extended warranty covering parts failure for a period of five years. This warranty shall be non-prorated.
- G. Heat pump units except for WSHP-35-\* shall be:
  - Trane
  - Daikin
  - Carrier
- H. 100% outside air heat pump unit WSHP-35-\* shall be:
  - Aaon
  - United Cool Air
  - Trane with modifications for 100% outside air.
  - Carrier with modifications for 100% outside air.

### 2.2 AIR COIL

- A. Air to refrigerant coil shall be constructed of copper tubes with aluminum fins mechanically bonded to the tubes, tested for 400 psig (2758 kPa).

### 2.3 HEAT EXCHANGER

- A. Heat exchanger shall be for water to refrigerant heat transfer.

### 2.4 REVERSING VALVE

- A. Reversing valve shall be hermetic construction with replaceable external solenoid valve.
- B. Reversing valve shall be energized only in heating operation.

2.5 EXPANSION DEVICE

- A. Expansion device shall be capillary type to meter refrigerant flow between the air and water coils using multiple distributor tubes.

2.6 BLOWER AND MOTOR

- A. Blower and motor shall be direct centrifugal type. Motor shall be split capacitor type with thermal overload protection, single or multi-speed type, have 2-year lubrication capacity, and be initially factory lubricated.

2.7 CONDENSATE DRAIN PAN

- A. Condensate drain pan shall be insulated 14 gauge (2 mm) galvanized steel, dip-painted pan.
- B. Drain pan shall be pitched when unit is mounted level.
- C. Drain pan shall be provided with a minimum 3/4 inch (19 mm) drain connection.

2.8 FILTERS

- A. Filters shall be one inch thick throwaway type, mounted in filter rack on unit with bottom or side access as required for filter replacement.

2.9 CASING

- A. Unit casing shall house all equipment and shall be constructed of rigid steel frame, which supports all components and shall have exterior metal panels attached to the steel frame. All cabinet components shall be paint dipped and interior shall be acoustically lined with one inch (25 mm) thick, 3/4-pound (0.34 kg) density fibrous glass secured and coated to prevent detachment and erosion of fibers. Cabinet finish shall be baked enamel. Removable panels shall be provided for equipment access.
- B. Casing shall be provided with a minimum of four brackets for overhead support of units.
- C. Casing shall be provided with flanges for supply and return duct connections.

2.10 CONTROLS

- A. The unit control panel shall be factory wired and mounted within the unit casing. Panel shall include relays, 24 volt transformer and safety controls, all arranged for connection to remote thermostat hereinafter specified in Section 230900 INSTRUMENTATION AND CONTROL FOR HVAC. Safety controls shall protect the unit during both cooling and heating operation, including overload protection for both the motor compressor and the blower motor; overloads in each phase of three phase motors shall be provided. Freeze protection shall be provided to directly protect the heat exchanger using a device that will not cause nuisance shutdown due to low ambient temperatures and which shall be adjusted to trip out at circulating water temperature no lower than 40 degrees F (4.4 degrees C). Safety controls shall be wired through a lockout relay to hold unit off until unit is reset, either at the circuit breaker panel, or through the central program relay. Unit shall start and operate with a minimum ambient temperature of 40 degrees F (4.4 degrees C) and system water flow.

## 2.11 WATER CONNECTIONS

- A. Water connections to each unit shall be made using reinforced fire-rated stainless steel braided hose assembly suitable for 200 psig (1379 kPa) working pressure. When tested per ASTM-84, flame spread shall not exceed 25 and smoke density not exceed 50. Each hose shall have one fixed male IPT end and one union male IPT end. Each hose shall be 36 inches (900 mm) long and diameter same as unit connections. Hose assemblies shall be furnished by unit manufacturer.
- B. Provide 400 psi (2758 kPa) WOG work pressure ball shutoff valve on supply and return and circuit setter balancing valve on supply.

## 2.12 HANGER KIT

- A. For suspended units, unit manufacturer shall provide neoprene-in-shear hanger kits for units up to 3-1/2 tons (12.3 kW) and spring type hanger kits for 4 tons (14 kW) and larger.

## 2.13 OPERATING SYSTEM CONTROL AND ALARM PANEL

- A. Contractor shall furnish and install a factory assembled and wired solid state electronic control panel to:
  - 1. Control the addition of supplementary heat to the heat pump water loop upon a loop temperature drop to a floating control point.
  - 2. Automatic reset upwards upon a drop in outdoor temperature.
  - 3. Control the rejection of surplus heat from the heat pump water loop upon a temperature rise to the selected control point.
  - 4. Monitor the flow of water in the loop, and its temperature.
  - 5. Call the operation of the loop primary and standby circulating pumps, providing for both manual and automatic energization of the standby pump.
  - 6. Sound alarm and indicate fault in the event of loss of water flow, or water temperatures above or below the maximum or minimum control safe limits.
  - 7. Prohibit simultaneous operation of supplementary heating and heat rejection functions.
- B. Panel shall be furnished complete, by the manufacturer of the heat pumps, and shall include electronic temperature sensor for the water loop (in well), plug-in relays, push-to-test indicator lights, alarm horn and terminal blocks for all field wiring connections. The power supply to the panel shall be 120 volts, 1 phase, 60 Hertz, and shall incorporate provisions for mounting an integral transformer for operation at other voltages and frequencies. Panel shall include electronic temperature sensor for the outdoor air temperature (in weatherproof enclosure).
- C. The panel shall incorporate electronic temperature indicators for both water loop and outdoor air temperatures, with dual Celsius and Fahrenheit scales.
  - 1. The water temperature scale range shall be 50°F to 110°F (10°C to 43.3°C).
  - 2. The air temperature scale range shall be -40°F to 120°F (-40°C to 48.9°C).
- D. The panel shall contain provisions for field installing an optional remote repeater panel, which shall duplicate the three red alarm condition lights, the alarm horn, alarm silence switch, push-to-test (lights) switch, and shall not require a separate power source. The alarm silence switch shall silence both main and repeater alarms. Interconnection between the main panel and the repeater panel shall be by field wiring, N.E.C. Class II (low voltage).

- E. The panel shall incorporate provisions for switching from the normal temperature sensors, to operation by an optional "plug-in" simulator test panel, to facilitate initial commissioning including verification of control and alarm operations, and for servicing.
- F. A normally closed or normally open contact, which is energized if an alarm condition occurs, and which may be used in a control circuit to interrupt the operation of the heat pump units, shall be provided.
- G. All control functions herein described shall be switched by plug-in relays, with contact ratings of 1/4 HP @ 120 VAC/10 amp @ 240 VAC. Normally open contacts shall be provided for all control functions, except heat rejection damper control, which shall be single pole, double throw to accommodate either powered open/powered closed, or powered open/spring-return type damper motors.
- H. The panel enclosure shall be NEMA 1, and shall have appropriate knockouts on all sides, for power supply and field wiring connections. All terminals for field wiring shall be of the compression type, accept 12 GA. solid wire, and be rated for not less than 10 amps @ 300 volts. The solid state circuitry shall be of modular construction to permit field replacement of any circuit board without soldering.
- I. Install the temperature sensor well, the flow switch, and thermometer well in the main water loop line, as shown on the plans, before filling in the system. Furnish and install all field wiring from panel controlled motor starters, damper motor(s), supplementary heater control circuit, flow switch, from sump heater contactor auxiliary contacts to pilot lights on panel, and from the panel to the temperature sensors.
- J. The Automatic Pump Sequencing circuit of the panel shall:
  - 1. Automatically activate a full capacity standby circulating pump whenever the selected operating pump fails.
  - 2. Indicate "flow normal" condition whenever the lead or standby pump is operating and flow is "proven" by flow switch closure.
  - 3. Indicate "lead pump failure", and activate the alarm.
  - 4. Provide the manual selection of "lead" and "lag" pump operating sequence, with "reset" for the auto sequencer.
  - 5. Provide adjustable 5 to 15 second "ignore" of the flow switch opening, to prevent unnecessary pump sequencing which could occur if the flow switch is "fooled" by water turbulence, etc. The sequence of operation shall be as follows:
    - a. The lead pump manual selector switch is placed in either position for selection of the lead pump.
    - b. The panel is energized with 120 volt power.
    - c. The 5 to 15 second "ignore" timing of an open flow switch condition starts.
    - d. "P-1 PUMP-ON" or "P-2 PUMP-ON" lights shall indicate that the selected lead pump was energized and flow is proven, and the "ignore" time is placed on standby.
    - e. In the event that flow is not proven within the 5 to 15 second "ignore" timing period, or in the event that a flow interruption occurs later, the selected lead pump will be locked out, the standby pump activated, the alarm horn activated, the red "AC lockout" light activated, and all supplementary heat and heat rejector functions interrupted until successful operation of the standby pump is proven.
    - f. When normal flow has been restored, the standby pump light will be activated, heat rejector or supplementary heat functions will be permitted to be re-established, as required, with delayed start-up between stages.
    - g. After the cause of the flow interruption has been eliminated, by repairing or replacing the failed pump, or by correcting a system restriction, the selector switch shall be briefly placed in the reset position (Off) to reset the sequencer and its timer, and then placed in the desired position to re-establish the desired "lead/lag" sequence.

#### 2.14 HEAT REJECTION CONTROL

- A. The Heat Rejection Control Sequencing Circuit of the panel shall provide four stages of heat rejection, with an 85°F (29.4°C) setpoint for the first stage, adjustable plus or minus 5°F (2.8°C).
- B. The differential between stages 1 and 2 shall be 3°; between 2 and 3, 2°; between 3 and 4, 3°; plus or minus 1/2°.
- C. Typical sequence of operation shall be as follows:
  - 1. On a loop temperature rise to 85°F (29°C), control shall energize the damper relay to open a positive closure damper mounted on discharge of cooler, and an amber light shall illuminate.
  - 2. On a further rise to 88°F (31°C), control shall close starter circuit to recirculating spray pump motor(s), and an amber pilot light shall illuminate.
  - 3. On a rise to 90°F (32°C), control shall close starter circuit to low speed windings of the cooler fan motor.
  - 4. On a rise to 93°F (34°C), control shall close starter control circuit to cause the cooler fan motor to switch from low to high speed operation.
  - 5. On a temperature drop to 3° below the closure point, each stage shall be de-energized in reverse order.

#### 2.15 SUPPLEMENTARY HEAT CONTROL

- A. The supplementary heat control circuit of the panel shall provide one stage of supplementary heat control, with a 65°F (18.3°C) setpoint, adjustable plus or minus 5°F (2.8°C).
- B. The control differential shall be 3°, plus or minus 1/2°.
- C. Two pairs of normally open contacts shall be provided for the first stage of "head add", to activate the supplementary heater, and any auxiliary apparatus.
- D. On a water loop temperature drop to the setpoint, the control shall close both pairs of contacts to activate stage one of the heater, and an amber light shall illuminate.
- E. Outdoor air temperature is to reset the "heat add" control point up 8° as the outdoor air temperature falls from 60°F to 0°F.
- F. The supplemental heat stages must all be off at 80°F (26.6°C) loop water temperature, regardless of setting, reset, etc.

#### 2.16 SYSTEM SAFETY CONTROL AND ALARM FUNCTIONS

- A. The sequence and operation of the safety control functions shall be as follows:
  - 1. Loss of loop water flow shall deactivate all stages of control. Damper, spray pumps, fan motors, and supplemental heat must not operate until flow is proved, and must stop immediately on loss of flow.
  - 2. When flow is restored and proven, or in the event of power interruption, there shall be a delay between stages to limit current inrush.

3. On a loop temperature fall to 8°F below the supplementary heat control setpoint, the control shall open the normally closed safety contacts (used in optional circuitry to suspend operation of the heat pump units).
4. On a loop temperature rise to 105°F (40.6°C), the control shall open the normally closed safety contacts.
5. In the event of loss of loop water flow, the control shall "ignore" the signal for the selected delay period, and then attempt to initiate pump sequencing, as described previously. During the attempt to start the standby pump and to prove flow, the normally closed safety contacts shall open, and all control functions shall be deactivated.

B. The operation of the Alarm Functions shall be as follows:

1. The alarm shall sound and a red light be illuminated in the event of loss of water flow, high temperature, or low temperature.
2. The light shall extinguish, and the alarm automatically silence upon a return to normal temperatures.
3. The alarm shall sound until manually silences, except when loss of flow results in pump sequencing, the alarm shall automatically silence when flow is re-established, as described previously.
4. A manual alarm silence switch shall be provided.

2.17 ALL WSHP UNITS SHALL BE CAPABLE OF HOT-GAS REHEAT OPERATION.

### **PART 3- EXECUTION**

#### **3.1 INSTALLATION**

- A. Heat pumps shall be suspended from structure with hanger rod at each corner. Install vibration isolators in hanger rods.
- B. Hydronic piping system shall be flushed and cleaned in strict accordance with heat pump manufacturer's installation instructions. Use no chemicals without approval of heat pump manufacturer.

**END OF SECTION**



**SECTION 238223**  
**ENERGY RECOVERY UNITS**

**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. Work Included:
1. Energy recovery units
  2. Filters

1.3 SUBMITTALS

- A. General: All submittals shall comply with the requirements of Division 1 - GENERAL REQUIREMENTS and Section 230500 - MECHANICAL GENERAL.
- B. Product Data: Data shall be submitted on the following items:
1. Energy recovery units (including performance curves and sound power levels)
  2. Energy recovery wheels
  3. Bearings (including bearing shaft diameter and maximum fan RPM)
  4. Filters
- C. Operation and Maintenance Data: Data shall be provided on the following items:
1. Energy recovery units
  2. Energy recovery wheels
  3. Bearings
  4. Filters

1.4 QUALITY ASSURANCE

- A. Standards:
1. Air Conditioning and Refrigeration Institute (ARI):
    - a. Standard 410, Standard for Forced Circulation Air-Cooling and Air-Heating Coils.
    - b. Standard 430, Standard for Central-Station Air-Handling Units, 1999 Edition.
    - c. Standard 1060, standard for rating air to air energy recovery ventilation equipment.
  2. Air Movement and Control Association (AMCA):
    - a. Standard 210, Laboratory Method of Testing Fans for Rating.
    - b. Standard 300, Reverberant Room Method for Sound Testing of Fans
    - c. Standard 330 Laboratory Method of Testing In-Duct Sound Power.
  3. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE):
    - a. Standard 52, Methods of Testing Air Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
    - b. Standard 84-1991, Methods of Testing Air to Air Heat Exchangers.
  4. American Society for Testing and Materials (ASTM):
    - a. Standard E84, Surface Burning Characteristics of Building Materials.
    - b. Anti-Friction Bearing Manufacturers Association, Inc. (AFBMA):
    - c. Standard 9, Load Ratings and Fatigue Life for Ball Bearings.

5. Mechanical Power Transmission Association (MPTA) and Rubber Manufacturer's Association (RMA):
  - a. Engineering Standards for Drives Using Narrow Multiple V-Belts.
  - b. Standard 1977, Engineering Standards for Drives Using Classical Multiple V-Belts.
6. National Electrical Manufacturer's Association (NEMA):
  - a. Motors and Generators.
7. Underwriter's Laboratories (UL):
  - a. Standard 900, Air Filter Units.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Energy recovery units received and stored on the job site shall be stored with the wooden shipping skids in place. Under no condition shall the units be stored in such a way that metal components are in direct contact with the ground.
- B. Energy recovery units stored on the job site shall be covered with 6 mil polyethylene sheet, taped in place, to protect the units from damage and the weather.

### PART 2 - PRODUCTS

#### 2.1 ENERGY RECOVERY UNITS

- A. Energy recovery units shall be the indoor factory fabricated type. Units shall be provided with fans, energy recovery wheel, high efficiency motors and drives, and casing. Units shall have performance ratings certified in accordance with ASHRAE 84. Energy recovery units shall be:

Greenheck	ERV
Des Champs	RAX
Semco	FV
Governair	HWL

- B. Casing:
  1. Casing shall be of frame and panel 1 inch (25mm) single wall construction. The frame shall be constructed to permit removal of panels without affecting the structural integrity of the unit. Base shall be designed for curb mounting.
  2. Frame shall be constructed of minimum 14 gauge G90 galvanized steel angles.
  3. Panels shall be non-load bearing and constructed of G90 galvanized steel. Casing shall be 20 gauge minimum galvanized steel. Panels shall be secured to the frame with corrosion protected screws or bolts.
  4. Casings shall be internally insulated with fiberglass insulation. Insulation shall have neoprene sprayed face and shall comply with ASTM E84 for maximum flame and smoke ratings of 25-flame and 50-smoke. Insulation thickness and density shall be 1-inch and 3 lb./cu.ft. Insulation shall be adhered to inside of casing with a waterproof adhesive.
  5. All panels shall be gasketed at the factory with 1/4-inch thick and 3/4-inch wide closed cell neoprene gaskets.
  6. Access shall be provided for fans filters and motor operated dampers. Energy recovery wheel shall be mounted on a slide out type track for inspection.
  7. Access doors shall be of same thickness and construction as panels. Access doors shall be removable, hinged on one side and latched on the other.

- C. Fans:

1. Fans shall be double width, double inlet, centrifugal type with galvanized steel scroll housing. Fans shall have forward curved blades or backward inclined, air foil blades. Fans shall be constructed and rated in accordance with AMCA 210 for air quantity and system total static pressure. All unit air moving performance, RPM, brake horsepower and selection procedures shall be certified in accordance with ARI Standard 430-89 and bear the ARI seal. Fans shall have the same corrosion protection and finish as specified for casing. Fan scroll housing discharge shall be attached to casing using flexible duct connection suitable for static pressure rating of the fan.
2. Fans shall be statically and dynamically balanced in the casing at the factory. Each fan shall be provided with separate motor and drive to allow balancing for exhaust and supply airflows. Units specified to be variable frequency driven shall be balanced over the full range of modulation.
3. Fans shall be mounted and keyed to fan shaft. Fan shafts shall be turned, ground, and polished hot rolled steel with a maximum RPM not to exceed 80% of the first critical speed. Fan shaft shall not pass through its first critical speed as the unit comes up to rated RPM.
4. Shaft bearings inside the casing shall be self-aligning pillow block ball type. Shaft bearings outside the casing shall be flange type. Bearings shall have AFBMA Standard No. 9 rated L-50 life of not less than 100,000 hours at the maximum catalogued RPM for the fan in the air unit casing; bearing rated at design conditions will not be acceptable. Bearings mounted internally, or otherwise inaccessible, shall have extended grease lines to exterior of casing terminated with a grease fitting in a serviceable location.
5. Fan and motor assembly shall be internally isolated. The fan shall be mounted on a steel, isolation base with neoprene isolators. Fan isolation shall be complete and shall prevent metal-to-metal contact.

D. Motors and Guards:

1. Fan motors shall be high efficiency type and shall comply with Section 230513 – COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT.
2. Motors shall be open drip proof with common mounting base provided for fan and motor. Internal mounting bases shall be provided with isolators as specified above. Motors shall be mounted on adjustable steel bases with 2 adjusting screws.
3. Motor shall be sized to drive the fan taking into account belt losses. Whenever starting requirements exceed operating requirements, the motor shall be large enough to start the fan without overheating. As a minimum, motors shall be sized at 120 percent of design brake horsepower requirements. No motor shall be selected within the service factor range. Where necessary to provide practical drive ratios for low fan RPM, a 1200 RPM motor shall be used. Motor RPM shall not exceed 1800 RPM.
4. In calculating the fan brake horsepower, the following shall be added to the external static pressure indicated on the drawings:
  - a. Casing losses.
  - b. Energy Recovery wheel losses.

E. Fan Drives:

1. Fan drive shall consist of V-belt and sheaves.
2. Belts shall be designed for 150 percent (minimum) of the connected motor capacity. The area of the belt contact on the smaller sheave shall be not less than 120 degrees.
3. Sheaves shall be fixed pitch type selected based on the scheduled design conditions. Sheaves shall be as large as the minimum size recommended for each belt section by MPTA and RMA Standards 1974 and 1977. The motor sheave shall comply with NEMA MG1-14.42a for minimum diameter and maximum width. Centerline distance between fan and motor sheave shall not exceed three times the sum of the sheave diameters nor be less than the diameter of the larger sheave.

F. Energy Recovery Wheels

1. Wheel shall be the enthalpy type designed for both sensible and latent heat recovery using silica gel as the desiccant. Wheel performance shall be certified in accordance with ASHRAE 84-1991. Wheels over 26 inches in diameter shall be constructed of removable segments

## 2.2 FILTERS

- A. Filters shall be air handling unit manufacturer's standard 2-inch thick throwaway type complying with UL 900 for Class I constructio

## **PART 3 - EXECUTION**

### 3.1 INSTALLATION

- A. Floor mounted units shall be mounted on vibration isolators unless provided with factory installed isolators for internal motor and drives.

**END OF SECTION**

## SECTION 238239

### UNIT HEATERS

#### 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. Work Included:
  - 1. Unit Heaters
  - 2. Wall Heaters
  - 3. Ceiling Mounted Heaters

##### 1.3 SUBMITTALS

- A. General: All submittals shall comply with the requirements of Division 1 - GENERAL REQUIREMENTS and Section 230500 COMMON WORK RESULTS FOR HVAC.
- B. Product Data: Data shall be submitted on the following items:
  - 1. Unit Heaters
  - 2. Wall Heaters
  - 3. Ceiling Mounted Heaters
- C. Operation and Maintenance Data: Data shall be provided on the following items:
  - 1. Unit Heaters
  - 2. Wall Heaters
  - 3. Ceiling Mounted Heaters

##### 1.4 QUALITY ASSURANCE

- A. Standards:
  - 1. National Electrical Code (NEC)
  - 2. Underwriter's Laboratories (UL)

##### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Electric heating equipment received and stored on the job site shall be stored in dry storage spaces, (e.g. building, trailer, or shed) whenever possible. Electric heating equipment shall be stored in shipping cartons on wooden rails, or wooden pallets. Under no condition shall the electric heating equipment be stored in such a way that metal components are in direct contact with the ground or floor slabs.
- B. Where it is not practical to store items within an enclosure, electric heating equipment may be stored on wooden rails or wooden pallets outside.
- C. Electric heating equipment shall be covered with 6 mil polyethylene sheet (taped in place) to protect the equipment from damage and the weather.

**PART 2 - PRODUCTS**

2.1 ELECTRIC UNIT HEATERS

- A. Unit heaters shall be UL labeled vertical or horizontal discharge type as indicated on the drawings. Heaters shall have steel housing with baked enamel finish, resistance heating elements, integral fan and motor, discharge louvers, mounting bracket and fan/heater controls.
- B. Elements shall be the finned tubular sheathed type and wired to terminal block.
- C. Fan shall be propeller type with permanently lubricated motor.
- D. Discharge louvers on horizontal units shall be individually adjustable. Discharge louvers on vertical units shall be type indicated on the drawings.
- E. Unit heater controls shall include power contactor(s) automatic reset high limit switch, fan delay relay, control power transformer (24 volts), and connections for remote thermostat. Provide thermostat with heater.
- F. Mounting bracket, unless indicated otherwise on the drawings, shall be manufacturer's standard bracket.
- G. Unit heaters shall be:

	<u>Horizontal</u>	<u>Vertical</u>
Berko	HUH	----
Q Mark	MUH	MUH
Indeeco	UCI	UCI/UVI
Redd-i Heat	RUH	----
Electromode	EUH/EUL/EUS	VDB

2.2 WALL HEATERS

- A. Wall heaters shall be surface or recessed wall mounted type as indicated on the drawings. Unit shall include cabinet, resistance element, fan, motor, controls, and mounting brackets. Unit shall be tamperproof with concealed controls.
- B. Cabinet shall be 16 gauge (1.61 mm) (minimum) steel with factory baked enamel finish. Color shall be selected by the Architect from the manufacturer standard color chart. Discharge and inlet grilles shall be front mounted. Front panel shall be removable without dismounting unit.
- C. Heating element shall be finned tubular sheathed type.
- D. Fan shall be propeller type with permanently lubricated motor.
- E. Unit controls shall include integral thermostat, automatic reset high limit switch, power contactor, built-in power relay, fan delay relay, and disconnect switch.
- F. Wall heaters shall be:
  - 1. Berko; FRC Series
  - 2. Q Mark; AWH Series
  - 3. Indeeco; WCI Series
  - 4. Electromode; EWA Series, Tamperproof

### 2.3 CEILING MOUNTED HEATERS

- A. Ceiling mounted heaters shall be recessed ceiling mounted type. Unit shall include face plate, resistance elements, fan, motors, controls, and mounting frame.
- B. Face plate shall be 16 gauge (1.61 mm) (minimum) steel with factory baked enamel finish. Color shall be selected by the Architect from the manufacturer's standard color chart. Discharge inlet grilles shall be front mounted. Front panel shall be removable without dismantling unit. Control cabinet shall be mounted within unit behind front cover.
- C. Heating elements shall be finned tubular sheathed type.
- D. Fans shall be forward curved centrifugal type with permanently lubricated 3-speed motor. Motor shall comply with Section 230513 COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT.
- E. Unit controls shall include integral thermostat, automatic reset high limit switch, fan delay relay, fan control switch (ON-AUTO and HIGH-MED-LOW), control power transformer, night set-back relay, and disconnect switch.
- F. Cabinet heaters shall be:
  - 1. Berko; ---
  - 2. Indeeco; ---
  - 3. Q Mark; CDF Series
  - 4. Electromode; ---

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Unit Heaters:
  - 1. Electric unit heaters shall be suspended from structure using hanger rods. Where indicated on the drawings to be wall mounted, bracket shall be bolted to hollow masonry wall with spring wing toggle bolts or to solid masonry wall with self tapping anchors.
- B. Wall Heaters:
  - 1. Wall heaters shall be mounted with the bottom of the cabinet 12 inches (300 mm) above the finished floor.
- C. Ceiling Mounted Heaters:
  - 1. Ceiling mounted heaters shall be installed per manufacturer's recommendations.

**END OF SECTION**

## SECTION 260500

### BASIC ELECTRICAL REQUIREMENTS

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

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

##### 1.2 SUMMARY

- A. This division of the Specifications, Division 26, covers the complete interior and exterior electrical systems as indicated on the drawings or as specified herein. Provide all materials, labor, equipment and supervision to install electrical systems.

##### 1.3 QUALITY ASSURANCE

- A. All electrical work shall be in accordance with the following codes and agencies:
  - 1. The National Electrical Code (NFPA 70), 2017 edition
  - 2. The National Electrical Safety Code (ANSI C-2), 2012 edition
  - 3. The International Building Code, 2012 edition
  - 4. Occupation Safety and Health Administration (OSHA)
  - 5. Manufacturer's written requirements.
  - 6. Municipal ordinances governing electrical work.
  - 7. Georgia ammendments to referenced codes.
- B. Material Standards: All material shall be new and shall conform to the standards where such have been established for the particular material in question. Publications and Standards of the organization listed below are applicable to materials specified herein.
  - 1. American Society for Testing and Materials (ASTM)
  - 2. Underwriters' Laboratories, Inc. (UL)
  - 3. National Electrical Manufacturer Association (NEMA)
  - 4. Insulated Cable Engineers Association (ICEA)
  - 5. Institute of Electrical and Electronic Engineers (IEEE)
  - 6. National Fire Protection Association (NFPA)
  - 7. American National Standards Institute (ANSI)
  - 8. Manufacturer's Written Requirements

##### 1.4 PERMITS

- A. Obtain all permits and inspections for the installation of this work and pay all charges incident thereto. Deliver to the Owner all certificates of said inspection issued by authorities having jurisdiction.



1.5 WARRANTY

- A. The Contractor warrants to the Owner and Engineer that materials and equipment furnished under the Contract will be of good quality and new unless otherwise required or permitted by the Contract Documents, that the Work will be free from defects not inherent in the quality required or permitted, and that the Work will conform with the requirements of the Contract Documents. Work not conforming to these requirements, including substitutions not properly approved and authorized, may be considered defective. The Contractor's warranty excludes remedy for damage or defect caused by abuse, modifications not executed by the Contractor, improper or insufficient maintenance, improper operation, or normal wear and tear under normal usage. If required by the Engineer/Owner, the Contractor shall furnish satisfactory evidence as to the kind and quality of materials and equipment.

1.6 DRAWINGS

- A. The drawings indicate the arrangements of electrical equipment. Review existing conditions; existing conditions shall govern. Coordinate installation of electrical equipment with structural system and mechanical equipment and access thereto. Coordinate installation of electrical equipment with ductwork and piping, and wall thickness.
- B. Do not scale drawings. Obtain dimensions for layout of equipment based on existing conditions.
- C. Bring all discrepancies shown on different drawings, between drawings and specifications or between documents and field conditions to the immediate attention of the Owner/Engineer.
- D. Equipment layout is based on one manufacturer's product. Where equipment selected by the Contractor for use on the job differs from layout, the Contractor shall be responsible for coordinating space requirements and connection arrangements.

1.7 SUBMITTALS:

- A. Shop Drawings and Product Data:
  - 1. The Contractor shall submit for review by the Engineer data of materials and equipment to be incorporated in the work. Submittals shall be supported by descriptive material, catalogs, cuts, diagrams, performance curves, and charts published by the manufacturer to show conformance to specification and drawing requirements; model numbers alone will not be acceptable. Provide complete electrical characteristics for all equipment.
  - 2. Refer to the individual sections for identified equipment and materials for which submittals are required. As a minimum submittals are required for the following:
    - a. Wires and cables
    - b. Supporting devices
    - c. Boxes
    - d. Electrical identification
    - e. Circuit directories
    - f. Panelboards
    - g. Fuses
    - h. Dsconnects
  - 3. Refer to the SHOP DRAWINGS, PRODUCT DATA AND SAMPLES section for required procedures.
- B. Record Documents
  - 1. Refer to Division 01 for record documents and related submittals.

1.8 OPERATION AND MAINTENANCE DATA AND INSTRUCTIONS

- A. Refer to Division 01 for detail requirements.
- B. Printed Material: Provide required printed material for binding in operation and maintenance manuals.

1.9 EQUIPMENT REQUIRING ELECTRICAL SERVICE

- A. Review all specification sections and drawings for equipment requiring electrical service. Provide service to and make connections to all such equipment requiring electrical service. Refer to ELECTRICAL CONNECTIONS FOR EQUIPMENT section for connection requirements.
- B. Drawings indicate design loads and voltages and corresponding control equipment, feeders, and overcurrent devices. If equipment actually furnished have loads other than those indicated on the drawings or specified herein, control equipment, feeders, and overcurrent devices shall be adjusted in size accordingly at no additional cost to the Owner. Such adjustment shall be subject to the review of the Engineer/Owner.
- C. Incidental items not indicated on Drawings or mentioned in Specifications but that can legitimately and reasonably be inferred to belong to the Work or be necessary in good practice to provide a complete system, shall be furnished and installed as though itemized here in detail. This includes connection requirements for air conditioning and refrigeration equipment as outlined by NEC Article 440.

1.10 MECHANICAL SYSTEMS INTERFACE

- A. All control wiring for heating, ventilating and air conditioning systems shall be installed under Division 23. Review Division 23 specifications and shop drawings for control systems to assure compatibility between equipment furnished under Division 26 and wiring furnished under Division 23.
- B. Motor controllers (starters) shall be furnished and installed under Division 26, unless specified to be furnished as an integral component of the equipment. Provide the number and type of auxiliary contacts necessary to interlock the equipment and provide the specified control sequence.
- C. Power wiring to all motors and motor controllers and between motors and controllers shall be provided in Division 26.
- D. All electric heating equipment shall be provided and installed under Division 23 - HEATING, VENTILATING AND AIR CONDITIONING. Power wiring to all electric heating equipment shall be provided under Division 26 of these specifications.

1.11 SCHEDULING OF OUTAGES

- A. Electrical work requiring interruption of electrical power which would adversely affect the normal operation of the other portions of the Owner's property, shall be done at time other than normal working hours. Normal working hours shall be considered eight A.M. to five P.M. Monday through Friday.
- B. Schedule all work requiring interruption of electrical power two weeks prior to actual shutdown. Submit schedule in writing indicating extent of system to be de-energized, date and time when power is intended to be interrupted, and date and time power will be restored. Schedule shall be subject to the approval of the Engineer and the Representative of the Owner.

### 1.12 SITE INVESTIGATION

- A. Prior to submitting bids of the project, visit the site of the work to become aware of existing conditions which may affect the cost of the project. Where work under this project requires extension, relocation, reconnections or modifications to existing equipment or systems, the existing equipment or systems, shall be restored to their original condition, with the exception of the work under this contract, before the completion of this project.
- B. Verify the secondary service voltage of the buildings to be served and transmit written verification to the Engineer prior to submitting shop drawings or ordering any voltage rated materials for use in the buildings to be served.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. All materials shall be new.
- B. Furnish all materials specified herein or indicated on the drawings.
- C. Materials of the same type shall be the product of one manufacturer.
- D. All materials shall be UL listed and shall bear UL label. ETL listed material shall bear ETL label. ETL label shall be accepted in lieu of UL when the UL testing standards have been followed.

## PART 3 - EXECUTION

### 3.1 PRODUCT DELIVERY, STORAGE, HANDLING, AND PROTECTION

- A. Inspect materials upon arrival at Project and verify conformance to Contract Documents. Prevent unloading of unsatisfactory material. Handle materials in accordance with manufacturer's applicable standards and suppliers recommendations, and in a manner to prevent damage to materials. Store packaged materials in original undamaged condition with manufacturer's labels and seals intact. Containers which are broken, opened, damaged, or watermarked are unacceptable and shall be removed from the premises.
- B. All material, except items specifically designed to be installed outdoors shall be stored in an enclosed, dry building or trailer. Areas for general storage shall be provided by the Contractor. Provide temperature and/or humidity control where applicable. No material for installation, including conductors, shall be stored other than in an enclosed weathertight structure. Equipment stored other than as specified above shall be removed from the premises.
- C. Equipment and materials shall not be installed until such time as the environmental conditions of the job site are suitable to protect the equipment or materials. Conditions shall be those for which the equipment or materials are designed to be installed. Equipment and materials shall be protected from water, direct sunlight, cold or heat and high humidity at all times. Equipment or materials damaged or which are subjected to these elements are unacceptable and shall be removed from the premises and replaced.

3.2 CLEANING AND PAINTING

- A. Remove oil, dirt, grease and foreign materials from all raceways, fittings, boxes, panelboard trims and cabinets to provide a clean surface for painting. Touchup scratched or marred surfaces of panelboard and cabinet trims, motor control center, switchboard or equipment enclosures with paint furnished by the equipment manufacturers specifically for that purpose.
- B. Unless indicated on the drawings or specified herein to the contrary, all painting shall be done under the PAINTING Section of these Specifications.

3.3 ELECTRICAL SYSTEMS OPERATIONAL TESTS, MANUFACTURERS SYSTEMS CERTIFICATION AND DESIGN AUTHORITY ASSISTANCE.

- A. Testing
  - 1. Refer to the individual specification sections and the ELECTRICAL EQUIPMENT ACCEPTANCE TESTING section of the specifications for test requirements.
  - 2. Prior to the final inspection, the systems or equipment shall be tested and reported as therein specified. Five (5) typewritten copies of the tests shall be submitted to the Engineer for approval.
  - 3. All electrical systems shall be tested for compliance with the specifications.
- B. Design Authority Assistance
  - 1. The Contractor shall provide personnel to assist the Engineer or his representative during all construction review visits. The Contractor shall provide all necessary tools and equipment to demonstrate the system operation and provide access to equipment, including screwdrivers, wrenches, ladders, flashlights, circuit testing devices, meters, keys, radios, etc.
  - 2. Remove equipment covers (i.e. panelboard trims, motor controls, device plates, and junction box covers) as directed for inspection of internal wiring. Accessible ceilings shall be removed as directed for inspection of equipment installed above ceilings.
  - 3. Energize and de-energize circuits and equipment as directed. Demonstrate operation of equipment and systems as directed by the Representative.

**END OF SECTION**

**SECTION 260519**  
**WIRES AND CABLES**

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. The work required under this section of the specifications consists of furnishing, installation and connections of the building wiring system, 600 volts and below. Exterior branch circuit wiring and feeder conductors extended beyond the building are included. Wiring systems for alarm systems are not included in this division unless specified to be included, by reference, in the respective divisions for alarm and communication systems.

1.3 QUALITY ASSURANCE

- A. Industry Referenced Standards. The following specifications and standards are incorporated into and become a part of this Specification by Reference.
1. Underwriters' Laboratories, Inc. (UL) Publications:
    - a. No. 44: Rubber - Insulated Wire and Cables
    - b. No. 83: Thermoplastic - Insulated Wires
    - c. No. 493: Thermoplastic - Insulated Underground Feeder and Branch Circuit Cables
    - d. No. 486: Wire Connectors and Soldering Lugs
  2. Insulated Cable Engineers Association Standards (ICEA):
    - a. S-61-402: Thermoplastic Insulated Wire and Cable
  3. National Electrical Manufacturer's Standards (NEMA):
    - a. WC-5: Thermoplastic Insulated Wire and Cable
  4. National Fire Protection Association Publication (NFPA):
    - a. No. 70: National Electrical Code (NEC)
- B. Acceptable Manufacturers. Products produced by the following manufacturers which conform to this specification are acceptable.
1. Hydraulically applied conductor terminations:
    - a. Square D
    - b. Burndy
    - c. IlSCO
    - d. Scotch (3M)
    - e. Thomas and Betts (T&B)
    - f. Anderson
  2. Mechanically applied (crimp) conductor terminations:
    - a. Scotch (3M)
    - b. Ideal
    - c. Thomas and Betts (T&B)
    - d. Burndy

3. Vinyl electrical insulating tape:
  - a. Scotch (3M)
  - b. Tomic
  - c. Permacel
4. Twist-On Wire Connectors:
  - a. Scotch (3M)
  - b. Ideal
  - c. Buchanan
5. Encapsulated insulating kits:
  - a. Scotch (3M)
  - b. Raychem
  - c. Essex Group, Inc.
6. Portable cable fittings:
  - a. Crouse Hinds
  - b. Appleton
  - c. T&B
7. Insulated cable:
  - a. Brand-Rex Co.
  - b. Cablec Corp.
  - c. Carol Cable Co., Inc.
  - d. The Okonite Co.
  - e. Pirelli Cable Corp.
  - f. Senator Wire and Cable Co.
  - g. Southwire Co.
  - h. Houston Wire & Cable Co.
  - i. Aetna Insulated Wire Co.
  - j. American Insulated Wire Corp.

- C. Performance: Conductors shall be electrically continuous and free from short circuits or grounds. All open, shorted or grounded conductors and any with damaged insulation shall be removed and replaced with new material free from defects.

## **PART 2 - PRODUCTS**

### **2.1 GENERAL MATERIALS REQUIREMENTS**

- A. Provide all materials under this section of the specifications.
- B. All wire and cable shall be UL listed and shall bear a UL label along the conductor length at intervals not exceeding 24 inches.
- C. All conductors shall have size, grade of insulation, voltage and manufacturer's name permanently marked on the outer cover at intervals not exceeding 24 inches.
- D. Conductor size shall be a minimum of No. 12 AWG. Conductor size shall not be less than indicated on the drawings. The minimum size of emergency systems conductors shall be No. 10 AWG.
- E. Insulation voltage level rating shall be 600 volts.

## 2.2 PRODUCT/MATERIALS DESCRIPTION

- A. Conductors No. 10 AWG and smaller shall be solid copper, 75°C. type THW, THWN or XHHW unless otherwise indicated on the drawings, required by the National Electrical Code, or specified elsewhere in Division 26. Where fixtures are used as raceway use 90°C type THHN or XHHN conductors.
- B. Conductors larger than No. 10 AWG shall be stranded copper, 75°C, type THW or XHHW or 90°C., type THHN/THWN, XHHW, unless otherwise indicated on the drawings, required by the National Electrical Code, or specified herein.
- C. Control conductors for use on 120 volt control wiring systems shall be No. 12 AWG stranded type THHN/THWN, unless indicated otherwise on the drawings.
- D. Splices and taps (No. 10 AWG and smaller) - Connectors for solid conductors shall be solderless, screw-on, spring pressure cable type, 600 volt, 105°C. with integral insulation and UL approved for aluminum and copper conductors. Connectors for stranded conductors shall be crimp-on type with integral insulating cover.
- E. Splices and taps (No. 8 and larger) - Hydraulically applied crimping sleeve or tap connector sized for the conductors. Insulate the hydraulically applied connector with 90°C., 600 volt insulating cover provided by the connector manufacturer. Insulator materials and installation shall be approved for the specific application, location, voltage and temperature and shall not have an insulation value less than the conductors being joined.
- F. Electrical insulating tape shall be 600 volt, flame retardant, cold and weather resistant, minimally .85 mil thick plastic vinyl material; Scotch No. 88, Tomic No. 85, Permacel No. 295.

## PART 3 - EXECUTION

### 3.1 EXECUTION

- A. Install all wiring in raceway system, except where direct burial cable or other conductors are indicated or specified not to be installed in raceway.
- B. Connect all conductors. Torque each terminal connection to the manufacturers recommended torque value. A calibrated torqueing tool shall be used to insure proper torque application. Any conductors nicked or ringed while removing insulation shall be replaced.
- C. Do not install more conductors in a raceway than indicated on the drawings. A maximum of three branch circuits are to be installed in any one conduit, on 3 phase 4 wire system, unless specifically indicated otherwise on the drawings. No two branch circuits of the same phase are to be installed in the same conduit, unless specifically indicated on the drawings.
- D. Conductors shall be tested to be continuous and free of short circuits and grounds.
- E. Identification
  - 1. Conductors within pull boxes shall be grouped and identified with nylon tie straps with circuit identification tag.
  - 2. Identify each control conductor at its terminal points with wrap around tape wire markers. I.D. to indicate terminal block and point designation, or other appropriate identifying indication.

3. Refer to ELECTRICAL IDENTIFICATION section of these specifications for additional identification requirements.
- F. Color Code Conductors.
1. Color code all secondary service, feeder and branch circuit conductors. Control and signal system conductors need not be color coded.
  2. Coding shall be as follows:
    - a. 208Y/120 volt three phase four wire wye system - Phase A: Black, Phase B: Red, Phase C: Blue, Neutral: White
    - b. 480/277 volt, three phase, four wire system – Phase A: Brown, Phase B: Orange, Phase C: Yellow, Neutral: Gray.
  3. Conductors No. 6 and smaller shall have solid color compound insulation or continuous color finish. Conductors No. 4 and larger shall have colored phase tape. Colored tape shall be installed on conductors in every box, at each terminal point, cabinet or other enclosure.
  4. Grounding conductors shall be green.
- G. Maintain phase rotation established at service equipment throughout entire project.
- H. Group and lace with nylon tie straps all conductors within enclosures, i.e. panels, motor controllers motor control center, switchboard, terminal cabinets, fire alarm cabinets and control cabinets.
- I. Make splices in conductors only within junction boxes. Do not splice conductors in pull boxes, panelboards, safety switches, switchboard, motor control center, wiring troughs or motor control enclosures.
- J. Terminate conductors No. 10 AWG and smaller specified in Division 26 to be stranded, with crimp type lug or stud. Direct termination of stranded conductors without crimp terminator to terminal screws, lugs, or other points is not permitted even if terminal is rated for stranded conductors. Crimp terminal shall be the configuration type suitable for terminal point. Crimp lugs shall be applied in strict accordance with the manufacturer's written requirements.

**END OF SECTION**



**SECTION 260526**  
**SECONDARY GROUNDING**

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. The work required under this section of the specifications consists of furnishing, installation and connections of the building secondary grounding systems. Exterior branch circuit wiring and feeder conductors extended beyond the building are included. The building electrical system is a 3 phase, 4 wire grounded wye system supplemented with equipment grounding system. Equipment grounding system shall be established with equipment grounding conductors; the use of metallic raceways for equipment grounding is not acceptable.

1.3 QUALITY ASSURANCE

- A. Industry Referenced Standards. The following specifications and standards are incorporated into and become a part of this Specification by Reference.
1. Underwriters' Laboratories, Inc. (UL) Publications:
    - a. No. 44: Rubber - Insulated Wire and Cables
    - b. No. 83: Thermoplastic - Insulated Wires
    - c. No. 467: Electrical Grounding and Bonding Equipment
    - d. No. 493: Thermoplastic - Insulated Underground Feeder and Branch Circuit Cables
    - e. No. 486: Wire Connectors and Soldering Lugs
  2. National Electrical Manufacturer's Standards (NEMA):
    - a. WC-5: Thermoplastic Insulated Wire and Cable
    - b. WC-7: Cross-Linked-Thermosetting Polyethylene Insulated Wire and Cable
  3. National Fire Protection Association Publication (NFPA):
    - a. No. 70: National Electrical Code (NEC)
- B. Acceptable Manufacturers. Products produced by the following manufacturer which conform to this specification are acceptable.
1. Hydraulically applied conductor terminations:
    - a. Square D
    - b. Burndy
    - c. IlSCO
    - d. Scotch (3M)
    - e. Thomas and Betts (T & B)
    - f. Anderson
  2. Mechanically applied (crimp) conductor terminations:
    - a. Scotch (3M)
    - b. Ideal
    - c. Thomas and Betts (T & B)

- d. Burndy
- 3. Exothermic connections:
  - a. Cadweld

## **PART 2 - PRODUCTS**

### 2.1 GENERAL MATERIALS REQUIREMENTS

- A. Provide all materials under this section of the specifications. All materials shall be new.
- B. All materials shall be UL listed and bear a UL label.
- C. Refer to the specific specification section for the description and requirements of materials mentioned herein for installation.

### 2.2 GROUNDING CONDUCTORS

- A. Grounding electrode conductor shall be bare or green insulated copper conductor sized as indicated on the drawings.
- B. Equipment grounding conductors shall be green insulated type THW, THWN, or XHHN conductors sized as indicated on the drawings. Where size is not indicated on the drawings, conductor size shall be determined from the National Electrical Code table on sizes of equipment grounding conductors.
- C. Bonding jumpers shall be flexible copper bonding jumpers sized in accordance with the National Electrical Code tables for grounding electrode conductors.

### 2.3 MOTOR CONTROLLERS, AND DISCONNECT SWITCHES

- A. Provide a conductor termination grounding lug bonded to the enclosure of each equipment item.

## **PART 3 - EXECUTION**

### 3.1 INSTALLATION

- A. Ground all non-current carrying parts of the electrical system, i.e., wireways, equipment enclosures and frames, junction and outlet boxes, machine frames and other conductive items in close proximity with electrical circuits, to provide a low impedance path for potential grounded faults.
- B. Equipment Grounding Conductor
  - 1. Grounding conductors for branch circuits are not shown on the drawings; however, grounding conductors shall be provided in all branch circuit raceways and cables. Grounding conductors shall be the same AWG size as branch circuit conductors.
  - 2. Grounding conductors for feeders are typically indicated on the drawings and the raceway is sized to accommodate grounding conductor shown. Where grounding conductor size is not indicated on the drawings, conductor shall be in accordance with the equipment grounding conductor table of the National Electrical Code.

3. A grounding conductor shall be installed in all flexible conduit installations. For branch circuits, grounding conductor shall be sized to match branch circuit conductors.
4. The equipment grounding conductor shall be attached to equipment with bolt or sheet metal screw used for no other purpose. Where grounding conductor is stranded, attachment shall be made with lug attached to grounding conductor with crimping tool.
5. Ground all motors by drilling and tapping the bottom of the motor junction box and attaching the equipment grounding conductor to the box with a round head bolt used for no other purpose. Conductor attachment shall be through the use of a lug attached to conductor with crimping tool.
6. Equipment grounding conductors shall terminate on panelboard, switchboard, or motor control center grounding bus only. Do not terminate on neutral bus. Provide a single terminal lug for each conductor. Conductor shall terminate in the same section as the phase conductors originate. Do not terminate neutral conductors on the ground bus.

### 3.2 TESTING

- A. The Contractor shall test the installation in accordance with the ELECTRICAL EQUIPMENT ACCEPTANCE TESTING section of this specification.

**END OF SECTION**

**SECTION 260529**  
**SUPPORTING DEVICES**

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Extent of supports, anchors, sleeves and seals is indicated by drawings and schedules and/or specified in other Division - 26 sections.
- B. Types of supports, anchors, sleeves and seals specified in this section include the following:
  - 1. Clevis hangers.
  - 2. C-clamps.
  - 3. I-beam clamps.
  - 4. Two-hole conduit straps.
  - 5. Round steel rods.
  - 6. Expansion anchors.
  - 7. Toggle bolts.
  - 8. Wall and floor seals.
- C. Supports, anchors, sleeves and seals furnished as part of factory-fabricated equipment are specified as part of that equipment assembly in other Division - 26 sections.

1.3 QUALITY ASSURANCE

- A. NEC Compliance: Comply with NEC requirements as applicable to construction and installation of electrical supporting devices.
- B. NECA Compliance: Comply with National Electrical Contractors Association's "Standard of Installation" pertaining to anchors, fasteners, hangers, supports, and equipment mounting.
- C. UL Compliance: Provide electrical components which are UL-listed and labeled.

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's data on supporting devices including catalog cuts, specifications, and installation instructions, for each type of support, anchor, sleeve and seal.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURED SUPPORTING DEVICES

- A. General: Provide supporting devices which comply with manufacturer's standard materials, design and construction in accordance with published product information, and as required for complete installation; and as herein specified. Where more than one type of supporting device meets indicated requirements, selection is Installer's option.
- B. Supports: Provide supporting devices of types, sizes and materials indicated; and having the following construction features:
1. Clevis Hangers: For supporting 2" rigid metal conduit; galvanized steel; with 1/2" diameter hole for round steel rod; approximately 54 lbs. per 100 units.
  2. C-Clamps: Black malleable iron; 1/2" rod size; approximately 70 lbs. per 100 units.
  3. I-Beam Clamps: Black steel, 1-1/4" x 3/16" stock; 3/8" cross bolt; flange width 2"; approximately 52 lbs. per 100 units.
  4. Two-Hole Conduit Straps: For supporting all conduit types, (EMT, RGC, IMC).
  5. Hexagon Nuts: For 1/2" rod size; galvanized steel; approximately 4 lbs. per 100 units.
  6. Round Steel Rod: Black steel; 1/2" diameter; approximately 67 lbs. per 100 feet.
  7. Offset Conduit Clamps: For supporting 2" rigid metal conduit; black steel; approximately 200 lbs. per 100 units.
- C. Anchors: Provide anchors of types, sizes and materials indicated, with the following construction features:
1. Toggle Bolts: Springhead; 3/16" x 4"; approximately 5 lbs. per 100 units.
  2. Expansion sleeve anchors by Hilti or Phillips Redhead: 1/2"; approximately 38 lbs. per 100 units.
  3. Manufacturers: Subject to compliance with requirements, provide anchors of one of the following:
    - a. Ackerman Johnson Fastening Systems Inc.
    - b. Hilti
    - c. Ideal Industries, Inc.
    - d. Joslyn Mfg and Supply Company
    - e. McGraw Edison Company
    - f. Phillips Redhead
    - g. Rawlplug Company Inc.
- D. Sleeves and Seals: Provide sleeves and seals, of types, sizes and materials indicated, with the following construction features:
1. Wall Seals: Provide factory-assembled watertight wall seals, of types and sizes indicated; suitable for sealing around conduit, pipe, or tubing passing through walls. Construct seals with steel sleeves, malleable iron body, neoprene sealing grommets and rings, metal pressure rings, pressure clamps, and cap screws.
- E. U-Channel Strut Systems:
1. Provide U-channel strut system for supporting electrical equipment, 12-gage hot-dip galvanized steel, of types and sizes indicated; construct with 9/16" diameter holes, 8" o.c. on top surface, with standard green finish, and with the following fittings which mate and match with U-channel.
    - a. Fixture hangers.
    - b. Channel hangers.
    - c. End caps.
    - d. Beam clamps.
    - e. Wiring studs.
    - f. Conduit clamps.

- g. Conduit hangers.
- h. U-bolts.
- 2. Manufacturers: Subject to compliance with requirements, provide channel systems of one of the following:
  - a. Allied Tube and Conduit Corporation.
  - b. B-Line Systems, Inc.
  - c. Elcen Metal Products Company.
  - d. Greenfield Mfg Company, Inc.
  - e. Midland-Ross Corporation.
  - f. OZ/Gedney Div; General Signal Corporation.
  - g. Power-Strut Div; Van Huffel Tube Corporation.
  - h. Unistrut Div; GTE Products Corporation.

## 2.2 FABRICATED SUPPORTING DEVICES

- A. Pipe Sleeves: Provide pipe sleeves of one of the following:
  - 1. Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate sleeves from the following gage metal: 3" and smaller, 20-gage; 4" to 6", 16-gage; over 6", 14" gage.
  - 2. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe.
  - 3. Iron Pipe: Fabricate from cast-iron or ductile-iron pipe.
  - 4. Plastic Pipe: Fabricate from Schedule 80 PVC plastic pipe.
- B. Sleeve Seals: Provide modular mechanical type seals, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

## PART 3 - EXECUTION

### 3.1 INSTALLATION OF SUPPORTING DEVICES

- A. Install hangers, anchors, sleeves and seals as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to insure supporting devices comply with requirements. Comply with requirements of NECA and NEC for installation of supporting devices.
- B. Coordinate with other electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.
- C. Install hangers, supports, clamps and attachments to support piping properly from building structure. Arrange for grouping of parallel runs of horizontal conduits to be supported together on trapeze type hangers where possible. Install supports in compliance with NEC requirements.
- D. Torque sleeve seal nuts, complying with manufacturer's recommended values. Ensure that sealing grommets expand to form watertight seal.
- E. Remove burrs from ends of pipe sleeves.

**END OF SECTION**

## SECTION 260533

### RACEWAYS

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

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

##### 1.2 SUMMARY

- A. This section covers the complete interior and exterior raceway system.
- B. Definition: The term conduit, as used in this Specification, shall mean any or all of the raceway types specified.

##### 1.3 QUALITY ASSURANCE

- A. Referenced Industry Standard: The following specifications and standards are incorporated into and become a part of this Specification by reference.
  - 1. Underwriters' Laboratories, Inc. (UL) Publications:
    - No. 1 Flexible Metal Electrical Conduit
    - No. 6 Rigid Galvanized Conduit
    - No. 467 Electrical Grounding and Bonding
    - No. 651 Rigid Nonmetallic Electrical Conduit
    - No. 797 Electrical Metallic Tubing
    - No. 1242 Intermediate Metal Conduit
  - 2. American National Standards Institute (ANSI):
    - C-80.1 Rigid Galvanized Conduit.
    - C-80.3 Electrical Metallic Tubing.
  - 3. National Fire Protection Association (NFPA):
    - No. 70 National Electrical Code (NEC).
- B. Acceptable Manufacturers: Products of the following manufacturers, which comply with these specifications, are acceptable.
  - 1. Metallic Conduit Fittings:
    - a. Appleton
    - b. Carlon
    - c. Crouse Hinds
    - d. Killark
    - e. O-Z/Gedney
    - f. RACO
    - g. Thomas and Betts
  - 2. Support Channel:
    - a. Kindorf
    - b. Powers
    - c. Unistrut

3. Non-Metallic Conduit and Fittings:
  - a. Carlon
  - b. Certainteed
  - c. Thomas and Betts

C. Coordination

1. Coordinate conduit installation with electrical/mechanical equipment furnished.
2. Coordinate conduit installation with contract documents and other contractors. Adjust installation to eliminate conflicts. Review all shop drawings submitted under this and other sections to insure coordination with all equipment requiring electrical service and to avoid conflict interferences. Coordinate installation sequence with other contractors to avoid conflicts including equipment access and provide the fastest overall installation schedule.

1.4 STORAGE AND HANDLING

- A. Refer to the BASIC ELECTRICAL REQUIREMENTS section of the specifications for storage and handling requirements.
- B. Non-metallic conduits stored on site prior to installation shall be stored on a surface off of the ground and shall be protected from the direct rays of the sun and from debris.
- C. Damaged, oxidized, warped, improperly stored material or material with excessive amounts of foreign debris will be removed from the project and replaced with new materials.

**PART 2 - PRODUCTS**

2.1 GENERAL MATERIALS REQUIREMENTS

- A. Furnish all materials specified herein.
- B. All conduit and fittings shall be listed and bear a label by Underwriters' Laboratories (UL) for use as raceway system for electrical conductors.
- C. Raceway is required for all wiring, unless specifically indicated or specified otherwise.
- D. Size: The minimum size of conduit shall be 1/2". The size of all conduits shall be in accordance with the NEC, but, not less than indicated on the drawings.

2.2 EMT CONDUIT FITTINGS

- A. Electrical Metallic Tubing (EMT) couplings and connectors shall be steel "concretetight" type. Malleable iron, die cast or pressure cast fittings are not permitted. Fittings 2.0" and smaller shall be gland and ring compression type. Connectors for conduits 2.5" and larger shall be set screw type with two (2) screws each or compression type. Couplings for conduits 2.5" and larger shall be set screw type with four (4) screws each or compression type.



### 2.3 RIGID AND IMC CONDUIT FITTINGS

- A. Fittings for rigid steel and IMC shall be standard threaded couplings, locknuts, bushings and elbows. All materials shall be steel or malleable iron only. Set screw or non-thread fittings are not permitted. Bushings shall be metallic insulating type consisting of insulating insert molded or locked into the metallic body of the fittings. Erickson-type couplings may be used to complete a conduit run.

### 2.4 NON-METALLIC CONDUIT AND FITTINGS

- A. Non-metallic conduit shall be heavy wall, Schedule 40 PVC.
- B. Non-metallic conduit fittings shall be of the same material as the conduit furnished and be the product of the same manufacturer.
- C. Glue for all non-metallic conduit and fittings shall be provided as required by the manufacturer of the conduit being used.

### 2.5 CONDUIT SUPPORTS

- A. All parts and hardware shall be zinc-coated or have equivalent corrosion protection.
- B. Conduit straps shall be two hole galvanized metal type.
- C. Conduit support channels shall be 1.5" x 1.5" x 14 gauge galvanized (or with equivalent treatment) channel. Channel suspension shall be 3/8" threaded steel rods. Use swivel type connector to attach suspension rods to structure. Spring steel clips are not acceptable. Wire or chain is not acceptable for conduit hangers.
- D. Individual conduit hangers shall be galvanized spring steel specifically designed for the purpose, sized appropriately for the conduit type and diameter, and have pre-assembled closure bolt and nut and provisions for receiving threaded hanger rod. Support with 1/4" threaded steel rod for individual conduits 1.5" and smaller and 3/8" rod for individual conduits 2.0" and larger.
- E. Individual conduit straps on metal studs shall be spring steel and should wrap around entire face of stud securely biting into both edges and have provisions for screwing into stud. Size appropriately for conduit to be support. Tie wraps are not acceptable.
- F. Support multiple conduits from metal studs using pre-assembled bar hanger assembly consisting of hanger bar, retaining clips and conduit straps.
- G. Refer to SUPPORTING DEVICES section of these specifications for additional material requirements.

### 2.6 FLEXIBLE CONDUIT AND FITTINGS

- A. Flexible conduit shall be steel metallic type. Where specified herein, indicated on the drawings, or when used in damp or wet locations, as classified by the National Electrical Code, flexible conduit shall be liquid tight.
- B. All flexible conduit shall be classified as suitable for system grounding. All flexible (liquid tight) conduits shall be UL listed as sunlight (UV) resistant.

- C. Connectors for flexible conduit shall be steel insulated throat type rated as suitable for system ground continuity. Connectors for liquid tight flexible conduit shall be screw-in ground cone type.
- D. Flexible conduit shall not be less than 1/2" trade size and in no case shall flexible conduit size be less than permitted by the National Electrical Code for the number and size of conductors to be installed herein.

## 2.7 MISCELLANEOUS CONDUIT FITTINGS AND ACCESSORIES

- A. Vinyl all weather electrical tape for corrosion protection shall be Scotch #88, Tomic #85, Permacel #295.
- B. Expansion and deflection couplings shall be in accordance with UL 467 and UL 514. They shall accommodate 3/4" deflection, expansion, or contraction in any direction and shall allow 30 degree angular deflections. Couplings shall contain an internal flexible metal braid to maintain raceway system ground continuity.
- C. Fire and smoke stop materials shall be rock wool fiber, silicone foam, or silicone sealant, UL rated to maintain the fire floor or fire wall partition rating.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. General
  1. Conceal all conduits, except in unfinished spaces such as equipment rooms or where indicated by symbol on the drawings.
  2. Install as complete raceway runs prior to installation of cables or wires.
  3. Flattened, dented, burned, or deformed conduits are not permitted and shall be removed and replaced.
  4. Secure rigid conduit i.e., rigid galvanized conduit and intermediate metal conduit, to sheet metal enclosures with two (2) locknuts and insulated bushing. Secure EMT to sheet metal enclosures with insulated throat connectors with lock nut..
  5. Fasten conduit support device to structure with wood screws on wood, toggle bolts on hollow masonry, anchors as specified on solid masonry or concrete, and machine bolts, clamps, or spring steel clips, on metal studs. Nails are not acceptable.
  6. Protect conduits against dirt, plaster, and foreign debris with conduit plugs. Plugs shall remain in place until all masonry is complete.
  7. Seal all conduits originating from outside building from below grade, and all conduits entering exterior mounted electrical equipment with insulating electrical putty to prevent entrance of moisture. Spray foam is not acceptable.
  8. Install conduit with wiring, including homeruns as indicated on the drawings. Any change resulting in a savings in labor or materials is to be made only in accordance with a contract change. Deviations shall be made only where necessary to avoid interferences and when approved by Architect by written authorization.
  9. Conduits which penetrate roof membranes shall be installed in accordance with manufacturer's recommendations.
  10. Use flexible conduit for connection to vibrating equipment and rotating machinery and for connection from junction box to flush mounted lighting fixtures only.
  11. Separate raceway systems are to be installed for power systems and for control, signal and communications systems. Do not install control, signal or communications cables in the same raceways as branch circuit or feeder cables, unless indicated otherwise on the drawings.

12. Provide expansion fitting in all conduits where length of run exceeds 200 feet or where conduits pass building expansion joints.
- B. Uses Permitted
1. Conduits installed in direct contact with earth shall be schedule 40, heavy wall PVC. Conduits which penetrate building roof shall be RGC or IMC. Conduits installed exterior to the building shall be RGC or IMC.
  2. All other conduit, unless excluded herein, not permitted in accordance with the National Electrical Code, or otherwise indicated on the drawings, shall be electrical metallic tubing (EMT).
  3. Conduit types shall not be mixed indiscriminately with other types in the same run, unless specified herein or required by the NEC.
  4. Use flexible conduit for connections to motors, electrical duct heaters and unit heaters.
    - a. Flexible conduit used for connection of motors, electric duct heaters and unit heaters shall not exceed 18" in length.
    - b. Maintain ground continuity through flexible conduit with green equipment grounding conductor; do not use flexible conduit for ground continuity.
    - c. Liquid tight conduit shall be used to connect all mechanical equipment in mechanical equipment rooms and exterior installations.
  5. No conduit requiring cutting of cross-webs of concrete masonry units is permitted. Conduit shall be threaded through cells or concrete masonry units lowered around conduit. Neither horizontal joint reinforcement nor bond beam reinforcement shall be cut for conduit installation. Conduits shall not be run horizontally in walls.
- C. Below Grade Raceway Installations
1. Direct Burial Conduit
    - a. Install top of conduits 24" minimum below finished grade. Maximum depth shall be 36".
    - b. Install top of conduits 30" minimum below grade, below roads and any other paved surfaces.
    - c. Where transition is made from below grade PVC installation to a metallic conduit system above grade, make transition with rigid galvanized elbow and extend above grade with galvanized rigid steel conduit. For corrosion protection, where the elbow penetrates surface, wrap with vinyl all-weather electrical tape or coat with bituminous asphaltic compound, for 6" above and below concrete surface.
    - d. Conduit shall be run following the most direct route between points.
- D. Concealed (Above Ceilings and in Walls) and Exposed Raceway Installation
1. Conduit shall be run parallel or at right angles to existing walls, ceilings, and structural members.
  2. Support branch circuit conduits at intervals not exceeding 10 ft. and within three feet of each outlet, junction box, cabinet or fitting. Attach individual branch circuit conduits to structural steel members with beam conduit clamps and to non-metallic structural members with one hole conduit straps. For exposed conduits and where conduits must be suspended below structure, single conduit runs shall be supported from structure by hangar rod and conduit clamp assembly. Multiple conduits shall be supported by trapeze type support suspended from structure. Do not attach conduits to ceiling suspension system channels or suspension wires.
  3. Install all conduits or sleeves penetrating rated fire walls or fire floors to maintain fire rating of wall or floor.
  4. Conduits rigidly secured to building construction on opposite sides of a building expansion joint shall be provided with an expansion and deflection coupling. In lieu of an expansion coupling, conduits 2-1/2" and smaller may be provided with junction boxes on both sides of the expansion joint connected by 15" of slack flexible conduit with bonding jumper.

3.2 ADJUSTMENT, CLEANING AND PROTECTION

- A. Clean: Upon completion, clean all installed materials of paint, dirt, and construction debris. All conduit systems shall be cleaned of water and debris prior to the installation of any conductors.

3.3 REUSE OF EXISTING CONDUITS

- A. Where existing conduits are specified to be re-used, each conduit shall be cleaned prior to the installation of conductors or cables. A standard flexible mandrel with a diameter approximately 1/4" less than the inside diameter of the conduit shall be pulled through and then a brush with soft bristles which has a diameter equal to the inside diameter of the conduit.
- B. All conduit fittings shall be checked for tightness and retightened, if necessary, and all supports verified and adjusted.

**END OF SECTION**

## SECTION 260533.01

### BOXES

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

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

##### 1.2 SUMMARY

- A. The work required under this section of the specifications consists of the installation of outlet boxes, pull boxes, and junction boxes throughout the wiring system including box supports.
- B. Definition: Box, as used in this specification, includes all outlet, device, junction, and pull boxes. Feeder shall mean all conductor circuits larger than #8 AWG.

##### 1.3 QUALITY ASSURANCE

- A. Referenced Industry Standards: The following specifications and standards are incorporated into and become a part of this specification by reference.
  - 1. Underwriters' Laboratories, Inc. (UL) Publications:
    - a. No. 50: Electrical Cabinets and Boxes
    - b. No. 467: Electrical Grounding and Bonding Equipment
    - c. No. 514: Electrical Outlet Boxes and Fittings
  - 2. National Fire Protection Association (NFPA):
    - a. No. 70: National Electrical Code (NEC)
- B. Coordination: Review architectural drawings for areas where outlets occur within specific architectural or structural features and install outlets as shown on architectural drawings; or if not shown, accurately center and align boxes within the architectural features or detail.

#### PART 2 - PRODUCTS

##### 2.1 GENERAL MATERIALS REQUIREMENTS

- A. Furnish all materials specified herein.
- B. All boxes shall be UL listed and labeled.
- C. Boxes shall be galvanized steel sheet metal, unless rustproof cast metal is specified or required by the NEC, or unless otherwise specified or indicated on the drawings.

## 2.2 OUTLET AND JUNCTION BOXES

- A. Boxes shall be 4-11/16" square boxes 2 1/4" deep, with blank cover.
- B. Outlet boxes in exposed wiring system shall be cast metal FS boxes with matching device plate.
- C. Extension rings shall not be permitted on a box to increase the volume.

## 2.3 PULL BOXES

- A. Dimensions of pull boxes shall not be less than those dimensions required by the National Electrical Code for the number, size and position of conductors entering the box.
- B. Provide box covers for pull boxes.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. All boxes shall be completely accessible and as required by the NEC. Provide access panels in any non-accessible spaces to allow access to boxes installed. Crawling above ceilings to access boxes is not acceptable.
- B. Boxes shall not be smaller than indicated in this section of the specifications and shall be larger if required by Article 370 of the National Electrical Code for the number and size of conductors installed.
- C. Support every box from structure:
  - 1. Secure to wood with wood screws.
  - 2. Secure to hollow masonry with toggle bolts.
  - 3. Secure to metal with sheet metal screws, machine bolts, or clamps.
  - 4. Anchors for solid masonry and concrete shall be self drilling expansion shields, insert expansion shields, or lead shields with machine bolts.
  - 5. Where box is suspended below structure, support from structure with threaded steel rod. Secure rod directly to outlet boxes with double nuts. For pull boxes larger than 18" x 18" x 6", construct 1-1/2" x 1-1/2" x 14 gauge metal channel frame. Connect frame to box by bolting and secure frame to threaded rod at each corner.
  - 6. Hub type cast boxes need not be directly attached to structure if rigid conduit is used and supported in conformance with the NEC.
- D. Remove only knockouts as required and plug all unused openings. Use threaded plugs for cast boxes and snap-in metal plugs for sheet metal boxes.
- E. Install pull boxes only in unfinished spaces or concealed above ceilings, except when indicated on the drawings or approved by the Engineer.
- F. Install pull boxes when any of the following conditions apply:
  - 1. Where indicated on the drawings.
  - 2. Where conduit run exceeds 200 ft. from box to box or box to terminal.
  - 3. Where conduit contains more than 4-90 degree bends or the equivalent offsets.

4. To facilitate conductor installation or to insure that the manufacturer's maximum pulling tension is not exceeded.
  5. As described in the RACEWAYS section of the specifications for crossing expansion joints.
- G. Do not splice conductors in pull boxes. Splices are not permitted in pull boxes except when approved in writing by the Engineer or where shown on the drawings. Where splices are permitted, make splices with splicing sleeves attached to conductors with hydraulic crimping tool. Split bolt connectors are not acceptable for splices within pull boxes.
- H. Where a pull box is required, one shall be installed for each individual branch circuit conduit. It shall contain only the conductors in the conduit. A combined pull box for multiple branch conduits is not permitted, unless approved by the Engineer or indicated on the drawings. Where permitted for multiple circuits within pull box:
1. Circuit conductors shall be individually laced with nylon tie straps of the type with enlarged tab to permit identification of each circuit and feeder within pull box. Identify each with respect to load served.
- I. Box covers shall be in place and secured to box.
- J. Identification
1. Refer to ELECTRICAL IDENTIFICATION section of these specifications for additional requirements.

### 3.2 CLEANING AND ADJUSTMENT

- A. After completion, clean all work of dirt, paint and construction debris.

**END OF SECTION**

## SECTION 260533.02

### ELECTRICAL CONNECTIONS FOR EQUIPMENT

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

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

##### 1.2 SUMMARY

- A. Extent of electrical connections for equipment is indicated by drawings and schedules. Electrical connections are hereby defined to include connections used for providing electrical power to equipment.
- B. Applications of electrical power connections specified in this section include the following:
  - 1. To resistive heaters.
  - 2. From electrical source to motor starters.
  - 3. From motor starters to motors and disconnect switches to motors.
- C. Electrical connections for equipment, not furnished as integral part of equipment, are specified in Division - 23 and other Division - 26 sections, and are work of this section.
  - 1. Division 01 - GENERAL REQUIREMENTS
  - 2. Division 23 - MECHANICAL
- D. Motor starters and controllers, not furnished as integral part of equipment, are specified in applicable Division - 26 sections, and are work of this section.
- E. Raceways and wires/cables required for connecting motors and other electrical units of equipment are specified in applicable Division 26 sections, and are work of this section.
- F. Electrical identification for wire/cable conductors is specified in Division 26 section, ELECTRICAL IDENTIFICATION, and is work of this section.
- G. Refer to Division 23 sections for control system wiring; work is not included in this section.

##### 1.3 QUALITY ASSURANCE

- A. NEC Compliance: Comply with applicable requirements of NEC as to type products used and installation of electrical power connections (terminals and splices), for junction boxes, motor starters, and disconnect switches. NEC Article 110-14, "ELECTRICAL CONNECTIONS" applies to above.
- B. IEEE Compliance: Comply with Std 241, "IEEE Recommended Practice for Electric Power Systems in Commercial Buildings" pertaining to connections and terminations.
- C. ANSI/NEMA Compliance: Comply with applicable requirements of ANSI/NEMA and ANSI/EIA standards pertaining to products and installation of electrical connections for equipment.
  - 1. ANSI/EIA RS-364-21A: "Insulation Resistance Test"



- D. UL Compliance: Comply with UL Std 486A, "Wire Connectors and Soldering Lugs for Use With Copper Conductors" including, but not limited to, tightening of electrical connectors to torque values indicated. Provide electrical connection products and materials which are UL-listed and labeled.
  - 1. STD. NO. 486A; Wire Connectors and Soldering Lugs for Use with Copper Conductors.
  - 2. STD. NO. 486C; Splicing Wire Connectors.
  - 3. STD. NO. 486D; Insulated Wire Connectors for Use With Underground Conductors.
- E. ETL Compliance: Provide electrical connection products and materials which are ETL-listed and labeled.
- F. ASTM Compliance: Comply with Standard B539 "Standard Methods for Measuring Contact Resistance of Electrical Connections (Static Contacts)."
- G. Federal Specifications:
  - 1. J-C-30 Electrical Cable and Wire (Power, Fixed Installation).
  - 2. J-C-145 Electrical Power Cable and Electrical Wire (Weather Resistant).
  - 3. W-C-596 1 through 212-Series. (Connectors).
  - 4. W-S-610 Splice Conductor
  - 5. HH-I-553 Electrical Insulation Tape (Rubber, Natural, and Synthetic).
  - 6. HH-I-595 Electrical Plastic Insulation Tape, Pressure Sensitive Adhesive.

#### 1.4 SUBMITTALS:

- A. Product Data: Submit manufacturer's data on electrical connections for equipment products and materials.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver electrical connection products wrapped in proper factory-fabricated type containers.
- B. Store electrical connection products in original cartons and protect from weather, construction traffic and debris.
- C. Handle electrical connection products carefully to prevent breakage, denting, and scoring finish.

## PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS:

- A. Manufacturers: Subject to compliance with requirements, provide products of one of the following (for each type of product):
  - 1. AMP Incorporated.
  - 2. Appleton Electric Company.
  - 3. Arrow-Hart Div, Crouse-Hinds Company.
  - 4. Bishop Div, General Signal Corporation.
  - 5. Burndy Corporation.
  - 6. General Electric Company.
  - 7. Gould, Inc.
  - 8. Harvey Hubbell Inc.
  - 9. Ideal Industries, Inc.
  - 10. Reliable Electric Company.

11. Square D Company
12. Thomas and Betts Corporation.

## 2.2 MATERIALS AND COMPONENTS

- A. General: For each electrical connection indicated, provide complete assembly of materials, including but not necessarily limited to, pressure connectors, terminals (lugs), electrical insulating tape, heat-shrinkable insulating tubing, cable ties, solderless wire-nuts, and other items and accessories as needed to complete splices and terminations of types indicated.
- B. Metal Conduit, Tubing and Fittings:
  1. Provide metal conduit, tubing and fittings of types, grades, sizes and weights (wall thicknesses) indicated for each type service. Where types and grades are not indicated, provide proper selection as determined by Installer to fulfill wiring requirements and comply with NEC requirements for raceways. Provide products complying with Division 26 BASIC ELECTRICAL MATERIALS and RACEWAYS section, and in accordance with the following listing of metal conduit, tubing and fittings:
    - a. Rigid steel conduit.
    - b. Rigid metal conduit fittings.
    - c. Electrical metallic tubing.
    - d. EMT fittings.
    - e. Flexible metal conduit.
    - f. Flexible metal conduit fittings.
    - g. Liquid-tight flexible metal conduit.
    - h. Liquid-tight flexible metal conduit fittings.
- C. Wires, Cables, and Connectors:
  1. Provide wires, cables, and connectors complying with Division 26 basic electrical materials and methods section "WIRES AND CABLES".
  2. Wires/Cables: Unless otherwise indicated, provided wires/cables (conductors) for electrical connections which match, including sizes and ratings, of wires/cables which are supplying electrical power. Provide copper conductors with conductivity of not less than 98% at 20°C (68° F).
  3. Connectors and Terminals: Provide electrical connectors and terminals which mate and match, including sizes and ratings, with equipment terminals which are recommended by equipment manufacturer for intended applications.
  4. Electrical Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing and boots, wirenuts and cable ties as recommended for use by accessories manufacturers for type services indicated.

## PART 3 - EXECUTION

### 3.1 INSTALLATION OF ELECTRICAL CONNECTIONS:

- A. Install electrical connections as indicated; in accordance with equipment manufacturer's written instructions and with recognized industry practices, and complying with applicable requirements of UL, NEC and NECA's "Standard of Installation" to ensure that products fulfill requirements.
- B. Coordinate with other work, including wires/cables, raceway and equipment installation, as necessary to properly interface installation of electrical connections for equipment with other work.

- C. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams. Mate and match conductors of electrical connections for proper interface between electrical power supplies and installed equipment.
- D. Maintain existing electrical services to occupied areas and operational facilities, unless otherwise indicated, or when authorized otherwise in writing by Engineer. Provide temporary service during interruptions to existing facilities. When necessary, schedule momentary outages for replacing existing wiring systems with new wiring systems. When that "cutting-over" has been successfully accomplished, remove, relocate, or abandon existing wiring as indicated.
- E. Cover splices with electrical insulating material equivalent, or of greater insulation resistivity rating, than electrical insulation rating of those conductors being spliced.
- F. Prepare wires by cutting and stripping covering jacket, and insulation properly to ensure uniform and neat appearance where cables and wires are terminated. Exercise care to avoid cutting through tapes which will remain on conductors. Also avoid "ringing" copper conductors while skinning wire.
- G. Trim wires as short as practicable and arrange routing to facilitate inspection, testing and maintenance.
- H. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturers published torque tightening values for equipment connectors. Accomplish tightening by utilizing proper torquing tools, including torque screwdriver, beam-type torque wrench, and ratchet wrench with adjustable torque settings. Where manufacturer's torquing requirements are not available, tighten connectors and terminals to comply with torquing values contained in UL 486A.
- I. Provide flexible conduit for motor connections, and other electrical equipment connections, where subject to movement and vibration.
- J. Provide liquid-tight flexible conduit for connection of motors and other electrical equipment where subject to movement and vibration, and also where connections are subject to one or more of the following conditions:
  - 1. Exterior location.
  - 2. Moist or humid atmosphere where condensate can be expected to accumulate.
  - 3. Corrosive atmosphere.
  - 4. Water spray.
  - 5. Dripping oil, grease, or water.
- K. Fasten identification markers to each electrical power supply wire/cable conductor which indicates their voltage, phase and feeder number in accordance with Division 26 section ELECTRICAL IDENTIFICATION. Affix markers on each terminal conductor, as close as possible to the point of connection.

### 3.2 FIELD QUALITY CONTROL

- A. Upon completion of installation of electrical connections, and after circuitry has been energized with rated power source, test connections to demonstrate capability and compliance with requirements. Ensure that direction of rotation of each motor fulfills requirement. Correct malfunctioning units at site, then retest to demonstrate compliance.

**END OF SECTION**

## SECTION 260553

### ELECTRICAL IDENTIFICATION

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

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

##### 1.2 SUMMARY

- A. Extent of electrical identification work is as outlined by this specification.
- B. Types of electrical identification work specified in this section include the following:
  - 1. Buried cable warnings.
  - 2. Electrical power, control and communication conductors.
  - 3. Operational instructions and warnings.
  - 4. Danger signs.
  - 5. Equipment/system identification signs.
- C. Refer to Division 01 General Requirements section IDENTIFICATION SYSTEMS, for equipment and system nameplates, and performance data; not work of this section.

##### 1.3 QUALITY ASSURANCE

- A. NEC Compliance: Comply with NEC as applicable to installation of identifying labels and markers for wiring and equipment.
- B. UL Compliance: Comply with applicable requirements of UL Std 969, "Marking and Labeling Systems", pertaining to electrical identification systems.
- C. ANSI Compliance: Comply with applicable requirements of ANSI Std A13.1, "Scheme for the Identification of Piping Systems".
- D. NEMA Compliance: Comply with applicable requirements of NEMA Std No's WC-1 and WC-2 pertaining to identification of power and control conductors.

##### 1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's data on electrical identification materials and products.
- B. Samples: Submit samples of each color, lettering style and other graphic representation required for each identification material or system.

## PART 2 - PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide electrical identification products of one of the following (for each type marker):
1. Almetek
  2. Brady, W.H. Company
  3. Calpico Inc.
  4. Cole-Flex Corporation
  5. Direct Safety Company
  6. George-Ingraham Corporation
  7. Griffolyn Company
  8. Ideal Industries, Inc.
  9. LEM Products, Inc.
  10. Markal Company
  11. National Band and Tag Company
  12. Panduit Corporation
  13. Seton Name Plate Company
  14. Tesa Corporation

### 2.2 ELECTRICAL IDENTIFICATION MATERIALS

- A. Except as otherwise indicated, provide manufacturer's standard products of categories and types required for each application. Where more than single type is specified for an application, selection is Installer's option, but provide single selection for each application.
- B. Color-Coded Plastic Tape:
1. Provide manufacturer's standard self-adhesive vinyl tape not less than 3 mils thick by 1-1/2" wide.
    - a. Colors: Unless otherwise indicated or required by governing regulations, provide orange tape.
- C. Underground-Type Plastic Line Marker:
1. Manufacturer's standard permanent, bright-colored, continuous-printed plastic tape, intended for direct-burial service; not less than 6" wide x 4 mils thick. Provide tape with printing which most accurately indicates type of service of buried cable.
- D. Cable/Conductor Identification Bands:
1. Provide manufacturer's standard vinyl-cloth self-adhesive cable/conductor markers of wrap-around type, either pre-numbered plastic coated type, or write-on type with clear plastic self-adhesive cover flap; numbered to show circuit identification.
- E. Plasticized Tags:
1. Manufacturer's standard pre-printed or partially pre-printed accident-prevention and operational tags, of plasticized card stock with matt finish suitable for writing, approximately 3-1/4" x 5-5/8", with brass grommets and wire fasteners, and with appropriate pre-printed wording including large-size primary wording, e.g., DANGER, CAUTION, DO NOT OPERATE.
- F. Self-Adhesive Plastic Signs:
1. Provide manufacturer's standard, self-adhesive or pressure-sensitive, pre-printed, flexible vinyl signs for operational instructions or warnings; of sizes suitable for application areas and adequate

- for visibility, with proper wording for each application, e.g., 208V, EXHAUST FAN, RECTIFIER.
2. Colors: Unless otherwise indicated, or required by governing regulations, provide white signs with black lettering.
- G. Baked Enamel Danger Signs:
1. General: Provide manufacturer's standard "DANGER" signs of baked enamel finish on 20-gage steel; of standard red, black and white graphics; 14" x 10" size except where 10" x 7" is the largest size which can be applied where needed, and except where larger size is needed for adequate vision; with recognized standard explanation wording, e.g., HIGH VOLTAGE, KEEP AWAY, BURIED CABLE, DO NOT TOUCH SWITCH.
- H. Engraved Plastic-Laminate Signs:
1. Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in sizes and thicknesses indicated, engraved with engraver's standard letter style of sizes and wording indicated, black face and white core plies (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
  2. Thickness: 1/8", except as otherwise indicated.
  3. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate substrate.

## 2.3 LETTERING AND GRAPHICS

- A. General: Coordinate names, abbreviations and other designations used in electrical identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturer or as required for proper identification and operation/maintenance of electrical systems and equipment. Comply with ANSI A13.1 pertaining to minimum sizes for letters and numbers.

## PART 3 - EXECUTION

### 3.1 APPLICATION AND INSTALLATION

- A. General Installation Requirements:
1. Install electrical identification products as indicated, in accordance with manufacturer's written instructions, and requirements of NEC and OSHA.
  2. Coordination: Where identification is to be applied to surfaces which require finish, install identification after completion of painting.
  3. Regulations: Comply with governing regulations and requests of governing authorities for identification of electrical work.
- B. Box Identification:
1. After completion, using an indelible wide tip marker, indicate on the cover of each junction and pull box the designation of the circuits contained therein, i.e., A-1, 3, 5. Use a black marker for normal power circuits.
- C. Underground Cable Identification:
1. During back-filling/top-soiling of each exterior underground electrical cable, install continuous underground-type plastic line marker, located directly over buried line at 6" to 8" below finished

- grade. Where multiple small lines are buried in a common trench and do not exceed an overall width of 16", install a single line marker.
2. Install line marker for every buried cable, regardless of whether direct-buried or protected in conduit.
- D. Cable/Conductor Identification:
1. Apply cable/conductor identification, including voltage, phase and feeder number, on each cable/conductor in each box/enclosure/cabinet where wires of more than one circuit or communication/signal system are present, except where another form of identification (such as color-coded conductors) is provided. Match identification with marking system used in panelboards, shop drawings, contract documents, and similar previously established identification for project's electrical work. Refer to WIRES AND CABLES section of these specifications for color coding requirements.
- E. Operational Identification and Warnings:
1. Wherever required by OSHA or directed by the Owner, to ensure safe and efficient operation and maintenance of electrical systems, and electrically connected mechanical systems and general systems and equipment, including prevention of misuse of electrical facilities equipment by unauthorized personnel, install self-adhesive plastic signs or similar equivalent identification, instruction or warnings on switches, outlets and other controls, devices and covers of electrical enclosures. Where detailed instructions or explanations are needed, provide plasticized tags with clearly written messages adequate for intended purposes.
- F. Danger Signs:
1. In addition to installation of danger signs required by governing regulations and authorities, install appropriate danger signs at locations indicated and at locations subsequently identified by Installer of electrical work or the Owner as constituting similar dangers for persons in or about project.
    - a. High Voltage: Install danger signs wherever it is possible, under any circumstances, for persons to come into contact with electrical power of voltages higher than 110-120 volts.
    - b. Critical Switches/Controls: Install danger signs on switches and similar controls, regardless of whether concealed or locked up, where untimely or inadvertent operation (by anyone) could result in significant danger to persons, or damage to or loss of property.
- G. Equipment/System Identification:
1. Install engraved plastic-laminate sign on each major unit of electrical equipment in building. Except as otherwise indicated, provide single line of text, 1/4" high lettering, white lettering in black field. Provide text matching terminology and numbering of the contract documents and shop drawings. Provide signs for each unit of the following categories of electrical work:
    - a. Electrical cabinets and enclosures.
    - b. Disconnect switches
    - c. Motor control center devices.
    - d. Motor controllers
    - e. Panelboards
  2. Install signs at locations indicated or, where not otherwise indicated, at location for best convenience of viewing without interference with operation and maintenance of equipment. Secure to substrate with fasteners, except use adhesive where fasteners should not or cannot penetrate substrate. Identification of flush mounted cabinets and panelboards shall be on the inside of the device.
  3. Individually mounted circuit breakers, disconnect switches and each feeder breaker in distribution panels and motor control centers and feeder breakers in switchboards and motor controllers shall be identified with an engraved plastic laminate sign. Plastic nameplates shall be multicolored laminated plastic with faceplate and core as scheduled. Lettering shall be engraved minimum 1/4" high letters.

- a. 208/120 volt normal power equipment shall be identified with black faceplate with white core/letters.
- b. 480/277 volt normal equipment shall be identified with white faceplate with black core/letters.
- c. Equipment identification is to indicate the following:
  - 1) Equipment ID abbreviation (EX. HP-3).
  - 2) Voltage, phase, wires and frequency.
  - 3) Emergency or other system.
  - 4) Power source origination. Example:
    - a) HP-3
    - b) 208V, 3 phase, 3 wire
    - c) Normal System
    - d) Circuit HA-1
- d. Submit complete schedule with the shop drawings listing all nameplates and information contained thereon.

**END OF SECTION**



**SECTION 262413.01**  
**SWITCHBOARDS – EXISTING**

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. The work required under this section of the Specifications consists of modifications to existing switchboard as designated on the drawings. All new materials and devices provided shall be an integral part of the switchboard provided under this section of the specifications.

1.3 QUALITY ASSURANCE

- A. The following specifications and standards are incorporated into and become a part of this Specification by reference.
  - 1. National Electrical Manufacturers Association (NEMA) Standards:
    - a. PB-2: Dead Front Distribution Switchboards
    - b. PB-2.1: General Instruction for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards rated 600 volts or less.
  - 2. Underwriters Laboratories, Inc. (UL):
    - a. UL-489: Molded Case Circuit Breakers and Circuit Breaker Enclosures
    - b. UL-891: Deadfront Electrical Switchboards
    - c. UL-977: Fused Power Circuit Devices
  - 3. Institute of Electrical and Electronics Engineers (IEEE):
    - a. STD-241: IEEE Recommended Practices for Electric Power Systems in Commercial Buildings
  - 4. National Fire Protection Association (NFPA):
    - a. NFPA-70: The National Electrical Code

1.4 SUBMITTALS

- A. Refer to the BASIC ELECTRICAL REQUIREMENTS section for submittal requirements.
- B. Product Data: Provide data for branch circuit-devices added.
- C. Closeout Submittals: As follows:
  - 1. Record Drawings: Include in each set:
    - a. Schedule of each overcurrent protection device indicating unit ampere rating and trip and or fuse rating added.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products from the existing manufacturer of the switchboard.

## 2.2 OVERCURRENT DEVICES - GENERAL

- A. Protective devices shall be fixed mounted fusible switch and/or molded case breaker with interrupting rating, frame and trip ratings to match existing minimum available.
- B. Devices shall be manually operated (MO) unless electrically operated (EO) is indicated on the drawings.
- C. Fuses for switches shall be furnished by the contractor under the FUSES section of this specification.

## 2.3 FUSIBLE SWITCHES

- A. Protective devices as shown shall be quick-make quick-break fusible switches. Fusible switches 30 amperes through 600 amperes frames shall be furnished with rejection type fuse clips unless otherwise scheduled. Fusible switches 800 amperes through 1200 amperes shall be furnished with Class L fuse clips. Switches shall incorporate safety cover interlocks to prevent opening the cover with the switch in the "on" position or prevent placing the switch in the "on" position with the cover open. Provide defeater for authorized personnel. Handles shall have provisions for padlocking and shall clearly indicate the "on" or "off" position. Front cover doors shall be padlocked in the closed position.

## 2.4 MOLDED CASE BREAKERS

- A. Protective devices as shown shall be molded case circuit breakers providing complete circuit overcurrent protection by having inverse time and instantaneous tripping characteristics, and where applicable, be current limiting.
  - 1. Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make, quick-break over-center switching mechanism that is mechanically trip free. Automatic tripping of the breaker shall be clearly indicated by handle position. Contacts shall be non-welding silver alloy and arc extinction shall be accomplished by means of arc chutes.
  - 2. Circuit breaker interrupting capacities shall match existing.
- B. Breakers 150 ampere and below shall be thermal-magnetic trip with inverse time current characteristics. Breakers with 250 and 400 ampere frame shall be thermal-magnetic or solid-state trip, as applicable.
- C. Breakers with 600 amperes frame and above shall be solid-state trip complete with built-in current transformers, solid-state trip unit and flux transfer shunt trip. Breakers shall have trip rating plugs with ratings as indicated on the drawings. Rating plugs shall be interlocked so they are NOT interchangeable between frames and interlocked such that a breaker cannot be latched with the rating plug removed.

## 2.5 NAMEPLATES

- A. Engraved nameplates shall be furnished for all feeder circuits. Nameplates shall give item designation and circuit number as well as frame size and appropriate trip rating. Refer to ELECTRICAL IDENTIFICATION section of this specification.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas and conditions under which components are to be installed, and notify General Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

3.2 INSTALLATION

- A. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Stds 486 A and B, and the National Electrical Code.

3.3 FIELD QUALITY CONTROL

- A. Refer to ELECTRICAL EQUIPMENT ACCEPTANCE TESTING section of this specification.
- B. Contractor shall verify in the field that all factory-made connections and terminations are torqued to manufacturer's recommended tolerances.

3.4 ADJUSTING AND CLEANING

- A. Adjust operating mechanisms for free mechanical movement.
- B. Touch-up scratched or marred surfaces to match original finishes.

3.5 GROUNDING

- A. Provide equipment grounding connections. Tighten connections to comply with tightening torques specified in UL Std 486A to assure permanent and effective grounds.

**END OF SECTION**

**SECTION 262416**  
**PANELBOARDS - EXISTING**

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. The work required under this section of the specifications consists of the furnishing, installation and connection of branch circuits and circuit breakers to existing panelboards.

1.3 QUALITY ASSURANCE

- A. Industry Referenced Standards. The following specifications and standards are incorporated into and become a part of this Specification by Reference.
  - 1. Underwriters' Laboratories, Inc. (UL) Publications:
    - a. No. 489: Molded Case Circuit Breakers and Circuit Breaker Enclosure
  - 2. National Electrical Manufacturer's Association (NEMA) Publications:
    - a. No. AB-3: Molded Case Circuit Breakers
  - 3. National Fire Protection Association (NFPA):
    - a. No. 70: National Electrical Code (NEC)
- B. Acceptable Manufacturers: Products of the existing panel board manufacturers, which comply with these specifications, are acceptable.

1.4 SUBMITTALS

- A. Refer to BASIC ELECTRICAL REQUIREMENTS for submittal requirements.
- B. Manufacturers Product Data:
  - 1. Submit material specifications and installation data for products specified under Part 2 - Products to include:
    - a. Circuit breakers
- C. Shop Drawings: Submit shop drawings to indicate information not fully described by the product data to indicate compliance with the contract drawings.
  - 1. Provide a schedule indicating circuit breaker type, trip and size, poles, frame type, and interrupting capacity.
  - 2. Nameplate identification designation schedule.
- D. Record Drawings. Include in each set:
  - 1. A complete set of panelboard manufacturers product data and shop drawings indicating all post bid revisions and field changes.

2. A copy of each panelboard directory incorporating all post bid revisions and field changes.

## **PART 2 - PRODUCTS**

### 2.1 GENERAL MATERIALS REQUIREMENTS

- A. Furnish all materials specified herein.
- B. All circuit breakers shall be UL listed and bear a UL label.

### 2.2 BUSSING AND INTERIORS

- A. Provide neutral and ground busses with sufficient number of lugs to singularly terminate each individual conductor requiring a connection.
- B. The ground bus shall be installed on studs bolted to the panel enclosure or panel frame. The ground bus shall not be attached to the panel interior.

### 2.3 ENCLOSURES

- A. Furnish and install a new typed directory mounted on inside of doors.

### 2.4 CIRCUIT BREAKERS

- A. Interrupting rating of all circuit breakers in panelboards operating on 208Y/120 volt system shall have UL rating of not less than 10,000 RMS symmetrical amps at system voltage. Breakers for use in 480/277 volt system shall have UL rating of not less than 14,000RMS symmetrical amps at system voltage. Provide circuit breakers with higher interrupting capacity when required by existing conditons. Field verify.
- B. Circuit breakers shall be provided with trip rating, poles and minimum interrupting rating as indicated on the drawings or specified herein.
- C. Multi-pole breakers shall be common trip and common reset; tie handle connection between single pole breakers is not acceptable.
- D. Branch circuit breakers shall be quick-make, quick-break, thermal magnetic type bolted to the bus.
- E. Molded case circuit breakers shall have automatic, trip free, non-adjustable, inverse time, and instantaneous magnetic trips for 100 ampere frame or less.
- F. Circuit breakers shall be the product of existing panelboard manufactuerers.

### 2.5 SEPARATELY ENCLOSED MOLDED CASE CIRCUIT BREAKERS

- A. Where separately enclosed molded case circuit breakers are shown on the drawings, provide circuit breakers in accordance with the applicable requirements of those specified above.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Lace and group conductors installed in panels with nylon tie straps. Only one conductor shall be installed under terminal of individual circuit breakers. Form and train conductors in panel enclosure neatly parallel and at right angles to sides of box. Uninsulated conductor shall not extend beyond one-eights inch from terminal lug.
- B. Do not splice conductors in panels. Where required, install junction box adjacent to panel and splice or tap conductors in box. Refer to number of conductors in a conduit limitation defined in the conductors and cables section of the specifications and do not exceed.
- C. Conductors not terminating in panelboard shall not extend through or enter panel enclosure.
- D. Maintain conductor phase color code requirement described in the wires and cables section of the specifications.
- E. Furnish and install in each existing panelboard a new typewritten circuit directory mounted under clear plastic in a directory frame on interior of panel door. Directory shall reflect all field changes or additions and existing not changed.
- F. Install push-in knock-out closure plugs in any new and existing unused knock-out openings.
- G. Identification
  - 1. All circuit breakers shall be identified as to equipment served.
  - 2. Refer to the ELECTRICAL IDENTIFICATION section of these specifications for identification requirements.
  - 3. Submit complete schedule with the shop drawings listing all nameplates and information contained thereon.

#### **3.2 CLEANING AND ADJUSTMENT**

- A. After completion, clean the interior and exterior of dirt, paint and construction debris.
- B. Touch up paint all scratched or marred surfaces with factory furnished touch up paint of the same color as the factory applied paint.
- C. Adjust and align panelboard interior and trim in accordance with manufacturers recommendations, and to eliminate gaps between the two.

#### **3.3 FIELD QUALITY CONTROL**

- A. Refer to the ELECTRICAL EQUIPMENT ACCEPTANCE TESTING section of this specification.
- B. Contractor shall verify in the field that all factory-made connections and terminations are torqued to manufacturer's recommended tolerances.

**END OF SECTION**

## SECTION 262813

### FUSES (600 VOLTS AND BELOW)

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

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

##### 1.2 SUMMARY

- A. This Service and Distribution section specifies low-voltage (600-volts and below) overcurrent protective devices (fuses) for building power distribution systems.
- B. Types of fuses specified in this section include the following:
  - 1. Class L time-delay.
  - 2. Class RK1 time-delay.
  - 3. Class RK5 time-delay.
  - 4. Class K5 time-delay, non-current-limiting.
  - 5. Class H non-current-limiting.
  - 6. Class T current-limiting.

##### 1.3 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of fuses of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Codes and Standards: The following specifications and standards are incorporated into and become a part of this specification by reference.
  - 1. Underwriters Laboratories, Inc. (UL) Publications:
    - a. UL 198 B; Class H Fuses.
    - b. UL 198 C; High-Interrupting-Capacity-Limiting Type Fuses.
    - c. UL 198 D; High-Interrupting-Capacity Class K Fuses.
    - d. UL 198 E; Class R Fuses.
    - e. UL 198 F; Plug Fuses.
    - f. UL 198 G; Fuses for Supplementary Overcurrent Protection.
    - g. UL 198 H; Class T Fuses.
    - h. UL 198 L; D-C Fuses for Industrial Use.
    - i. UL 198 M; Mine-Duty Fuses.
    - j. UL 512; Fuseholders.
    - k. UL Product Directory; Electrical Construction Materials.
  - 2. National Fire Protection Association (NFPA)
    - a. NFPA 70; National Electrical Code
  - 3. American National Standards Institute (ANSI)
    - a. C97.1; Low Voltage Cartridge Fuses 600 Volts or Less

- C. Acceptable Manufacturers: Subject to compliance with requirements, provide fuses of one of the following:
1. Bussmann Div; Cooper Industries.
  2. Commercial Enclosed Fuse Company
  3. General Electric Company
  4. Shawmut Div; Gould Inc.
  5. Littlefuse, Inc.

#### 1.4 SUBMITTALS

- A. Manufacturer's Product Data: Submit manufacturer's technical product data on fuses, including specifications, electrical characteristics installation instructions, furnished specialties and accessories. In addition, include voltages and current ratings, interrupting ratings, current limitation ratings, time-current trip characteristic curves, and mounting requirements.

### **PART 2 - PRODUCTS**

#### 2.1 GENERAL

- A. Except as otherwise indicated, provide fuses of types, sizes, ratings, and average time-current and peak let-through current characteristics indicated, which comply with manufacturer's standard design, materials, and constructed in accordance with published product information, and with industry standards and configurations.
1. Class L Time-Delay Fuses: Provide UL Class L time-delay fuses rated 600-volts, 60 Hz, with 200,000 RMS symmetrical interrupting current rating for protecting transformers, motors, and circuit-breakers.
  2. Class RK1 Time-Delay Fuses: Provide UL Class RKI time-delay fuses rated 600-volts, 60 Hz, with 200,000 RMS symmetrical interrupting current rating for protecting motors and circuit-breakers.
  3. Class RK5 Time-Delay Fuses: Provide UL Class RK5 time-delay fuses rated 600-volts, 60 Hz, with 200,000 RMS symmetrical interrupting current rating for protecting motors.
  4. Class K5 One-Time Fuses: Provide UL Class K5 one-time fuses rated 250-volts, 60 Hz; with 100,000 RMS symmetrical interrupting current rating for protecting non-inductive loads.
  5. Class H Fuses: Provide UL Class H fuses rated 600-volts, 60 Hz, with 10,000 RMS symmetrical interrupting current rating, for protecting general purpose light duty feeders.
  6. Class T Fuses: Provide UL Class T fuses rated 600-volts, 60 Hz, with 200,000 RMS symmetrical interrupting current rating for protection of physically small devices.

### **PART 3 - EXECUTION**

#### 3.1 INSTALLATION

- A. Install fuses as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to ensure that protective devices comply with requirements. Comply with NEC, and NEMA standards for installation of fuses.
- B. Coordinate with other work, including electrical wiring, as necessary, to interface installation of fuses with other work.



- C. Install fuses in fused switches, if any.
- D. For types and ratings required, furnish additional fuses, amounting to one unit for every 5 installed units, but not less than one set of 3 of each kind.
- E. Prior to energization of fusible devices, test devices for continuity of circuitry and for short-circuits. Replace malfunctioning units with new units, and then demonstrate compliance with requirements.

**END OF SECTION**

**SECTION 262816**  
**CIRCUIT AND MOTOR DISCONNECTS**

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This section covers disconnect switches for electrical equipment, 600V and below, and fuses mounted in the disconnect devices.
- B. Furnish and install disconnect switches for any of the following conditions:
  - 1. Where indicated on the drawings.
  - 2. For all motors located out-of-sight of its motor controller and/or branch circuit breaker.
  - 3. Where required by the National Electrical Code.
  - 4. For all water heaters.
  - 5. For all duct heaters, wall heaters, unit heaters etc.

1.3 QUALITY ASSURANCE

- A. Referenced Industry Standard: The following specifications and standards are incorporated into and become a part of this Specification by reference.
  - 1. Underwriters' Laboratories, Inc. (UL) Publications:
    - a. No. 98: Enclosed Switches
    - b. No. 198.2: High-Interrupting Capacity Fuses, Current Limiting Type
    - c. No. 198.4: Class R fuses
  - 2. National Fire Protection Association (NFPA) Publications:
    - a. No. 70: National Electrical Code (NEC)
  - 3. National Electrical Manufacturers Association (NEMA) Publications:
    - a. No. KS 1: Enclosed Switches
- B. Acceptable Manufacturers: Products of the following manufacturers, which comply with these specifications, are acceptable:
  - 1. General Electric
  - 2. Cutler-Hammer
  - 3. Square D
  - 4. Siemens
- C. Coordination: Coordinate installations with architectural and structural features, equipment installed under other sections of the specifications and electrical equipment to insure disconnect switch access and insure that clearance minimums are provided.

## **PART 2 - PRODUCTS**

### 2.1 GENERAL MATERIAL REQUIREMENTS

- A. Furnish all materials specified herein.
- B. All disconnects and fuses shall be UL listed and bear a UL label.
- C. Fuses shall be heavy duty, type HD horsepower rated as required for motor load served.
- D. Switches shall be 600 volt rated, except for use in system below 240 volt, when they may be 250 volt rated. Switches shall be heavy duty rated. General duty switches are not acceptable.
- E. Furnish a solid neutral for each switch being installed in a circuit which includes a neutral conductor.
- F. Furnish an equipment grounding conductor lug bonded to the switch enclosure.
- G. Disconnect switches shall be non-fusible safety switch, unless fused type is specified or indicated on the drawings, with the number of poles required to disconnect all ungrounded conductors serving equipment.
- H. Enclosure shall be NEMA Type One in all interior dry locations and shall be NEMA Type 3R in all damp, wet, or exterior locations, unless other type is indicated on the drawings or specified herein.

### 2.2 PRODUCT/MATERIAL DESCRIPTION

- A. Switching mechanism shall be quick-make, quick-break type.
- B. Where non-fused disconnect switches are indicated on the drawings or specified for use as disconnects, they shall be the non-fused type.
- C. Switches shall have the following features:
  - 1. Provide line terminal shields in all switches.
  - 2. Each switch shall have provisions for padlocking in the "OFF" position.
  - 3. Each switch shall have door interlocks to prevent door from being opened when switch is in closed position. Provide inconspicuous means to defeat interlock mechanism.
  - 4. Provide permanent nameplate indicating switch rating in voltage, amperes and horsepower.
  - 5. Arch chute for each pole.
- D. Disconnect switches for three phase motors rated two horsepower and above shall be three pole nonfusible type rated as indicated on the drawings. Disconnect switches for three phase motors rated below two horsepower shall be three pole manual motor starter switches without overload protection. Disconnect for single phase motors shall be single or two pole horsepower rated switches without overload protection.
- E. Fusible switches through 600 amp shall be provided with rejection clips to accept RK1 or RK5 class fuses only. Fusible switches larger than 600 amp shall be suitable for class L fuses. Furnish and install a complete set of fuses in each disconnect sized as indicated on the drawings. Fuses serving predominantly motor or transformer loads shall be dual-element, time delay type, otherwise non-time delay fast acting type is required. Fuses shall be current limiting with 200,000 AIC.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Locate disconnect switches to maintain line of sight and to provide working clearance and full accessibility as required by the National Electrical Code.
- B. Unless indicated otherwise on the drawings, locate disconnects adjacent to equipment served.
- C. Lace and group conductors installed in disconnect with nylon tie straps. Only one conductor shall be installed under terminals. Form and train conductors in enclosure neatly parallel and at right angles to sides of box. Uninsulated conductor shall not extend beyond 1/8" from terminal lug.
- D. Mounting and Support
  - 1. Enclosure shall be secured to structure by a minimum of four (4) fastening devices. A 1.5" minimum diameter round washer shall be used between head of screw or bolt and enclosure.
  - 2. Mounting
    - a. Enclosures shall be mounted where indicated on the drawings or specified herein. Support from the structure with fastening device specified.
    - b. Attach enclosure directly to masonry, concrete, or wood surfaces.
    - c. Mount enclosure on metal channel (strut), which is connected to structure with fastening device specified, for installations on steel structure, sheet metal equipment enclosure, or sheet rock walls.
    - d. Where enclosure is not indicated on a wall or structure, construct a metal channel (strut) free standing frame secured to floor, pad, or other appropriate building structure.
    - e. Mount switch with handle between 36" and 60" above floor or grade, unless otherwise indicated on the drawings.
- E. Do not splice conductors in enclosure. Where required, install junction box or wireway adjacent to disconnect and splice or tap conductors in box. Refer to number of conductors in a conduit limitation defined in the WIRES AND CABLES section of the specifications and do not exceed.
- F. Conductors not terminating in disconnect shall not extend through or enter disconnect enclosure.
- G. Install push-in knock-out closure plugs in any unused knock-out openings.
- H. Identification
  - 1. Disconnect switches shall be identified.
  - 2. Refer to the ELECTRICAL IDENTIFICATION section of the specifications for identification requirements.

#### **3.2 CLEANING AND ADJUSTMENT**

- A. After completion, clean the interior and exterior of dirt, paint and construction debris.
- B. Touch up paint all scratched or marred surfaces with factory furnished touch up paint of the same color as the factory applied paint.

**END OF SECTION**

**SECTION 262913**  
**MOTOR CONTROLLERS**

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. The work required under this section of the specifications consists of the installation of motor controllers for all integral or fractional horsepower motors not controlled by magnetic starters provided as an integral component of a specific piece of equipment. Provide all material under this section of the specifications.

1.3 QUALITY ASSURANCE

- A. ANSI/NEMA Standards Publication ICS 1 - General Standards for Industrial Control and Systems.
- B. ANSI/NEMA Standards Publication ICS 2 - Standards for Industrial Control Devices, Controllers and Assemblies.
- C. UL 508 Standards for Industrial Control Devices, Controllers and Assemblies - Industrial Control Equipment.

1.4 ACCEPTABLE MANUFACTURERS

- A. The products of General Electric, Square D, Siemens or Eaton conforming to these specifications are acceptable.

**PART 2 - PRODUCTS**

2.1 MAGNETIC STARTERS

- A. Magnetic starters shall be across-the-line circuit breaker combination type non-fusible disconnect combination type when remotely located from circuit breaker in panel or switchboard; otherwise magnetic starters shall be non-combination type. Where circuit breaker type are used, UL interrupting rating of circuit breaker shall not be less than the rating of the overcurrent device immediately upstream.
- B. Magnetic starters shall be NEMA size one unless other size is shown on the drawings or unless larger size is required by actual motor controlled. Enclosures shall be NEMA one unless otherwise shown on the drawings or specified in this section of the specifications. Starters shall be for operation at the voltage and phase arrangement indicated.

- C. Each magnetic starter shall have overload relays in each phase leg. Control voltage shall be 120 volts provided from a control power transformer built into starter. Provide fuse for control coil. Provide Hand-Off-Automatic switch, in cover of starter unless otherwise indicated on the drawings. Interlocks shall be provided to provide control sequence indicated on the drawings. Interlock contact shall be provided circuit breaker of combination magnetic starters to disconnect control circuit when circuit breaker is in "off" position.
- D. Operating handle of disconnect device in combination starters shall be interlocked with door to prevent opening door when starter is energized; however an inconspicuous means shall be provided to defeat this interlock. Operating handle must have provisions for not less than two padlocks.
- E. Overload heater elements shall be melting alloy or bi-metallic type and shall be selected from actual nameplate rating of motor furnished. Heater schedule shall be placed on inside of door of each starter.

## 2.2 MANUAL MOTOR STARTERS

- A. Manual motor starter shall be manually operated, trip free switching device with motor running protection overload elements in each ungrounded conductor of the motor circuit. Overload protection shall be melting alloy or bi-metallic manual reset type.
- B. Manual starters installed in finished spaces shall be provided in flush mounted enclosures. Those exposed to the weather shall be provided with NEMA 3R enclosure. All other enclosures shall be NEMA one type.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Secure wall mounted magnetic starters to mounting surface with wood screws on wood, toggle bolts on hollow masonry, and lead shields on solid masonry.
- B. Manual motor starters shall be provided for all fractional horsepower, single phase motors rated 1/6 HP or larger.
- C. Overload element shall be selected in accordance with full load nameplate rating of motor actually served. A heater schedule shall be provided on inside cover all motor starters.

### 3.2 IDENTIFICATION

- A. Refer to the ELECTRICAL IDENTIFICATION section of these specifications for identification requirements.

### 3.3 FIELD QUALITY CONTROL

- A. Refer to the ELECTRICAL EQUIPMENT ACCEPTANCE TESTING section of this specification.

**END OF SECTION**

## SECTION 266500

### ELECTRICAL EQUIPMENT ACCEPTANCE TESTING

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

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

##### 1.2 SUMMARY

- A. The work required under this section of the specifications consist of the start-up testing and inspection of the electrical equipment designated within. All labor and testing equipment which is required shall be provided under this section of the specifications.

##### 1.3 GENERAL

- A. The Contractor shall perform the tests as outlined below to insure system acceptance.
- B. When the tests and inspections have been completed, a label shall be attached to all devices tested. The label shall provide the name of the testing company, the date the tests were completed, and the initials of the individual who performed the tests.
- C. The tests shall insure that the equipment is operational and functioning within industry standards and manufacturer's tolerances. Forward all test reports to the Engineer at least two weeks prior to the project final inspection for review. Reports shall be bound as required by Division 01 of this specification.

##### 1.4 QUALITY ASSURANCE

- A. The testing and inspection shall comply with all applicable sections of the following codes and standards:
  - a. American National Standards Institute - ANSI
  - b. American Society for Testing and Materials - ASTM
  - c. Association of Edison Illuminating Companies - AEIC
  - d. Institute of Electrical and Electronics Engineers - IEEE
  - e. Insulated Power Cable Engineers Association - IPCEA
  - f. International Electrical Testing Association - NETA Acceptance Testing Specifications
  - g. National Electrical Code - NEC
  - h. National Electrical Manufacturers Association - NEMA
  - i. National Fire Protection Association - NFPA
  - j. State and Local Codes and Ordinances
- B. The inspection and testing shall comply with the project plans and specifications as well as with the manufacturer's drawings, instruction manuals, and other applicable data for the apparatus tested.

1.5 DIVISION OF RESPONSIBILITY

- A. The contractor shall perform routine insulation-resistance, continuity, and rotation tests for all distribution and utilization equipment.
- B. The contractor shall notify the Engineer prior to commencement of any testing.
- C. Any system, material or workmanship which is found defective on the basis of acceptance tests shall be reported to the Engineer.
- D. The contractor shall maintain a written record of all tests and, upon completion of project, shall assemble and certify a final test report.

1.6 SAFETY AND PRECAUTIONS

- A. Safety practices shall comply with applicable state and local safety orders as well as with the Occupational Safety and Health Act of 1970 (OSHA). Compliance with the National Fire Protection Association standard NFPA 70E and the Accident Prevention Manual for Industrial Operations of the National Safety Council shall be observed.
- B. Tests shall only be performed on apparatus which is de-energized.

1.7 REPORTS

- A. The test report shall include the following sections:
  - 1. Scope of testing
  - 2. Equipment tested
  - 3. Description of test
  - 4. Test results
  - 5. Conclusions and recommendations
  - 6. Appendix, including test forms
- B. Each piece of equipment shall be recorded on a data sheet listing the condition of the equipment as found and as left. Included shall be recommendations for any necessary repair and/or replacement parts. The data sheets shall indicate the name of the individual who tested the equipment and the date of the test completion.
- C. Record copies of the completed test report shall be submitted no more than 30 days after completion of the testing and inspection.

1.8 TEST EQUIPMENT

- A. All test equipment shall be in good mechanical and electrical condition. All field instruments shall have been calibrated within six months of the testing date, and dated calibration labels shall be visible on the testing equipment. Submit calibration certification in the final report.



## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- A. All materials are specified under other sections of this specification. All testing equipment required shall be provided under this section of the specifications.

## **PART 3 - EXECUTION**

### **3.1 EQUIPMENT TO BE TESTED**

- A. The following equipment shall be tested in accordance with the scopes of work which follow.
  1. Molded Case Circuit Breakers
  2. Motor Controllers
  3. Grounding System
  4. Cables, Low Voltage, 600 Volts Maximum

### **3.2 MOLDED CASE CIRCUIT BREAKERS**

- A. Visual and Mechanical Inspection
  1. Inspect cover and case, and check for broken or loose terminals.
  2. Operate breaker to check operation.

### **3.3 MOTOR CONTROLLERS**

- A. Visual and Mechanical Inspection
  1. Verify that the installing contractor has cleaned interiors and starter cells of accumulated dust, dirt, oil films, and other foreign material.
  2. Inspect bolted connections. The electrical contractor shall torque wrench tighten or remake any questionable connections.
  3. Check mechanical operation of starters for freedom from binding.
  4. Check motor circuit protector setting and overload relay heater size against contractor furnished list of motor nameplate full load current values.
- B. Electrical Tests
  1. Verify operation of each starter.
  2. Record heater catalog numbers for each starter and submit list for maintenance. List shall contain circuit number, description of equipment and motor full load amps.

### **3.4 GROUNDING SYSTEM**

- A. Visual and Mechanical Inspection
  1. Inspect wiring system for proper grounding. Green grounding conductor shall be connected to equipment, junction boxes, etc.

3.5 CABLES - LOW-VOLTAGE - 600V MAXIMUM

A. Visual and Mechanical Inspection

1. Inspect conductors for physical damage and proper connection.
2. Check cable mechanical connections to manufacturer's recommended values using a calibrated torque wrench.
3. Check cable color coding with applicable engineer's specifications and National Electrical Code standards.

B. Electrical Tests

1. Perform continuity test to insure proper cable connection.

**END OF SECTION**

**SECTION 283111**  
**FIRE ALARM SYSTEM**

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. The work required under this section of the specifications consists of the modifications necessary to the existing Fire Alarm System. Furnish, install and connect necessary air duct smoke detectors and control wiring as required for HVAC equipment replacements.
- B. Remove existing, reinstall, reconnect and test as required.
- C. Install new air duct detectors, connect to existing system and test as required.
- D. Refer to mechanical drawings for duct detectors impacted by mechanical scope of work.

1.3 QUALITY ASSURANCE

- A. Industry Referenced Standards: The following specifications and standards are incorporated into and become a part of the specification by reference.
  - 1. Underwriter's Laboratories, Inc. (UL) Publications:
    - a. No. 218: Smoke Detectors for Fire Protective Signaling Systems
  - 2. National Electrical Manufacturer's Association (NEMA) Publications:
    - a. No. SB9: Smoke Detection
  - 3. National Fire Protection Association (NFPA):
    - a. No. 70: National Electrical Code (NEC)
    - b. No. 72: National Fire Alarm and Signaling Code
- B. Acceptable Manufacturers: Products of the existing manufacturer, Notifier, which comply with these specifications are only acceptable.
- C. Coordination:
  - 1. Review shop drawings submitted under this and other sections, as well as other divisions, to insure coordination between work required among different trades. Coordinate the installation sequence with other contractors to avoid conflicts and to provide the fastest overall installation schedule. Coordinate installation with existing features, equipment installed under other sections of the specifications, and electrical equipment to insure access and so that clearance minimums are provided.
- D. Installer's Qualifications: Firm with installation experience on projects with fire alarm systems work similar to that required for this project.
  - 1. Firm with manufacturer's factory trained personnel.

2. Firm with factory authorized service organization and spare parts stock.

#### 1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, including specifications and installation instructions. Include standard or typical riser and wiring diagrams, and operation and maintenance instructions for inclusion in maintenance manuals.
- B. Wiring Diagrams: Submit dimensioned floor plan drawings indicating all device locations with corresponding address next to device. Plans shall include all conduit and wiring requirements indicating system interconnection, ampere and size of conductors and appropriate conduit size, and ancillary devices.

#### 1.5 DELIVERY, STORAGE, AND HANDLING:

- A. Handle fire alarm equipment carefully to prevent damage, breaking, and scoring. Do not install damaged equipment or components; replace with new.
- B. Store fire alarm equipment in clean, dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

### **PART 2 - PRODUCTS**

#### 2.1 FIRE ALARM AND DETECTION SYSTEMS:

- A. General: Provide complete fire alarm system products of types, sizes, and capacities indicated, which comply with manufacturer's standard design, materials, components; construct in accordance with published product information, and as required for complete installation. Provide fire alarm and detection systems for applications indicated.
- B. System Wiring and Supervision:
  1. Provide Class 1 initiating and alarm circuits with electrical supervision for shorts and open conditions.
  2. Install diodes or resistors in fire alarm control cabinet.
  3. Upgrade battery back-up as secondary power supply as required to take over supply to system.
- C. Provide the following features in addition to the basic system features specified elsewhere in this specification
  1. Control of auxiliary services:
    - a. Fan shut down relays.
- D. System Materials: Provide basic wiring materials which comply with Division 26 Basic Electrical Materials and Methods sections, RACEWAYS and BOXES, types to be selected by Installer.
  1. Provide conductors which are listed and approved for fire alarm usage.

#### 2.2 SYSTEM OPERATION

- A. Actuation of any alarm initiation device shall automatically initiate the following:

1. Provide signals to the mechanical controls to shut down or reroute air handling systems to prevent the recirculation of smoke. All signals shall be initiated by the FACP.

### 2.3 CONTROL PANELS

- A. Provide modifications to existing fire alarm control panel and remote graphic annunciator enclosures for housing devices and circuits necessary to perform required functions.
  1. Design devices to be modular, plug-in.
  2. Equip control panel for any additional address requirements.

### 2.4 AUTOMATIC FIRE DETECTORS: Provide manufacturer's standard construction automatic fire detectors, of the following types and temperature characteristics:

- A. Automatic Smoke (Combustion Products) Detectors: Provide manufacturer's standard construction automatic smoke detectors of the following types:
  1. Photoelectric, spot types, restorable, with pulsed infrared LED light source for operation on voltage indicated. Design detector for mounting on interchangeable type base, capable of operating on either 2-wire or 4-wire loop. Provide 135°F (57°C) fixed temperature heat detector in base and flashing LED indicator for normal operation which changes to steady on alarm condition.
  2. Provide photoelectric duct mount smoke detectors with sampling tubes as shown on mechanical plans. Duct mount smoke detectors shall be installed by the mechanical contractor and electrically connected to the fire alarm system by the electrical contractor. Each detector shall have its own SPDT 3 amp rated relay.
- B. Junction Boxes: Provide fire alarm junction boxes painted red enamel. Provide each box with suitable number of terminals and of proper size to hold wiring.

## PART 3 - EXECUTION

### 3.1 EXAMINATION:

- A. Examine areas and conditions under which fire alarm systems are to be installed.

### 3.2 INSTALLATION OF BASIC IDENTIFICATION:

- A. Install electrical identification in accordance with Division-26 Basic Electrical Materials and Methods section "Electrical Identification."

### 3.3 INSTALLATION OF BASIC WIRING SYSTEM MATERIALS:

- A. Install wiring, raceways, and electrical boxes and fittings in accordance with Division-26 Basic Electrical Materials and Methods sections, "Raceways", "Wires and Cables", and "Boxes" for wiring of non-power limited circuits.
- B. Install wiring of power-limited circuits in raceways.

- C. Install wires and cables without splices. Make connections at terminal strips in cabinets or at equipment terminals. Make soldered splices in electronic circuits in control cabinets.

3.4 INSTALLATION OF FIRE ALARM SYSTEMS:

- A. Install fire alarm system as indicated, in accordance with equipment manufacturer's written instructions and complying with applicable portions of NEC and NECA's "Standard of Installation."
- B. Wiring: Wiring of fire alarm system is work of this section, but is not specifically detailed on drawings.
  - 1. Complete wiring in accordance with manufacturer's requirements. Color code wiring and install per manufacturer's point-to-point wiring diagram. Determine exact number of wires for each type of device installed. Connect each device with sufficient wiring to complete its intended operation.

3.5 FIELD QUALITY CONTROL:

- A. Connection and Supervision: Make connections to panel under manufacturer's supervision. Run wiring to main terminal cabinet located adjacent to main fire alarm panel. Complete connections from this cabinet to panel utilizing Manufacturer's technicians.
- B. Work consists of additions or extensions , removal and reconnections to existing system. Prior to starting work, establish that system is in proper working order. If condition exists which prevents normal operation of specified additions and extensions, bring this fact to Engineers/Owners attention prior to doing work affecting existing system. Where work is done without such notification, it is assumed that connections have been made to a working system, and performance requirements and guarantee will apply to entire system.
- C. System Test and Approval: Submit shop drawings for function and operation only.
  - 1. Prior to final acceptance of system, manufacturer of system shall, in presence of Contractor, and Owner's Representative and Engineer's representative, test each sensing or detection device affected by work.
  - 2. Submit copy of test results in duplicate after signed by Owner's Representative to Engineer and, Owner.

**END OF SECTION**